Farmers' perspectives on post-border biosecurity: on-farm biosecurity knowledge and practices

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Abstract

Biosecurity threats, such as pest, weed and disease outbreaks, are perceived to be increasing. Experience from abroad managing outbreaks has shown that encouragement from governments may minimize financial burdens. This thesis aimed to explore and understand farmers’ biosecurity knowledge and practices. This is in response to Australian governments adoption of a shared responsibility approach to biosecurity, which gives farmers greater levels of responsibility for engaging in post-border biosecurity management. Research conducted by veterinary epidemiologists suggests that farmers across livestock industries have poor and inconsistent implementation of on-farm biosecurity practices. However, there is limited scholarly literature that explores on-farm biosecurity from the farmers’ perspective. To address this issue, this thesis investigates farmers’ biosecurity knowledge and practices. This research is positioned in the sociological sub-discipline of rural sociology, and contributes to the growing body of social science biosecurity literature. It uses the theoretical framework of the notion of good farming, and links to farmers’ tacit knowledge in managing on-farm biosecurity. This study contributes to rural social science theoretical understanding, as good farming has not previously been applied to biosecurity studies. The study focuses on sheep farmers in the Riverina region of New South Wales. Semi-structured interviews were
conducted during 2013 and 2014 to capture farmers’ perspectives of how they interpret and practice biosecurity.

This study found that farmers actively participate in biosecurity practices, and they use their tacit knowledge and lifetime of farming experience to manage endemic risks that also meet their existing priorities and goals. A key finding was that the majority of these farmers’ biosecurity practices align incidentally, rather than in a planned or intentional way, with government and industry recommendations. The term proposed to capture this process is ‘incidental biosecurity’. This finding builds on current literature by showing farmers’ biosecurity knowledge and practices occur incidentally, and not as a direct result of government and industry education programs. This research highlights the significance of understanding and acknowledging the role of farmers’ knowledge and practices in securing Australia’s food supply through post-border biosecurity management.
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I hereby declare that this submission is my own work and to the best of my knowledge and belief, understand that it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Charles Sturt University or any other educational institution, except where due acknowledgement is made in the thesis. Any contribution made to the research by colleagues with whom I have worked at Charles Sturt University or elsewhere during my candidature is fully acknowledged. I agree that this thesis be accessible for the purpose of study and research in accordance with normal conditions established by the Executive Director, Library Services, Charles Sturt University or nominee, for the care, loan and reproduction of thesis, subject to confidentiality provisions as approved by the University.

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<td>AHA</td>
<td>Animal Health Australia</td>
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<td>ASBV</td>
<td>Australian Sheep Breeding Values</td>
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<tr>
<td>AWI</td>
<td>Australian Wool Innovation</td>
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<tr>
<td>BMP</td>
<td>Best Management Practice</td>
</tr>
<tr>
<td>BSE</td>
<td>Bovine Spongiform Encephalopathy</td>
</tr>
<tr>
<td>CSU</td>
<td>Charles Sturt University</td>
</tr>
<tr>
<td>DAFF</td>
<td>Department of Agriculture (national)</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Primary Industries (NSW)</td>
</tr>
<tr>
<td>EADRA</td>
<td>Emergency Animal Disease Response Agreement</td>
</tr>
<tr>
<td>FMD</td>
<td>Foot and Mouth Disease</td>
</tr>
<tr>
<td>HPAI (H5N1)</td>
<td>Highly Pathogenic Avian Influenza</td>
</tr>
<tr>
<td>GATT</td>
<td>General Agreement on Tariffs and Trade</td>
</tr>
<tr>
<td>IRA</td>
<td>Import Risk Analysis</td>
</tr>
<tr>
<td>LHPA</td>
<td>Livestock Health and Pest Authority</td>
</tr>
<tr>
<td>LLS</td>
<td>Local Land Services</td>
</tr>
<tr>
<td>MLA</td>
<td>Meat and Livestock Australia</td>
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<tr>
<td>NLIS</td>
<td>National Livestock Identification System</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>NVD</td>
<td>National Vendor Declaration</td>
</tr>
<tr>
<td>OIE</td>
<td>World Organisation for Animal Health</td>
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<tr>
<td>Code</td>
<td>Full Form</td>
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<td>------</td>
<td>-----------</td>
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<tr>
<td>OJD</td>
<td>Ovine Johne’s Disease</td>
</tr>
<tr>
<td>PHA</td>
<td>Plant Health Australia</td>
</tr>
<tr>
<td>PIC</td>
<td>Property Identification Code</td>
</tr>
<tr>
<td>PP Board</td>
<td>Pastures Protection Board</td>
</tr>
<tr>
<td>RD&amp;E</td>
<td>Research, Development and Extension</td>
</tr>
<tr>
<td>RLPB</td>
<td>Rural Lands Protection Board</td>
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<td>SHS</td>
<td>Sheep Health Statement</td>
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<td>SPS</td>
<td>Sanitary and Phytosanitary measures</td>
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<td>Sheep CRC</td>
<td>Sheep Cooperative Research Centre</td>
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<tr>
<td>UK</td>
<td>United Kingdom</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>WTO</td>
<td>World Trade Organization</td>
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Chapter 1 – Introduction

Biosecurity is the process of controlling pests, weeds, and diseases through various management practices to minimise outbreaks. Pest, weed and disease outbreaks appear to be worsening (Maye, Ilbery, & Little, 2012; Waage & Mumford, 2008). However, the risk of outbreak is reduced by engaging in biosecurity practices (Armstrong, 2014, p. 199); therefore, the biosecurity practices currently undertaken should be further examined. The on-ground actors who participate every day in biosecurity practices are farmers. For the purpose of this study, biosecurity specifically refers to farmers’ on-farm animal health and hygiene practices. Farmers are the key actors in biosecurity, however little is known about their approach to the issues.

Previous research into farmers’ biosecurity practices has predominantly taken a positivist approach, which tends to overlook the farmers’ perspective of biosecurity management (Heffernan, Neilsen, Thomson, & Gunn, 2008; Sahlstrom, Virtanen, Kyyro, & Lyytikainen, 2014; Toma, Stott, Heffernan, Ringrose, & Gunn, 2013). Farmers’ perspectives have been considered as limited in some social science biosecurity literature (Enticott, 2008b). Other social science biosecurity literature, primarily from abroad, has focused on farmers’ biosecurity practices after an outbreak (Enticott, 2001; Mather & Marshall, 2011; Maye, Enticott, Naylor, Ilbery, & Kirwan, 2014). However, this thesis considers farmers’ practices in non-outbreak conditions. This chapter
outlines the research aims, research context, specific industry and location chosen for this research, and the structure of this thesis.

**Research Aims**

The broad aim of this thesis is to understand farmers’ biosecurity knowledge and practice, in the context of non-outbreak conditions, and how biosecurity is managed and prioritized by farmers. Additionally, this thesis seeks to explore how farmers learn about biosecurity risk management and it considers if their implementation of biosecurity practices on-farm aligns with government recommendations. The aims of this research are addressed through the findings from 23 semi-structured interviews conducted with sheep farmers in the Riverina region of New South Wales (NSW), Australia. This thesis contributes specifically to the social science biosecurity literature by providing insights into farmers’ biosecurity knowledge and practices, and how they are influenced by broader social, economic and environmental processes.
Research Context

Animal health outbreaks are of concern to global publics (Enticott, 2014a; Heffernan et al., 2008, p. 359) and result in significant social and economic costs. The significance of these costs means that countries should engage in preventing animal disease outbreaks. This is achieved through management of the broader biosecurity system across pre-border, border and post-border spaces. Breakdowns in the biosecurity system incur both direct and indirect social and economic costs; direct costs include culling, labour and farmer compensation, and indirect costs include food insecurity, limited farm income and a decline in tourism (Permin & Detmer, 2007, p. 41). It is increasingly accepted that the most cost-effective method of preventing animal disease is through on-farm biosecurity practices (Negro-Calduch, Elfadaly, Tibbo, Ankers, & Bailey, 2013), such as cleaning and disinfecting equipment and surveillance. However, there is limited research on the social elements of animal health management and preventative on-farm practices, specifically from farmers’ perspectives. Farmers’ perspectives matter because they are the first to notice anomalies in their farming system and they are best positioned to implement biosecurity risk management practices. This thesis is primarily interested in biosecurity at the farm level. Farmers practice biosecurity on their individual properties, which contributes more broadly to post-border biosecurity actions.
The term biosecurity is still relatively new. Its increased usage in government circles followed the 2001 Foot and Mouth Disease (FMD) outbreak in the UK (Donaldson, 2008) and has since been in common use (Black & Kireeva, 2009, p. 91). In the US, the term biosecurity increased in popularity after the USSR dissolved. At that time, research in genomics shifted the focus of biosecurity to the new threats (Collier, Lakoff, & Rabinow, 2004, p. 3) of bioterrorism and related health emergencies (Taylor-Clark, Blendon, Zaslavsky, & Benson, 2005, p. 138).

Biosecurity means different things to different groups of people, and international governance has played a role in guiding biosecurity risk management. Historically, quarantine at the border represented the predominant means by which countries minimised the transmission of pests, weeds and diseases. However, in recent years there has been a shift towards an integrated approach to biosecurity led by the Food and Agriculture Organisation of the United Nations (FAO). Biosecurity is viewed on a continuum of pre-border, border and post-border (Food and Agriculture Organization of the United Nations, 2007). This involves management, usually government-driven, to protect a country from a biosecurity outbreak. Management activities aim to protect people from the potential dangers due to the movement of animals, people and things, which are of public concern and are therefore a priority for governments.

There are various levels of definitions to consider when conceptualising biosecurity. The World Trade Organization (WTO) defines biosecurity as ‘a
strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyse and manage risks in the sectors of food safety, animal life and health, and plant life and health including associated environmental risk’ (Food and Agriculture Organization of the United Nations, n.d-a). However, each government has differing priorities, resources and governance structures that impact the way they interpret biosecurity in each country (Maye, Dibden, Higgins, & Potter, 2012). Although the definition could be extrapolated to include farmers, they are not explicitly referred to (Palmer, Sully, & Fozdar, 2009, p. 33), even though they are key players in the biosecurity continuum. This thesis is specifically interested in closing this gap by investigating farmers’ biosecurity knowledge and practices.

When an outbreak occurs, international procedures are in place for biosecurity management that are decided by the World Trade Organisation (WTO) and articulated in the WTO Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures. In accordance with the SPS agreement countries are prohibited from trading in the global marketplace until pest or disease prevalence is low, as ‘identified by the competent authority’ through measures such as control, surveillance and eradication (Food and Agriculture Organization of the United Nations, n.d-b). Such measures were evident in the Foot and Mouth Disease (FMD) and bird flu outbreaks. The fastest way to regain access to the global marketplace is to cull animals, a preferred
procedure that has been in existence since the fifteenth century (Waage & Mumford, 2008, p. 865).

While farmers’ biosecurity knowledge and practices have been given limited scholarly attention to date, they are the vanguards of biosecurity and there is a need to better understand how farmers encounter, comprehend and manage disease (Ilbery, 2012, p. 311). This study builds on the current social science biosecurity literature by investigating how farmers understand and practice biosecurity. The following section describes the geographical setting for this research and the sheep industry in the Riverina region of NSW, Australia.

**The Riverina Sheep Industry**

Since colonisation, sheep have been an important contributor to the Australian economy. Phrases such as *riding on the sheep’s back* and the *backbone of Australia’s economy*, were used to describe the value that Australians placed on the sheep industry, and specifically the wool industry. Although flock numbers have decreased as a result of droughts and international fibre market competitiveness (Meat and Livestock Australia, 2014b), sheep still play a significant role in Australian agricultural production. There has been a global decline in wool sales since the 1990s, and lamb production now provides farmers with greater returns. An increase in lamb numbers was marked by the slaughter of approximately 22,000,000 lambs in
2013/14 (Dahl, Martin, & Gray, 2014, p. 2). In 2014, an estimated 75 million head made up Australia’s sheep flock (Meat and Livestock Australia, 2014d), and approximately 27 million of those form the New South Wales flock (Pattison, Wilcox, Williams, & Curtis, February 2015, p. 3); the sheepmeat industry is worth approximately $3.9 billion (Meat and Livestock Australia, 2014d). As a consequence of the economic significance of the sheepmeat industry, governments are interested in maintaining post-border biosecurity spaces free from pests, weeds and diseases.

The Research Location

The sheep industry in the Riverina region of NSW was selected as the site of the study for two reasons: historical significance and convenience for the researcher. The Riverina region is historically significant as the birthplace of the Peppin Merino, which is a good wool producing breed from which approximately 70 percent of Australia’s flock is descended (McEwen, 2011). In addition, the favourable climate in this region is conducive to wool growing. As a British colony, Australia’s economy has historically relied on exported meat and wool products. Given the historical context, the value of the sheep farmed in the Riverina, and the growing threat to the region’s sheep industry posed by exotic and endemic disease risk, means that it is important to understand biosecurity from the perspective of farmers. Conveniently, the Riverina region is also where the Charles Sturt University (CSU) Wagga Wagga campus is
located, and where I am based. Therefore, the region was selected for logistical and convenience reasons in terms of ease of accessing sheep farmers.

The Riverina is located in south-western NSW (see Figure 1) and is known as an agricultural area where Merino sheep have been the primary livestock choice since the 1830s. The Riverina is one area in Australia known for mixed farming that includes prime lamb production.

Wagga Wagga is the largest inland town in NSW, and its centrality within the Riverina made it useful for meeting sheep farmers. Mapping of the Riverina agricultural boundaries changes with each renaming of the now named Local Land Services (LLS). An easy way to ascertain whether the farmers lived in the Riverina was to ask ‘Do you live in the Riverina?’ The interview boundaries
were beyond Hay in the north, past Gundagai in the east, out of Lockhart in the south and on the outskirts of Moulamein in the west (see Figure 2).

![Figure 2 Towns in the Riverina ("Riverina NSW Road Map," n.d)](image)

As per Figure 2, the Murrumbidgee River is a source of irrigation for the surrounding agricultural land. The Riverina’s temperatures range from a summer average of 31°C to a winter average of 12°C. It is a winter rainfall area with an average of 250-500 millimetres annually, although there is significantly less rainfall to the west of the region. The flat plains around Hay are suitable for dryland sheep on large sheep station, whereas the production of prime lamb is more popular in the higher, sandier and wetter landscape to the east of Wagga Wagga.

In the Riverina, Peppin Merinos are most common, which were originally bred on a farm near Deniliquin. Among the interviewed farmers, Merinos are the most common breed, however, cross-bred ewes are becoming increasingly
popular; Dorpers, Wilty Polls and White Suffolks were also run by the participants. The following section outlines the thesis structure.

**Overview – Thesis Structure**

There are seven subsequent chapters in this thesis. Chapter 2 reviews the relevant social science literature on post-border biosecurity. The review is categorised into three themes that are present in the literature: boundaries, science and local knowledge, and risk. The research questions that underpin the thesis are presented at the end of each section of literature. Chapter 3 discusses the chosen theoretical and methodological approach. Chapter 4 is the first analytical chapter using the collected data. It considers the array of farmers’ biosecurity practices employed on-farm. Chapter 5 investigates farmers’ risk perceptions and the role trust plays in the management of post-border biosecurity. The risks farmers are focused on immediately impact their productivity and surround the uncertainties of climates, markets and diseases. This contrasts with governments’ risk perception that is focused on exotic threats. To monitor risks, surveillance activities are employed by farmers. Chapter 6 is the final analytical chapter that explores farmers’ biosecurity knowledge. The variety of sources participants use to learn about biosecurity are identified. This chapter considers the significance of farmers’ tacit knowledge and biosecurity management. Chapter 7 discusses the key themes
identified in the preceding analytical chapters and how they address the research questions listed in the literature review. Chapter 8 concludes this thesis by identifying how the findings build on and contribute to the existing social science biosecurity literature.
Chapter 2 – Literature Review: Boundaries, Science, Risk and the notion of good farming

Introduction

The broad aim of this research is to investigate biosecurity from the farmers’ perspective by understanding their knowledge and practices. In order to address this aim it is first necessary to review both the existing social science biosecurity literature and veterinary epidemiology literature and examine how, and in what ways, farmers’ knowledge and practices are considered in that body of literature. The social science biosecurity literature is an emerging body of work that incorporates the sub-disciplinary areas of cultural, economic and rural geography, rural sociology, and the sociology of science and technology. It is characterised by three broad themes, which will be drawn upon in this chapter – (a) boundaries and biosecurity spatialities, (b) risk and trust, and (c) ‘scientific’ and ‘local’ knowledge. Each of these areas highlights the important role of governments and scientific knowledge in influencing biosecurity policy and practice.

This literature review demonstrates the limited ways in which farming knowledge and practices are taken into account in the existing literature. These limitations are discussed in the context of each of the broad themes in the social science biosecurity literature. Following discussion of the three themes, the theoretical framework for this research is presented, which focuses on farming practice and the notion of good farming. The theoretical
framework provides a basis for formulating this study’s research questions. The research questions are identified at the end of the theoretical framework. I begin with a brief introductory section on biosecurity in the Australian agricultural context.

**Australian biosecurity**

Australian pest, weed and disease governance measures follow international guidelines. The guidelines approach biosecurity as a continuum, which conforms to the model of responsibility-sharing among relevant actors. It is argued that a shift from the narrow concept of quarantine to the continuum more holistically reflects the pre-border, border and post-border nature of biosecurity (Beale, Fairbrother, Inglis, & Trebeck, 30 September 2008, p. xvii). An independent review of Australia’s biosecurity activities across the continuum was conducted for the 2008 Beale report. The Beale report defines biosecurity as ‘the protection of the economy, environment and human health from the negative impacts associated with entry, establishment or spread of exotic pests (including weeds) and diseases’ (Beale et al., 30 September 2008, p. 1). A key finding of the Beale report that has been adopted in policy at the national and state government levels is the notion of ‘shared responsibility’ (Beale et al., 30 September 2008).
Shared responsibility means a sharing of cost and risk across all the biosecurity players. In line with ‘contemporary business approaches’ (Beale et al., 30 September 2008, p. xvii) changes that have occurred as a result of a shared responsibility that sees farmers incurring higher levels of costs for post-border biosecurity management. Australian biosecurity policy is based on scientific knowledge and is shaped by recommendations from the Beale report. In 2012, an update of the Beale report was published that discusses how some of the recommendations have been addressed (Department of Agriculture Fisheries and Forestry, March 2012). They continue to be addressed with the 2014/2015 national government budget for biosecurity, across the continuum, of $20 million (DAFF, 2014).

In practice, shared responsibility is demonstrated by government and industry through the funding they provide to Animal Health Australia (AHA), which is the national body that raises awareness of biosecurity. AHA is a quasi-government organisation that assists with managing animal health protocols and practices. As a consequence of AHA’s quasi-government status, the organization can bring together governments and industry without being under the umbrella of government bureaucracy. It is uniquely positioned to close the gap between the national and state governments and livestock industries that jointly fund the agency. AHA attempts to close the gap by having a ‘flexible and responsive’ governance structure in regards to animal health issues (Animal Health Australia, 2014a). Even their slogan has shared responsibility undertones – ‘working together for animal health’ (Animal Health
According to AHA’s website their role includes ‘facilitate...build capacity...enhance...support’, in order to maintain partnerships across the various livestock industries and levels of governance.

Governments at the state level can follow the guidelines for biosecurity as set by the national government but have some flexibility, and of interest to this thesis is NSW. The NSW government came out with a biosecurity strategy from 2013-2021 and the focus is on shared-responsibility, which follows the national approach. On the front cover of the NSW biosecurity strategy shared-responsibility is defined as ‘government, industry and the people of NSW working together to protect the economy, environment and community from the negative impacts of animal and plant pests, diseases and weeds for the benefit of all people in NSW’ (NSW Government, May 2013). The placement on the front cover shows that the NSW government is keenly interested in sharing the cost burden of biosecurity management and it is everyone’s responsibility.

The most recent changes to Australian biosecurity government processes are a result of the senate passing the *Biosecurity Act 2015*, which supersedes the *Quarantine Act 1908*. The new Act will come into effect in 2016 (Department of Agriculture, 2015b), and more acutely recognises Australia’s need to streamline biosecurity regulations. The main implications of the Act for post-border biosecurity are that national, state and industry players will be legislatively bound to work ‘cooperatively to manage and address pest and disease incursions’ (Crothers, 2015). The national Department of Agriculture
asserts that farmers will benefit from having a strong and robust biosecurity system and that their livelihoods will be better protected from diseases (Department of Agriculture, 2015a). For the sheep industry, this may mean that the chances of an FMD incursion (named as the greatest risk to the industry (Hafi, Addai, Zhang, & Gray, 2015)) are minimized as people, procedures and responsibilities are streamlined to safeguard Australia from such threats.

The Australian scientific risk-based system recognises that a zero risk policy is unattainable (Beale et al., 30 September 2008, p. xvi). ‘Acceptable’ suggests that any further mitigation of the risk is of insignificant value (Renn, 2008, p. 149), and resources are allocated based on greatest risk. However, the extent of acceptable level remains questionable (Beck, 1992) and is variable ‘in different contexts’ (Giddens, 1990, p. 35). ‘Risk dominates policymakers agendas’ (Nerlich, Brown, & Wright, 2009, p. 345), and since the publication of the 2008 Beale report the national government has reformed some aspects of the biosecurity system (Willingham, 2011). The different states now regulate and monitor risks post-border. Farmers know that risk is part of their management practices (Fairweather & Keating, 1990, p. 5); risk is an issue both from the farmers’ side and the governance side. The interconnected web of interested parties in biosecurity means that ‘risk is governed via a heterogeneous network of interactive actors, institutions, knowledge and practices’ (Lupton, 1999, p. 87).
Australian governments are concerned with the exotic biosecurity risks that will affect the public space, and management centres on minimising the associated economic costs. Overseas disease outbreaks such as FMD cost approximately £8 billion (Donaldson, 2008, p. 1552), and previous estimates for Australia have been over $1 billion (AUD) on the first day of an outbreak (Willingham, 2011). Also as WTO best practice dictates, countries lose access to international trade during outbreaks while countries contain the risks (Donaldson, 2008), which results in lost income for farmers. With this knowledge, government priorities focus on planning for exotic incursions to minimise these extreme public costs.

Australian governments have been specifically concerned with economic modelling for costs during exotic disease outbreaks. The greatest threat for sheep is FMD (Hafi et al., 2015) and current Australian forecasts predict a delay of three weeks in the disease being reported (Roche, Garner, Wicks, East, & de Witte, 2014, p. 4). To control FMD, a yearly vaccination may be required for sheep at a cost of $4.12 per dose, and vaccination also lowers the value of the meat by an estimated 30 per cent (Hafi et al., 2015, p. 11). For Australian livestock farmers, compensation will be paid for animals that are culled during an exotic outbreak (Sheepmeat Council of Australia, April 2014, p. 15). As demonstrated above, each party’s preventative practices and plans show the risk management focus on remaining economically viable after an event. Economic concerns appear to be at the heart of risk management, with both actors basing risk assessments on the effect it will have on profitability.
In practice, shared responsibility is the dividing of biosecurity roles, responsibilities and costs between farmers, governments and industry. It is recognised that biosecurity risk management will be most successful by sharing responsibility and rebuilding trust between the actors (Hernandez-Jover et al., 2012, p. 258). However, further tensions may perhaps arise from the neoliberalist undertones of government post-border risk management policy.

This section explored the relevant Australian context of biosecurity, which has demonstrated governments’ commitment to protecting agricultural industries through shared responsibility. This is significant to this research, as governments and the sheep industry have identified FMD as the greatest risk to the industry. FMD outbreaks abroad have caused significant economic and social costs and therefore the Australian government seeks to minimise such impacts should the disease reach these shores. In Australia, national government expenditure for preventing biosecurity outbreaks is used to protect the country’s borders. Shared responsibility is influenced by boundaries, risk and science, which can shape the Australian biosecurity governance landscape. The next section reviews the literature relevant to the three broad themes of boundaries, risk and science.
Boundaries and biosecurity spatialities

Boundaries and borders are central to biosecurity. Boundaries are socially constructed as they are created through a common acceptance of inclusivity and exclusivity (Migdal, 2004, p. 6), and they are defined through negotiations of various agencies. For example, national governments construct boundaries to prevent exotic pest, weed and disease incursions. The construction of these boundaries fits into the broader category of prevention and biosecurity management, the direction of which is influenced by international governmental bodies, such as the WTO. Boundaries are enacted as a risk management measure to keep spaces disease free. Farmers are responsible for maintaining the physical boundaries of farm spaces in order to remain competitive in the global marketplace. However, as will be established in this section of the chapter there is little consideration of farmers’ role in the broader topic of prevention and biosecurity management and how they construct boundaries.

Boundaries are conceptualised in two key ways within the social science literature on biosecurity (Barker, 2008b; Bashford, 1998; Enticott, 2008b): conceptual boundaries, which refer to the ‘process of othering’ (Heap, Byrne, & Stuart-Fox, 2012, p. 81), and territorial boundaries, which are ‘simply the properties, including power, provided by the control of bordered political space’ (Maier, 2000, p. 808). The remainder of this section is divided into a discussion of the literature of both conceptual and territorial boundaries.
Conceptual boundaries

Boundaries ‘signify the point at which something becomes something else, and the way things are done changes, at which ‘we’ end and ‘they’ begin’ (Migdal, 2004, p. 5). This useful definition hints at the exclusionary nature of boundaries. ‘We’ are the humans and ‘they’ are categorised as ‘other’ in the form of a potential threat or danger (Bovina, 2009, p. 91). This shows that boundaries are exclusive and designed to maintain the purity of agricultural space, so that invasive, impure or alien epidemics are not engaged (Heap et al., 2012, p. 81). Conceptual boundaries are relevant to agricultural space as it is people (government, industry and farmers) who classify how and where the borders are enacted. Conceptual boundaries are relevant to agricultural space because it is people (government, industry and farmers) who classify how and where the borders are defined and enacted. Conceptual boundaries can be referred to with a variety of terms, such as we, they, other, in, out, clean and dirty.

A similar approach to boundaries indicates some form of exclusion in the way things are classified (Donaldson & Wood, 2004, p. 378). Exclusion is a type of classification that defines something as an alien species and recognises the outsider status (Buller, 2008, p. 1592); ‘this act of classification of naming, makes the alien, threatening event imaginable and representable’ (Joffe, 1999,
p. 95). Biosecurity boundaries are classified by governing bodies as a way to exclude diseases from the non-diseased population.

Disease has historically been referred to as ‘other’. For instance, human health examples of plagues were labelled in terms of foreignness (Bovina, 2009, p. 91). Interestingly, Bovina (2009) makes a distinction between Western and non-Western ways of viewing the ‘other’. Westerners see the ‘other’ as lacking control and self-discipline, whereas non-Western cultures replace control with ‘symbolic systems of purity’ (Joffe, 1999, p. 76) to distinguish belonging to ‘good’ spaces (Bovina, 2009, p. 93). Good spaces are defined as healthy, pure, and disease free. However, the commonality between Western and non-Western cultures is the universal desire of wanting to preserve the ‘good’ space (Joffe, 1999, p. 77). The good space is represented as ‘negotiations between exclusion and inclusion’ (Mol, 2005, p. 693) or the dividing line that differentiates what is ‘in’ or ‘out’ (Nerlich et al., 2009, p. 349).

Conceptually, scholars argue that biosecurity relies on distinguishing between ‘clean’ and ‘dirty’ spaces (Bashford, 1998, p. 387), although it is not as definitive in policy and practice. Clean space is the utopian view (Sibley, 1995, p. 77), which is unachievable because dirty spaces exist even in less threatening forms. Similarly, clean space is viewed as the unfeasible, perfected form (Foucault & Miskowiec, 1986, p. 24). Instead, it is more useful to think of spaces as dirty and less dirty, rather than clean. Australia follows a scientific risk-based system that recognises that zero risk is unobtainable
(Beale et al., 30 September 2008). This is relevant to the research aims of this project because minimal pest, weed and disease problems exist, however the government decides the appropriate minimal level to enable trading to continue. An example of government management of animal health risks is through the practical measure of quarantine.

Quarantine practices provide an example of how conceptual boundaries are enacted. Enacting boundaries has been a key biosecurity practice in Western countries since the early twentieth century (Bashford, 1998, p. 387). Quarantine is the process of keeping out contaminated people, animals and things by intercepting them at the point of entry into a country. It is a management tool used to assist in preventing the transfer of biosecurity threats. The significance of quarantine shows that belonging has been historically defined, and boundaries in Western society are not a new idea. What belongs is the ‘we’ and what does not belong is the ‘they’ (Migdal, 2004), and there are international biosecurity governance guidelines to differentiate between the two (Beale et al., 30 September 2008).

**Territorial boundaries**

In addition to conceptual boundaries are territorial boundaries, which are government controlled to maintain and reinforce the ‘cleaner’ spaces.

Traditionally, ‘the purpose of territorial boundaries is to clarify which entities are states and to separate states from each other in order to structure the
system’ (McCorquodale & Pangalangan, 2001, p. 859) or ‘the demarcation and protection of a state’s territory’ (Behr, 2007, p. 114). These are the territorial boundary ideals. There has been a shift, and territorial boundaries are now ‘de-territorialized’, as a result of a globalising world (Behr, 2007, p. 122).

Boundaries are de-territorialised because nation-state policies are no longer bound by national territory borders. Territorial boundaries appear primarily in the literature on nation-building and the nation-state (Lamont & Molnar, 2002; Lyon, 1994). However, they are applicable to biosecurity as governments play a crucial role in shaping how boundaries are adapted from international recommendations. In a broader sense, at the international level territorial boundaries continue to be defined similarly to colonial times through occupation and sovereignty (McCorquodale & Pangalangan, 2001, p. 867).

The political framing of borders has been affected, or blurred, by the global economy. The blurring of boundaries can occur as things move across the borders: ‘ideas, practices, people or objects may change shape as they move across geographical boundaries’ (Mol, 2005, p. 638). This process is a result of globalisation with increased movements, and for biosecurity it is important to reinforce the borders in order to keep the ‘other’ out.

Territorial boundaries are important in biosecurity because they provide a way for governments to manage national and sub-national spaces and avoid the infiltration of the unwanted ‘other’. National governments manage the movement of things and information for biosecurity and enforce the territorial boundaries, which is a highly spatialised form of control (Donaldson & Wood,
Territoriality is a way to secure an area that has been identified as risky (Maier, 2000, p. 816). This security is defined at the national level and in Australia this is simplified because the country is an island. However, post-border boundaries are defined by attempting to keep the risks out, if and when they arrive on land. Additionally, ‘the existence of territoriality within a population has important spatial, social and demographic consequences’ (Holloway, 1999, p. 871). These spatial boundaries can be defined by physical infrastructure and are a way for governments to maintain control (Maier, 2000, p. 820). Maier (2000) gives the example of railroads in early American colonisation. However, for biosecurity in the agricultural space, a relevant example is the process of quarantine at the border. More specifically for this project, fences are an example of physical infrastructure used to define post-border spaces. This form of territorial control is culturally derived despite inherent complexity (Pfeiffer, 2006, p. 21). On-ground biosecurity is complex because it includes surveillance, emergency response and monitoring, and the ongoing management of these resources by a variety of actors, including farmers.

Governing agents define how the space is classified. The agents enforce space in three ways, prevention, reduction and eradication, as governments have done since the nineteenth century (Bashford, 2006, p. 1). The enforcement of borders is geopolitical, as disease governance is concerned with both sides of the border. However, the best opportunity for disease prevention is to manage entities pre-border (Bashford, 2006, p. 2). ‘Unclean’
entities can enter the system at any place; therefore, such entities need to be regulated.

The regulating or formalising of space at the international level is done through the WTO. At the next level down in biosecurity governance are national governments, who manage pre-border, border and post-border operations. For example, in Australia there are various biosecurity agencies operating at the national and sub-national or state level. Of interest to this study is post-border biosecurity, which is under the control of state, or sub-national governments. At the start of the twenty-first century, post-border biosecurity initiatives were centred on the impacts to agriculture, and to an extent remains the case in Australia. However, in a global sense biosecurity is now inclusive of bioterrorism and health related epidemics, such as Severe Acute Respiratory Syndrome (SARS) (Van Wagner, 2008) and ecological concerns (Barker, 2008a, p. 1603), or more recently Ebola and Middle East Respiratory Syndrome (MERS).

Both territorial and conceptual biosecurity boundaries are exclusionary and necessary to maintain and enable some spaces to be disease-free. Traditionally, borders were territorial boundaries (Behr, 2007, p. 114) and were socially important in defining ‘us’ and ‘them’ (Lamont & Molnar, 2002, p. 170). How we externalise the ‘other’ is a result of history and culture (Joffe, 1999, p. 82). Alternatively, conceptual boundaries, or the practice of ‘othering’ (Heap et al., 2012, p. 81), refers to how these different groups define belonging in the space. A problem with conceptual boundaries in the
scientific world is that there are many ways in which to define, therefore we have ‘fuzzy boundaries’ that are continuously changing (Pennock, 2012, p. 5).

Both types of biosecurity boundaries discussed here exhibit a dichotomy of ‘othering’ that shows governments’ desire for regulating agricultural space. However, in general, farmers’ perspectives of biosecurity prevention and management are noticeably absent from the academic literature on the construction and management of boundaries and borders. Boundaries are applicable to this discussion of post-border biosecurity because farmers are one set of key actors who manage the ‘dirty’ and ‘less dirty’ spaces. Little is known about what farmers are doing to prevent threats and manage the boundaries for biosecurity purposes. Instead, there appears to be a greater focus on the activities governments are involved in to prevent disease outbreaks and manage biosecurity boundaries.

Risk, trust and surveillance

A second predominant theme in the social science biosecurity literature is around the relationship between risk, trust and surveillance. For the boundaries of this study risk is a socially constructed concept, which is applicable to biosecurity because government, industry and farmers actively manage the associated risks of farming activities. Some social science authors have framed biosecurity using Beck’s notion of the risk society (Donaldson,
2008; Palmer, Sully, et al., 2009; Wynne, 1996) or Foucault’s problematisation (Collier et al., 2004). Beck suggests that ‘science determines risks and the population perceives risks’, but one only perceives risks if one has knowledge of them (1992, p. 57). Beck’s work tends to focus on expert or scientific knowledge, which limits lay understandings of risk (Pellizzoni, 2003; Wynne, 1996; Young & Matthews, 2007). Alternatively, Foucault’s notion of problematisation analyses situations or events that result in uncertainty and show a shift in our prior understanding (Collier et al., 2004, p. 3). An example of this shift is how individuals are encouraged by governments to participate in self-regulation, to conform to risk-minimising behaviours, through for example, surveillance (Lupton, 1999, p. 25).

Risks are increased by the movement of products, animals, plants or humans, processed or live, which can compromise biosecurity boundaries. Risk is applicable to farming, and therefore biosecurity, because it ‘is an inherent feature of farming practices and the management of different agricultural sectors’ (Ilbery, Maye, Ingram, & Little, 2013, p. 131). Risk is managed and prioritised in a way that accords with how the actors perceive it.

Risk management, perception and surveillance

How risks are managed is relevant to biosecurity because national and sub-national governments are becoming increasingly involved in influencing how farmers manage their farms. A definition of risk management is ‘the
systemic application of management policies, procedures and practices to the
tasks of identifying, analysing, assessing, treating and monitoring risk’
(Hardaker, Huirne, Anderson, & Lien, 2004, p. 13). Governments decide on
acceptable levels of risks (Renn, 2008, p. 149), because complete removal is
unachievable, and they engage in activities to reduce the risk. Governments
then provide information to modify risk perceptions (Renn, 2008, p. 96). The
public accepts these risks if they are trusting and confident in the approach of
risk management (Slovic, 1993, p. 676) taken by governments. Risk
management is more likely to be successful if there is ‘inclusiveness of
interested parties and safety nets for possible long-term liability’ (Langford,
Marris, & O’Riordan, 1999, p. 35).

Biosecurity may be viewed as a form of risk management for farmers.
Risks are addressed in a way that accords with individuals’ construction of the
risk (Renn, 2008, p. 93). Therefore Ilbery et al’s construction of ‘risk of
feeling’ that farmers use as a way to make decisions about plant disease risk
based on intuition is applicable to the discussion of risk management (2012).
In their study, UK farmers drew upon both scientific knowledge and risk as
feeling when making risk management decisions about their crops. These
farmers had intuitive skill and local knowledge of conditions in knowing to
adjust chemical spray dosages. Farmers used ‘common sense, instinct,
experience and feeling’ (Ilbery, Maye, & Little, 2012, p. 313) to determine a
risk management pathway. This example demonstrates risk management in
action where farmers’ local understanding of their environment and how they
perceived risk enabled them to make successful management decisions. Studies like this that attempt to understand farmers’ perceptions of risk are recognised as necessary to assist with increasing implementation of on-farm biosecurity practices (Valeeva, Van Asseldonk, & Backus, 2011), such as surveillance.

Surveillance is an important proactive risk management biosecurity practice for maintaining control of the ‘clean space’. ‘Surveillance is the search for unknown incursions’ (Kompas, Nguyen, & Ha, 2015). It is one biosecurity activity, or tool (Morley, 2002, p. 136) that governments, industry, biosecurity professionals, and farmers engage in. However, farmer-level surveillance practices are absent from the World Organisation for Animal Health’s (OIE) recommendations (Palmer, Sully, et al., 2009, p. 33). Palmer et al. note that this is surprising as livestock health decisions are in the hands of the farmer (2009). Donaldson and Wood illustrate the different forms of a surveillance system during FMD (2004). In 2004 the WTO required export meat to be FMD free, which is one form of surveillance (Donaldson & Wood, 2004, p. 382). The FMD surveillance system used boundaries to categorise human and non-human. By humans having a system of surveillance in place it re-enforces the boundary between that which is categorised as ‘them’ and ‘us’ (Donaldson & Wood, 2004, p. 378). It is a good example of surveillance biosecurity, as areas on a UK map were categorically divided, and in this sense it was a surveillance system.
The current methods of biosecurity surveillance practices are costly and their effectiveness is difficult to assess. However, in accordance with Enticott, surveillance is just an ‘image of disease control’ (2008b, p. 1568). It is an example of saving one’s reputation, which was strategically employed during the Severe Acute Respiratory Syndrome (SARS) outbreak in Canada 2003, by installing airport screening for SARS as suggested by the World Health Organization (WHO). This expensive measure did more to protect business, tourism and global confidence in Canada than it did to prevent the spread of SARS (Van Wagner, 2008, p. 1656). In this case, again voluntary compliance (all citizens were to participate by quarantining themselves and staying indoors for 10 days) was expected. As Van Wagner suggests, imposing quarantine may not be the best way of dealing with disease outbreaks because of the high cost to implement and survey compliance (2008, p. 1651).

Australia’s surveillance responsibility, much like Canada, is conducted at the state level. For example, cars travelling from NSW to South Australia, enter a checkpoint for surveillance purposes in an attempt to keep fruit fly out of the state. Even with personnel checking vehicles, fruit dumping bins and a system of fines in place, the pest still travels through this human-made surveillance checkpoint. Another example of the imagery in biosecurity was evidenced during the FMD outbreak in the UK. Due to the large learning curve, biosecurity practices changed throughout 2001, and the agriculture minister at the time commented that disinfectant matting, which was originally thought to be useful, were found to be ‘more symbolic than real’ (Nerlich & Wright, 2006,
The defining of clean and dirty boundaries was a way to avert blame for this crisis situation (Nerlich & Wright, 2006, p. 458).

One example of failed surveillance was seen during the Egyptian avian flu outbreak, and a consequence of this failure was further economic devastation. In Egypt backyard birds are a common occurrence, and as part of the process of removing the disease officials required citizens to surrender birds, diseased or healthy, for slaughter within a particular radius. However, some citizens chose to hide them as a result of low government rebates for birds surrendered (Hinchliffe & Bingham, 2008, p. 1545). This process of culling and disease surveillance during an outbreak has existed since the eighteenth century (Enticott & Wilkinson, 2013, p. 92), and is the OIE’s preferred method ‘to regain disease free status’ (Mather, 2012; Mather & Marshall, 2011; Permin & Detmer, 2007). Similarly, the hiding of birds on-farm from biosecurity officials occurred during avian flu outbreaks in Vietnam, China, Laos and Nigeria (Permin & Detmer, 2007, p. 6). These examples of failed surveillance demonstrate that citizens must have a level of trust in authorities and perceive the usefulness in removing the disease with this method.

Research on risk has found a space between expert and public perceptions (Douglas, 1992, p. 11), where control is usually a predictor of risk perceptions (Knight, 2005; Lupton, 1999); ‘Public risk perception is understood through a distinctive form of rationality’ (Fischer, 2005, p. 55). Farmers’, as a sub-section of the public, definitions of risk are different to
those of governments, and they are marginalised due to the institutional culture and dominance of science (Wynne, 2005, p. 70). For example, farmers perceive risk in their everyday farming issues, rather than in international trade and welfare issues (Kristensen & Jakobsen, 2011, p. 122) which is the emphasis of biosecurity authorities.

Farmers and governments risk concerns are valid and different, which provides scaffolding for tensions and challenges that each actor faces in regards to biosecurity. Farmers and governments challenges towards biosecurity derive from the known and their ‘attitudes to risk are informed by previous experience’ (Garforth, Bailey, & Tranter, 2013, p. 462), which shapes their risk perception. Governments’ risk management priorities centre on exotic disease prevention planning. This contrasts with farmers’ risk management that is prioritized by endemic risks, and they perceive climate, markets and disease to be of greatest risk to their enterprise.

Farmers’ risk perceptions and how risks are managed are closely linked (Maye, Ilbery, et al., 2012, p. 339) to their identity (Larsen, 2009; McKechnie, 1999) and are a consequence of the complexity of cultural and social influences (Enticott, 2009; Pidgeon, 2008; Wynne, 1992b). These influences are from supportive sources that are sought once risk information is received (Langford et al., 1999, p. 45). One supportive information source for farmers is vets, and differing risk perceptions between the two have been reported (Simon-Grife et al., 2013). For example, among Spanish pig farmers the use of vaccination was mentioned by farmers as a biosecurity risk management
practice used during non-outbreak times, but it was not stated at all by vets (Simon-Grife et al., 2013, p. 226). Trust in risk information sources, such as vets, is recognised to be key because of the existing social relations between vets and farmers (Wynne, 1992a). Trust and risk are intertwined and the concept of trust is discussed below.

**Trust**

The main way that trust is applicable to this discussion by examining the ‘relations between members of the public and scientific experts’ (Yearley, 2000, p. 106). This also affects governments, as science informs a good biosecurity system (Beale et al., 30 September 2008, p. XV) and recommended practices (Food and Agriculture Organization of the United Nations, n.d-a). Trust is relevant to biosecurity studies because part of governments’ role as risk communicators is, ‘protecting the public from risks’ (Palmer, 2009, p. 60). This means that a level of trust is imperative to ensure that messages are received and preventative practices are implemented.

Although the complex ‘relationship between risk and trust is not well understood’ (Ilbery, 2012, p. 308), trust needs to be understood in relation to risk (Giddens, 1990, p. 30). Trusting relationships are much easier and quicker to destroy than develop (Langford et al., 1999; Slovic, 1999). The trusting relationship to consider for biosecurity is between farmers and governments. This is perhaps even more relevant now in Australia because of
the increasing emphasis on shared responsibility and declining public resources for post-border biosecurity. Therefore, there is a level of trust required for this relationship between farmers and government to fulfil their biosecurity roles and responsibilities.

The main issues of trust, or the lack thereof, are between farmers and governments (Enticott, 2008b; Palmer, 2009). Since the 1970s, the Australian government has removed subsidies and on-farm extension support (Vanclay & Lawrence, 1995). This is one contributing reason why farmers’ perceive that governments are untrustworthy (Palmer, Fozdar, & Sully, 2009, p. 363). Neoliberalist thinking means that these services, once provided by government, are now user pays. For example, in Australia, public funding for one-on-one extension was replaced by group extension and was observed through the rise of Landcare groups (Pannell et al., 2006, p. 1420).

Specifically, the Australian wool industry has received limited government funding for extension over the past 20 years and private extension services have failed to meet industry needs (Hunt & Coutts, 2009, p. 39.)

Risk and trust are entwined in the relationship between governments and farmers. A study of Norwegian dairy farmers found that perceived institutional risks were the farmers prime source of risk (Flaten, Lien, Koesling, & Valle, 2005, p. 23). Enticott also finds an ‘erosion of trust’ between farmers and government (2008b, p. 1578), whereby governments do not communicate effectively with farmers or use their local knowledge to decide on a better solution. The internalising or ignoring of information is dependent on the level
of trust (Eiser, Miles, & Frewer, 2002, p. 2425). This lack of trust by farmers toward government (Hernandez-Jover, Schemann, East, & Toribio, 2015; Naylor & Courtney, 2014) is seemingly common and ultimately does not lead to the best outcome for either party.

The mistrusting relationship between the public and science

The publics’ past experiences of ‘poor risk communication’ from governments has led to a mistrusting relationship (Pfeiffer, 2006; Wynne, 1992a). Farmers receive conflicting information (Vanclay, 1992a, p. 11) from governments and media in regards to animal health during outbreaks, and this can lead to trusting relationships experiencing damage. The complex nature of relationships, including trust, contributes to the way in which issues are received and perceived from expertise within scientific institutions (Lockie & Measham, 2012; McKechnie, 1999). One example of this was seen as a result of poor risk communication during the BSE outbreak (Pfeiffer, 2006, p. 262). During the 1986 British BSE crisis the government attempted to reduce cattle industry losses by downplaying the impacts of human exposure, resulting in the loss of trust between the public and government management (Tilney, 2004, p. 32). Unfortunately, over time the level of public trust in scientific institutions has diminished. Wynne suggests that a reason for this dissolving trust is the scientists’ assumptions and objectivist language, which should be challenged by the public (1996, p. 59)
Wynne’s study of the misunderstandings between farmers and scientists is often referenced (Irwin, Simmons, & Walker, 1999; Measham & Lockie, 2012), and the significance of his seminal research is that it demonstrates the uncertainties of scientific research findings and the importance of trust (Wynne, 1996, p. 20). Wynne’s study of farmers’ sheep affected by radioactive fallout from the Chernobyl accident provides another English example about the way in which scientific information is received by farmers, but not adopted (Wynne, 1996, p. 19). Farmers were involved in the scientific data collection process, however, they recognised inconsistencies regarding the locations of the monitoring and how samples were taken by scientists (Wynne, 1992b, p. 32). This data was not interpreted or presented in a useful way for farmers, which resulted in non-acceptance of the results (Wynne, 1992b, p. 20). Farmers perceived that their identities and knowledge were marginalised by the scientists, and were therefore less trusting of the results of the study (Wynne, 1996, p. 20). From this study we learn that the interaction between scientists and farmers is imperative and if there are perceived trust issues this can impact on the way scientific knowledge is received (Wynne, 1996, p. 21). This is relevant to the current research because both show the shortcomings of scientific studies in terms of including farmers’ perspectives and input into the findings.

Closer to home, West Australian sheep and cattle farmers have perceived that risks are linked to their trust in the government. The main trust concern in Western Australia relates to farmers reporting animal health concerns to the
local vet. There are very few vets per livestock unit, compared with other states in Australia and as a result, there is little reporting to vets, which means there is no evidence to suggest that diseases exist in Western Australia (Palmer, Fozdar, et al., 2009, p. 361). However, it more likely indicates that there is little trust in the government. Governments have no control over the reporting process. They can only inform farmers through agricultural extension methods such as education campaigns and communication strategies (Palmer, Sully, et al., 2009, p. 33). These types of extension methods have been reduced, although they are re-appearing in different formats, such as online. Palmer et al’s study shows that a level of trust is necessary to manage biosecurity issues. Trusted sources remain important for activities, such as biosecurity, where risks and benefits are not immediately tangible (Siegrist & Cvetkovich, 2000, p. 713). The role of trust is important in promoting biosecurity. However, what must also be considered are farmers’ existing practices and priorities and how these influence engagement with biosecurity. Farmers’ biosecurity knowledge and practices stem from a combination of scientific and local knowledge.

**Scientific and local biosecurity knowledge**
Scientific knowledge, for example veterinary science, plays a crucial role in biosecurity governance. Biosecurity governance, from the international through to the sub-national level, is heavily influenced by science that informs the biosecurity risk analysis approach adopted by many Western countries (Nairn, Allen, Inglis, & Tanner, 1996). This represents a linear style of knowledge distribution, which flows from scientists to governments and then to farmers. The top-down approach to knowledge dissemination has historical significance, and has tended to dominate the agricultural field for the past 60 years (Rogers, 1995). Scientists tend to overlook local farmer knowledge and do not incorporate anecdotal evidence into their studies (Enticott, 2001, p. 158) because it cannot be measured and validated in the same manner as scientific knowledge (Wynne, 1989). This has created a gap between scientific and local knowledge (Naylor et al., 2015). Local, public, lay and citizen knowledge are all terms that are used interchangeably in the literature as they refer to everything that is not institutionally bound. This section of the literature review explores the themes of the science vs. citizens debate, how science is communicated to publics (including biosecurity), how farmers’ knowledge is disregarded or downplayed by science, and the significance of farmers’ knowledge in biosecurity. Firstly, the role of science and governance is addressed.
Science and biosecurity governance

Science plays an imperative role in biosecurity governance because it is what national and sub-national governments utilise to conduct risk assessments and inform policy. Currently Australian biosecurity policy is based upon scientific research (New South Wales Department of Primary Industries, 2011). This models the international WTO SPS agreement, which uses a science-based risk assessment framework (Miljkovic, 2005). This filters down to the NSW state level where scientific researchers meet with the policy team, and the science informs government policy through devising suitable management strategies (Department of Primary Industries, n.d). These policy strategies have post-border implications for practices such as surveillance, monitoring and boundary maintenance during outbreaks (Beale et al., 30 September 2008). In Australia, there is a reciprocal history of scientists and farmers not utilising one another’s knowledge (Carr & Wilkinson, 2005, p. 255), and social science biosecurity research suggests the same (Enticott, 2008b; Wynne, 1996). The existing biosecurity knowledge of local farmers is one area this thesis will explore. Part of the problem from the perspective of the scientific community is that the public is assumed to have a scientific literacy deficit (Durant & Evans, 1989; Miller, 2004), which is discussed below.
Biosecurity is a scientific term, and as such it can be viewed as another arena where the public is assumed to be lacking understanding and knowledge. The deficit model is characterised by adult publics who are assumed to have low scientific literacy rates (Irwin & Michael, 2003, p. 22; Siegrist & Cvetkovich, 2000). The deficit model is the dominant approach used in scientific communications. This deficit has proved problematic as the public needs to know scientific knowledge in order to better understand and consume scientific and technological developments (Irwin & Michael, 2003, p. 23). This has implications for biosecurity messages that are delivered by governments and industry because they are scientifically based. Farmers, who are part of the farming subculture (Vanclay, Mesiti, & Howden, 1998) and a portion of adult populations, feel isolated from governments and science (Enticott & Vanclay, 2011, p. 305). This could be a consequence of farmers potentially not understanding the complexities in scientific communications due to the public’s apparent ignorance of science. The other view is that publics are able to comprehend scientific information when they are motivated to do so (Wynne, 1991, p. 118). This suggests that there is a need for scientific information to be locally contextualised and presented by trusted sources to local producers.

Rural studies have shown farmer knowledge making a positive contribution to biosecurity management in scientific inquiries (Enticott, 2001; Mather & Marshall, 2011; Wynne, 1992a). This points to a need for scientists
and governments to take heed of public knowledge and shift away from the traditional top-down flow of information (Irwin & Michael, 2003, p. 42). Part of farmers’ identity is knowing that they are good farm managers (Gray & Phillips, 2001; Vanclay et al., 1998). Therefore if farmers are not perceived as being useful to scientists, it can threaten their identity. It is important to recognise that each actor has legitimate knowledge (Enticott & Vanclay, 2011, p. 304).

The overwhelming conclusion in the current scholarly literature on post-border biosecurity practices is that farmers are not engaged sufficiently in biosecurity on-farm (Brennan & Christley, 2013; Nampanya, Rast, Khounsy, & Windsor, 2010) and part of the problem is their lack of knowledge (Heffernan et al., 2008, p. 364). The literature suggests that a narrative of increasing farmers’ knowledge will contribute to improvements in on-farm practice, which will in turn ensure greater compliance. At this stage the sheep industry has no experience with exotic incursions and compliance only extends to the use of NVD and NLIS. Farmers’ biosecurity behaviours are evaluated and their practices appear to be low or non-compliant (Dorea, Bergaus, Hofacre, & Cole, 2010, p. 1013). Scientists and governments continue to use the deficit model when communicating messages, which means farmers local knowledge will continue to be overlooked.
Science vs. citizens debate

The perception of science as the cultural authority has brought about an ongoing conflict between science vs. citizens (Gauchat, 2011; Miller, 2004; van der Ploeg, 1993; Wynne, 1996; Yearley, 2000), and how much scientific literacy the public needs in order to participate in policy issues (Miller, 2004, p. 273). Local knowledge conflicts with scientific expertise (Yearley, 2000), and what needs to be understood is how the separate categories of knowledge relate to one another (Leach, Scoones, & Wynne, 2005).

Since the early 1990s, lay knowledge and citizen science has been studied ‘alongside scientific forms of knowledge and understanding’ (Irwin et al., 1999, p. 1311). Previously, members of the public were assumed to be passive members of the relationship, because of the authoritative nature and knowledge of experts (McKechnie, 1999, p. 126). However, the current system of participatory democracy means that the public plays an active role in contributing to governance (Slovic, 1993). As a result, scientific literacy among voting populations needs to be increased so that citizens can sufficiently engage and act in the political sphere (Irwin & Michael, 2003; Miller, 2004). Scientific knowledge remains dominant in policy-making compared to public knowledge. The implications for this research are that farmers’ tacit biosecurity knowledge may be overlooked in both science and policy arenas.

The public has been labelled as having ‘lay or contextual knowledge’ (Irwin et al., 1999, p. 1311) by scientists. Scientific knowledge is held up as
the authority. However, the publics’ attitude towards science has changed, and one reason suggested by social commentators, such as Beck, is a result of late modernity and a differing public view of having scientific knowledge as the authority (Gauchat, 2011, p. 752).

The idea of ‘reflexive modernisation’ is used by Beck to describe a societal process through which the institutions in which scientific and technical expertise are embedded are simultaneously elevated in importance yet challenged by industry, citizen, non-government groups mobilising their own ‘knowledge’ and ‘expertise’ (Measham & Lockie, 2012, p. 5).

Science presumes an entitled status in society (Naylor et al., 2015; Yearley, 2000). As we further conceptualise the boundaries between the parties, labels such as ‘expertise’ (McKechnie, 1999, p. 127) remain in the discourse, yet expertise is a changing and contested term (Kerr, Cunningham-Burley, & Tutton, 2007, p. 385).

Risk experts believe that citizens cannot comprehend technical information, which leaves them liable to making fear-based assumptions or other rationales (Fischer, 2005, p. 55). There are five reasons that experts perceive difficulty with involving the public: ‘it is unnecessary within democracies; lay people lack expertise; they are not representative; there is commonly a lack of trust; decision-making is made more complex’ (Curry, 2012, p. 345). These reasons suggest that until there is a shift in scientific thinking to be mindful and inclusionary of ‘lay knowledge’, the ‘expert’ and ‘lay’ dichotomy will continue. This is problematic for biosecurity because farmers’
knowledge has a significant role in on-farm management, which currently appears to be overlooked by science.

*Lack of space for farmers’ knowledge in science*

Numerous scientific studies that adopt a positivist approach have been criticised for not acknowledging farmers’ understanding of the local environment (Riley, 2008), and for dismissing their ‘non-scientific’ knowledge (Pellizzoni, 2003, p. 330). The outcome of scientific studies is the diffusion of seemingly universally applicable scientific knowledge (Clark & Murdoch, 1997), which seems to only appease the scientific community, rather than the farmers. The scientific community has a different set of knowledge compared with farmers, which can be problematic. For example, farmers’ different knowledge compared to scientists resulted in a different set of definitions of an ‘ideal type’ of potato for Andean potato farmers (van der Ploeg, 1993). This was problematic as scientists determined the superior specifications of the potato, in the hope that farmers would adopt the new type. This example shows us that scientists need to maintain a dialogue with farmers, not only to appreciate their farming mastery, but also to work together with participants to create, in this example a product with the target audience.

There is space for local knowledge in science. Irwin, Simmons and Walker (1999) theorise three reasons why public knowledge is useful:

1. Lay views make the decision making process inclusive and legitimate.
2. Public knowledge contributes to policy making and debate.  
3. There are positive gains for policy makers and decision makers to listen to the publics’ contribution (1999, p. 1312).

Irwin et al’s case study of the social impacts of a chemical plant incident and local farmers’ risk perceptions in England show the importance of collective memory (1999). The local community were able to recall their impressions of the health outbreak, which was aided by individual observations (Irwin et al., 1999, p. 1315). If public knowledge was utilised the science would be better trusted and best management practices may be more widely adopted (Clark & Murdoch, 1997; Palmer, 2009; Riley, 2008; Wynne, 1992b).

Farmers are considered by some epidemiological scientists to have a lack of biosecurity knowledge (Heffernan et al., 2008; Moore, Merryman, Hartman, & Klingborg, 2008; Permin & Detmer, 2007; Racicot, Venne, Durivage, & Vaillancourt, 2012). The implications of a lack of biosecurity knowledge mean that often the recommendation is to increase farmer education of good biosecurity practices. This literature is from abroad and features in other livestock industries¹. For example, in Belgium less than 10 per cent of livestock farmers were able to articulate a definition for biosecurity (Laanen et al., 2014, p. 4). However, findings from overseas and Australia are limiting in the way that they assess farmers’ understanding of biosecurity, because they rely on a pre-existing definition of biosecurity developed by scientists and governments, which does not incorporate farmers’ understandings.

¹ This may be problematic as perhaps lessons learned overseas many not be applicable in the Australian sheep context.
In Australia farmers’ biosecurity knowledge is ascertained by asking them to define the term. In 2010, 16 per cent of Australian peri-urban farmers had no understanding of the term (Gilmour, Beilin, & Sysak, 2011, p. 288). Animal Health Australia (AHA) funds a triennial survey of biosecurity awareness in livestock producers across the country captures farmers’ understanding of the term biosecurity. In 2013 AHA survey results showed that almost half of the farmers surveyed gave definitions of biosecurity that were categorised as ‘related to controlling pests, weeds and diseases’ (Animal Health Australia, April 2014). The narrow way that Australia currently measures farmers’ biosecurity knowledge means that their tacit knowledge continues to be overlooked.

Although farmers’ localised knowledge tends to be disregarded (Morris, 2006; Vanclay, 2011; Wynne, 1996) it can be used to inform science and, consequently, policy. Morris (2006, p.114) describes how farmers should be included in agri-environmental policy, but this requires acceptance, understanding and incorporating both farmers’ and policymakers’ points of view. One example from the social science biosecurity literature is Enticott’s English badger study (2011), which demonstrates the disconnect between scientists and farmers as scientists repeatedly try to rid the countryside of badgers carrying Bovine Tuberculosis (bTB). His study details the Department of Environment, Food and Rural Affairs (DEFRA) scientists using statistical observations, which are ‘standard scientific practice’, to determine the cause, rather than how the disease was spread (Enticott, 2001, p. 155). However,
there was no proof that the badgers actually transmitted bTB. Scientists rejected the notion that farmers’ tacit knowledge could contribute to their research, although the National Farmers Union (NFU) recognised that the experience of farmers could contribute to good biosecurity practice (Enticott, 2008b, p. 1576). However, in England this localised knowledge or ‘anecdotes’ is problematic for policy makers to use in the decision-making process (Enticott, 2001, p. 158). Policy makers prefer quantitative methods of research as evidence because they believe it speaks more holistically of populations, rather than individual accounts (Enticott, 2001, p. 158).

Another useful example is the way in which global warming has been communicated on a scientific platform. As Holloway argues, this marginalises other knowledge, thus shaping farmers’ understanding of scientific knowledge (1999, p. 2017). Scientists’ findings would be most useful if they were integrated with farmers local understanding (Wilson, 1997, p. 307).

Ideally, for the science vs. citizens debate to have some resolution it would be useful for farmers and scientists to work together developing experiments and understanding the results – the triple loop learning approach (Eshuis & Stuiver, 2005, p. 143). Morris believes that a negotiation of knowledge from both parties can occur (2006, p. 122) and Tsouvalis et al provides examples of the existence of negotiation in differing knowledge cultures (2000). Negotiated knowledge enables various values across both groups – lay and professional – to be utilised and a greater understanding of the differing perceptions. Additionally, educating the public is important for
policy makers when it comes to addressing risk in an understandable way (Leach et al., 2005, p. 10). For biosecurity, the top-down process is common (Barker, 2008a, p. 1606), and the publics’ role is continuously undervalued. The undervaluing leads to a feeling of ‘institutional alienation’, where the public is disconnected by a lack of trust in bureaucratic institutions (Gauchat, 2011, p. 758). Farmers’ experience is ‘engaged and negotiated with increasingly specialised scientific knowledge forms’ (Holloway, 1999, p. 2017).

Contribution to the knowledge by both farmers and scientists may result in less conflict and rejection of scientific based knowledge (Eshuis & Stuiver, 2005). Currently, the literature shows science disregarding local farmer knowledge. In practice, this has implications for farmers’ uptake of biosecurity.

**Farmers’ uptake of biosecurity practices**

The implications for the uptake of practices is that they may go unrecognized or unreported by researchers who have different definitions of good biosecurity. Despite this farmers implement biosecurity practices to protect their properties from pest, weed and disease outbreaks. Farmers’ biosecurity knowledge and practices are often overlooked in the veterinary epidemiological literature, where existing research tends to focus on farmers’ attitudes towards biosecurity. For example, other Australian biosecurity studies have investigated farmers’ attitudes in the poultry (Hernandez-Jover et
al., 2015), pig (Hernandez-Jover et al., 2012), cattle and sheep (Palmer, Fozdar, et al., 2009) and horse industries (Firestone, Schemann, Toribio, Ward, & Dhand, 2011). These studies use top-down, researcher-imposed definitions of ‘good’ biosecurity and, as will be discussed in more detail later in this thesis, in doing so overlooks the depth of knowledge and practices that farmers deem significant in managing flock or animal health. Current Australian post-border biosecurity literature groups all grazing livestock together. However, this study only considers sheep as one particular cloven-hoofed species.

Information on farmers’ biosecurity practices, both abroad and in other industries, is frequently collected through survey methods, which often find that rates of implementation are poor (Casal, De Manuel, Mateu, & Martin, 2007; Gunn, Heffernan, Hall, McLeod, & Hovi, 2008; Heffernan et al., 2008; Noremark, Frossling, & Lewerin, 2010). In Australia, poultry exhibition farmers have been found to have moderate knowledge of biosecurity (Hernandez-Jover, Schemann, & Toribio, 2013). Small-scale pig farmers inconsistently use tags for traceability, even though it is a national requirement (Hernandez-Jover, Schembri, Toribio, & Holyoake, 2008, p. 1692). The equine industry experienced an influenza outbreak in 2007. At the time this prompted an increase in biosecurity practices, and 70 per cent of survey respondents were identified as having medium and high biosecurity compliance with good equine practices (Schemann, Taylor, Toribio, & Dhand, 2011, p. 307). A study of West Australian cattle and sheep farmers found little reporting to vets of
animal illness and deaths, which suggests that no evidence of disease exists (Palmer, Fozdar, et al., 2009, p. 361). These studies conclude overwhelmingly that Australian farmers’ from across a range of industries are reported to have poor biosecurity practices. This signifies a disconnection between recommended practices and on-farm uptake.

A reason for the disconnection is that the majority of biosecurity practices at the individual farm level are voluntary and some only become mandatory during an outbreak. For this study government recommended practices are found on the Farm Biosecurity website (http://www.farmbiosecurity.com.au/toolkit/plans-manuals). These practices, as set out by national and state government agencies, are considered best practice. However, farmers may not be aware of these biosecurity practices (Black & Kireeva, 2009, p. 91). ‘Good’ biosecurity practices can be viewed like any other insurance policy in that they reduce risk. Farmers practice risk reduction by seeking knowledge of best practice (Sligo & Massey, 2007, p. 170), but risk knowledge is changeable (Le Heron, 2005, p. 194). This means that farmers need to source relevant information specifically on biosecurity.

Farmers gather information from a multitude of different sources, which is problematic because biosecurity knowledge may be labelled differently and intertwined with other sources of information. This labelling makes it difficult to accurately ascertain how much farmers really know about biosecurity, as their on-farm biosecurity practices are often part of broader farm management. As Vanclay and Glyde found in regards to land degradation and
farmer knowledge, it is hard to assess the knowledge standard as there is no comparison or understanding of what farmers should know (1997, p. 60). Part of this is farmers knowing what exactly to look for. There is a biosecurity awareness campaign in Australia that takes the form of calling 1800 084 881 if a member of the public sees something abnormal. However, much like soil salting and soil erosion (Vanclay, 1992b), it is about farmers knowing the early warning signs. For example, the sheep/goat industry biosecurity plan does not detail the types of prevalent diseases, or what to look for or how to deal with them (Farm Biosecurity, 2003). Farmers’ input into such information sources is minimal.

Usually farmers receive a lot of information from a number of different agencies which can be conflicting (Vanclay, 1992a). However, in Australia biosecurity information almost always comes from state or national government agencies. Vanclay declares that if farmers knew the indicators there would be sufficient time to take the appropriate steps (Vanclay, 1992b, p. 106). He subtly suggests that extension information that advertises the early warning signs is more beneficial than the dramatic worst case scenario visuals (Vanclay, 1992b, p. 110). A comparison of extreme environmental degradation with the extreme culling pictures in the aftermath of the FMD outbreak in the UK news could be applied as both demonstrate some limitations of presenting information in this way.
Farmers’ knowledge and learning from scientific communications

The way in which scientific knowledge is relayed to the public, in this case farmers, is sometimes not well received (Wynne, 1992a, p. 21). One reason is because farmers’ knowledge, specifically their identity and relationship with the natural environment, exists in separate spheres compared to that of scientists or policy makers (Morris, 2006, p. 117). Farmers are not a homogenous group (Vanclay & Hely, 1997), and therefore how information is communicated needs to be on a variety of levels in order to engage them. The way scientific advice is administered does not account for local conditions, and therefore farmers often cannot adequately adapt the suggestions from the scientists to improve their yield (Wynne, 1996, p. 21). Despite Andean potato farmers having different issues compared with Australian sheep farmers, links have been made in Australian examples where participating in good biosecurity practices contributes to increasing productivity and profitability (van der Ploeg, 1993).

The theme of farmer knowledge links to the current study because it is important to appreciate the tacit knowledge that farmers have and the reasons for non-adoption of recommended practices. There is a much larger body of literature regarding farmers’ knowledge and adoption of new practices, especially in the Australian context (Vanclay, 1992a; Vanclay & Glyde, 1994; Wilkinson, 2011). The relevance of this work to the current study is the recognition that farmers’ knowledge matters. However, local farmer
knowledge has been continually missing from government reports and findings, which has impacted on the positive outcomes.

Scientific information for farmers usually comes from state agencies and industry bodies, which is then disseminated in rural publications, through agribusiness firms and through other farmers (Vanclay & Lawrence, 1995, p. 90). This means that farmers are subject to ‘the biosecurity agenda of regulatory bodies’ (Black & Kireeva, 2009, p. 91), which points to local knowledge being overlooked. This contributes to an ongoing communication misalignment between scientists and farmers, which has resulted from the way that information is communicated by regulatory bodies.

Biosecurity extension, such as education campaigns (Palmer, Sully, et al., 2009), has adopted the traditional top-down approach to knowledge transfer (Enticott & Wilkinson, 2013, p. 91), which includes the use of post-border biosecurity personnel. Farmers are experienced at receiving traditional extension through this top-down linear method. However, top-down extension has been criticised as inappropriate because it uses the diffusion of innovations model. In the Australian experience this method has not been beneficial for encouraging environmental practices (similar to biosecurity in that they are voluntary), because farmers’ knowledge is ignored and innovations are assumed to benefit farmers (Vanclay, 2004, p. 219). Instead, using multiple methods of extension is advocated as one of the best ways for the message to be communicated to farmers ‘to reinforce the message in different ways’ (Vanclay, 2011, p. 64).
Government-funded extension is one source of information that farmers use (Pannell et al., 2006, p. 12); however, ‘science and extension do not have automatic legitimacy and credibility’ (Vanclay, 2004, p. 220). Less funding and the failing of scientific research to appreciate local farmer knowledge creates farmer resistance to biosecurity information because of the way it is presented (Enticott, 2008b, p. 1576). Enticott found that even though farmers wanted scientific-based research on biosecurity, they rejected it as there was no input of their localised knowledge (Enticott, 2008b, p. 1576). A mix of local knowledge and scientific knowledge is needed for successful biosecurity, much like sustainable farming practices, which is why transfer of technology (TOT) models do not have the same merit (Ingram, 2008, p. 406).

Vanclay (2004) theorises 27 social principles as a way to examine extension and consider the challenges that farmers face. Those that are particularly relevant to this study are: Adoption is a socio-cultural process and farmers construct their own knowledge (Vanclay, 2004). Even though biosecurity is not just adopting one technology, but adopting a range of practices, it adheres to a socio-cultural process. Adoption of ideas or practices occurs when they are recognised as contributing to good farm management (Vanclay, 2004, p. 214). This also relates to farmers constructing their own knowledge, as farmer knowledge is developed through trial and error. Farmers have their own world view, and new technologies will be more easily and readily adopted if they are harmonised with their own practice, thinking and goals (Vanclay, 2004, p. 215). Vanclay’s findings and the recognised
limitations in Australian extension can be applied to the adoption of biosecurity practices. It may demonstrate some problems in the existing extension structure that impacts biosecurity.

It is now recognised that top-down extension is ineffective (Vanclay, 2004, p. 219), although this has been the predominant method used to encourage farmers to adopt good biosecurity practices in Australia. The implications of this has meant that while there is a general awareness of biosecurity, thanks to the media, the specific on-farm biosecurity practices are not always carried out (Flaten et al., 2005; Van Wagner, 2008). For example, in the Australian equine influenza outbreak of 2007 biosecurity guidelines were distributed by NSW DPI, which ‘included personal hygiene as well as equipment hygiene and access control measures’ (Schemann et al., 2011, p. 305). However horse owners were found to be non-compliant with the recommended measures (Firestone et al., 2011). Extension works better with multiple methods and when taking into account farmers’ unique situations (Vanclay, 2004).

The media has played an important role in transferring information from scientists to the public (Joffe, 1999, p. 92). During outbreaks, this has had both positive and negative biosecurity outcomes. Science has traditionally been at the forefront of biosecurity since its inception because it shapes BMP for governments, industry and farmers alike. A positive example of people complying with biosecurity recommendations can be found in Neupane, Khanal, Ghimire, Aro and Leppin’s study of avian flu in Nepal (2012). Their
research reveals that farm workers implemented the recommended biosecurity practices of washing their hands during the avian flu outbreak (Neupane, Khanal, Ghimire, Aro, & Leppin, 2012). This biosecurity information was communicated via radios, newspapers and television (Neupane et al., 2012). It was a reactionary process, but the media campaign enabled successful biosecurity practices to be adopted, which ultimately minimised the potential effects of the outbreak. The media campaign was successful in reaching farm workers who adopted the biosecurity practices more often than the farm owners (Neupane et al., 2012).

This contrasts with the UK FMD experience of good biosecurity practices that were also communicated via the national media. However, it proved less successful – the information and advice was inconsistent (Nerlich & Wright, 2006, p. 457). One issue with using national media is the limited depth of scientific information that can be provided in the allotted news story time frame (Miller, 2004, p. 282). Additionally, due to low scientific literacy rates (Miller, 2004) this places greater pressure on communication tools such as the national media to provide adequate information. Scientists perceive risk in using the national media that is comprehended by the public because there is a chance of different interpretations (Pfeiffer, 2006, p. 261). These are examples of the public being active in their engagement with scientific knowledge (Holloway, 1999, p. 2019). This type of risk communication has varied success. Despite farmers receiving conflicting information, they have to
be accepting of governments’ biosecurity best management practices because this is where the scientific knowledge primarily comes from.

From the literature it is shown that farmers’ uptake of biosecurity practices is poor and inconsistent. While the veterinary epidemiology literature explains this ‘problem’ in terms of farmers’ limited awareness and understanding of biosecurity, the sociological literature suggests that the reason for poor uptake relates to farmers’ tacit knowledge and practices being under-utilised and often overlooked. However, the sociological literature on farmers’ tacit knowledge and practices is yet to be systematically applied in the context of farm biosecurity. The following section considers how, through the notion of ‘good farming’, such knowledge and practices can be applied in a farm biosecurity context.

**Theoretical framework**

Good farming is used in this thesis as a theoretical framework as farmers’ biosecurity practices and knowledge provide rich examples of good farming. The theoretical framework used to underpin this thesis is the notion of good farming. Good farming is a culturally defined concept that varies within farmers’ social groups (Warren, Burton, Buchanan, & Birnie, 2016, p. 176). The notion of good farming is referred to as how farmers see
themselves as producers of the nation’s food supply (Burton, 2004, p. 195). Farmers’ identity is linked to seeing themselves as good farmers (Burton, 2004, p. 196). Biosecurity has not previously been applied to the notion of good farming. Farmers’ knowledge and practices are key to minimizing outbreaks and thus understanding them in the light of being active farm managers rather than as passive actors who must be told how to manage their own business. Farmers’ biosecurity practices are engaged in when they align with their individual values, goals and risk management (Higgins, Bryant, Hernadez-Jover, McShane, & Rast, 2016, p. 1148), in addition to their perception of good farming. This notion has been applied to other Australian rural studies (Bamberry, Dunn, & Lamont, 1997; Gray & Phillips, 2001) and abroad (Burton, 2004). Therefore, the established notion of good farming can also be applied to biosecurity. Currently, there is limited consideration in the literature of biosecurity under the theoretical framework of good farming. A reason for this choice is that farmers’ biosecurity knowledge and practices can be used an example to demonstrate good farming. Good farming is best suited for this study as consideration of farmers’ knowledge and practices are key.

Historically, the notion of good farming was tied to the productivist model (Burton, 2004, p. 195). The productivist model was predominant from World War II until the 1970s, where farmers’ role was to produce sufficient food for the population (Higgins et al., 2016, p. 1141). Good farmers were characterized by those who could increase production (Burton, 2004, p. 197). This meant that farms were intensive systems of production, which resulted in
some destruction to the landscape. Attempts to reverse landscape have been in governments agendas in the UK since the 1970s, where subsidies were used to encourage farmers to be land custodians and move away from intensive production (Burton, 2004, p. 195). Environmentalism, similar to biosecurity, is a voluntary set of practices that continue to challenge the notion of good farming. For example, there may be lowered social status for the farmer due to adopting new environmental behaviours (Burton, 2004, p. 196). Good farming remains a dynamic concept, which utilizes farmers’ knowledge as central to how good farmers are locally defined.

In practice good farming can be demonstrated when farmers utilize their local knowledge, which is expansive, and how they interpret their landscape to produce robust stock. Riley provides the example of farmers knowing the local weather signs (Riley, 2008). Scientists provide regional weather forecasts, but farmers’ intimate knowledge of their land means that they know what signs to look for and what the day’s weather will bring (Riley, 2008). This type of expert knowledge can contribute to them farming better as decisions are made utilising both scientific and local knowledge.

Part of farmers’ local knowledge perspective is how they see the rural landscape. Farmers’ perception of what a tidy landscape is differs from that of the public (Burton, 2012, p. 51). For example, farmers have an aesthetic preference that includes straight lines in the paddocks, and at different times of the year different activities will determine their status as good farmers (Burton, 2012, p. 58). Good farmers are judged by other farmers to have
‘tidy’ properties (Burton, 2012, p. 55). Tidy landscapes are challenged by newer understandings of good farming practices, such as environmentalism and increasingly biosecurity. For example, tree planting on farms to reduce salinity in the paddocks may mean plowed landscapes are straight lines because of the trees present. These particular adaptations to the traditional productivist role of farmers mean that the landscape, in addition to the definition of good farming, will change.

In the Australian context good farm management has been applied primarily to sustainable agriculture since the 1990s. Good farming is culturally defined as farmers who farm conservatively and take few risks (Phillips & Gray, 1995, p. 131). Further, farmers can be innovative by participating in sustainable practices (Phillips & Gray, 1995, p. 130). These definitions change as farming practice is redefined and consequently articulated by farmers. Phillips and Grays’ (1995) study is set in the Australian context and is relevant to the topic of biosecurity because many of the farming practices these farmers carry out are a sign of good farm management. Specifically, it is in the farmers’ interests, both financially and for perceptions of good farming, to minimise animal health problems that occur through pest, weed and disease incursions.

Since the 1990s in Australia, improving the farming environment became a government priority as paddocks were degrading from the removal of trees for agricultural production. Government initiatives were put in place to increase farmers’ awareness of the environment and encourage tree planting
on-farm. More recently, financial incentives have been paid to farmers, via market-based instruments, to encourage the adoption of environmental practices (Phillips & Gray, 1995, p. 130). Some of the issues addressed in rural environmental studies align with biosecurity. Both environmental and biosecurity initiatives have experienced low adoption rates; adoption of practices are more likely to occur when farmer’s expect said practice to complement their personal goals and align with the government initiative (Phillips & Gray, 1995, p. 131). Further, neither conservation nor biosecurity are directly concerned with increasing farm profit. They include proactive practices to greater ensure future on-farm survival, such as pest and weed management and vaccination of stock.

Participating in best management practices, as defined by experts, on-farm is part of being a good farmer. However, there are many examples where scientifically endorsed biosecurity best management practices have failed. Sometimes best management practice changes and some practices are only visually appealing, rather than being effective at minimising disease spread. Specifically, badgers have been problematic since the 1960s in England, and they have been conceptualised as pests because they disrupt the human/animal boundary (Phillips & Gray, 1995, p. 130). England has experienced a multitude of waves of eradication that has only resulted in their population numbers increasing due to disruptions of the very territorial badger boundaries (Phillips & Gray, 1995, p. 131). Changing management practices has implications for how farmers see themselves as good farmers.
Another example of changing management practices occurred during the UK FMD outbreak. Advice on biosecurity practices changed, through debates between policymakers and scientists (Morrison, Grieg, Read, Waller, & McCulloch, 2015; Pannell et al., 2006). As a result biosecurity staff experienced a large learning curve (Gilmour et al., 2011; Pannell et al., 2006), which made it difficult for farmers to determine how to ‘do the right thing’. For example, visually appealing practices such as closing footpaths in rural communities; disinfectant drive-over pads were placed on roads by both farmers and council staff (Cassidy, 2012, p. 207), and straw mats were used to remove dirt from tyres (Enticott, 2008b, p. 1572). All of these visually appealing practices were later deemed ineffective. However, these physical actions by various actors make biosecurity visible (Nerlich, 2004, p. 50). The examples of badger management and FMD demonstrate some of the extremes of science biosecurity communication failure. The negative experiences are economically costly, which means that there are limitations in the current system that social science research, such as this project, can attempt to understand. Local knowledge also contributes to the notion of good farm management.

This thesis applies the notion of good farming as discussed by rural sociologists to make sense of how farmers’ knowledge and practices influence how they do on-farm biosecurity. Additionally, this thesis contributes to the emergent social science biosecurity literature by recognizing the important role of good farming in regards to biosecurity boundaries, risk management and
acquiring knowledge about biosecurity. This contribution is achieved through the following three research questions:

**Research questions:**

- What role does farmers’ local knowledge play in their understanding of biosecurity and how do they learn about it?
- Which practices do farmers engage in to prevent threats and manage biosecurity on-farm?
- How do farmers manage risks and in what ways does this impact their ability to implement the recommended biosecurity practices?

**Conclusion**

This literature review has argued that farmers are being required by governments to play an increasingly significant role in post-border biosecurity. However, there has been a limited focus on farmer knowledge and practices in the social science biosecurity literature. The notion of good farming is used to frame this study as how farmers see and define themselves has implications for biosecurity practices. Social science research on biosecurity abroad has focused on emergency outbreaks, such as FMD in the UK or Asia’s bird
influenza. Both Enticott and Palmer et al explicitly state that there is a lack of published work on farmers’ biosecurity practices (Enticott, 2008b; Palmer, Sully, et al., 2009). This is where this thesis seeks to make a contribution.

The research questions in this thesis have been developed from the three themes presented in this literature review. They will enhance our understanding of farmers’ biosecurity knowledge and practice, specifically from their perspective. Much of the literature on boundaries focuses on the role of national or international governance agencies in enacting biosecure spaces. Boundaries are defined and enacted by a variety of actors. However, reporting of on-farm management and prevention for biosecurity threats in the social science literature is currently limited. There is a place for farmers’ knowledge in the biosecurity dialogue, therefore it is important to understand farmers’ biosecurity knowledge and how they learn about biosecurity. Biosecurity involves managing some of the risks that are present in agriculture. Given Australia’s size a multitude of actors from governments, industry and farmers are involved in managing biosecurity risk. To fulfil their roles in biosecurity management, a level of trust is needed between each party due to the removal of extension and the introduction of the notion of shared responsibility. As part of shared responsibility, the governments’ role is to raise awareness, which includes the distribution of recommended biosecurity practices, and farmers are expected to manage risks by following these recommendations. This study examines the everyday experience of biosecurity at the farmer
level, which is currently limited attention in the Australian and international literature.

The theoretical perspective chosen for this study is the notion of good farming. Good farming has not previously been applied to biosecurity studies. This thesis seeks to make a contribution to this body of literature by showing examples of good farming that these farmers construct and adhere to in regards to their biosecurity practice. The next chapter details the chosen methodological approach, and research methods.
Chapter 3 – Methodology

Introduction

This chapter outlines the methodology and methods used in this study. As discussed in Chapter Two, farmers’ knowledge and practices provide an important focus for scholarly inquiry because they are at the forefront of biosecurity management and their perspectives have been given limited attention to date in the social science biosecurity literature. The literature review demonstrated that studies of farmers, across a number of livestock industries, have often found poor and inconsistent rates of adoption of on-farm biosecurity practices (Gunn et al., 2008; Heffernan et al., 2008; Noremark & Sternberg-Lewerin, 2014). These types of studies, conducted predominantly by veterinary epidemiologists, are based on the use of survey data and follow a positivist approach. Such an approach is useful for answering ‘what’ questions, and gathering data from large populations of farmers. However, the limitations of these studies are that the ‘why’ and ‘how’ questions are not considered. This means that there is scope for a more exploratory approach to understand farmers’ biosecurity practices in greater depth.

To address the need for a more detailed understanding of farmers’ knowledge and practices an interpretivist theoretical approach is used in this research. Consistent with this approach, semi-structured interviews are used as the main data collection method. Semi-structured interviews provided an
appropriate method to explore and understand farmers’ biosecurity knowledge and practices, and they enable access to the richness of the social relationships that are crucial to an interpretivist theoretical approach. This study differs from other qualitative biosecurity studies on livestock because it focuses on the farmers’ perspective.

The aim of the current chapter is to discuss and justify the methodology and methods used to address the research questions. Firstly, I discuss the theoretical approach underpinning this project. This is followed by an outline of the research methods and techniques of data analysis. Then, finally I address the ethical considerations for this thesis. I begin with a brief overview of the research questions.

**Research questions**

The literature review chapter saw the development of three key research questions:

- What role does farmers’ local knowledge play in their understanding of biosecurity and how do they learn about it?
- Which practices do farmers engage in to prevent threats and manage biosecurity on-farm?
- How do farmers manage risks and in what ways does this impact their ability to implement the recommended biosecurity practices?

These questions guide the following research design.
Interpretive theoretical perspective

To address the research questions, an interpretive perspective was chosen to explore the experiences of farmers. Farmers are the participants whose experiences have been interpreted in the context of their social world (Denzin, 2004, p. 456). Interpretivism applies to this research because it enables exploration into the meaning that participants attribute to their biosecurity practices.

One of the features of interpretivism is its focus on understanding meanings developed by individuals. Meanings are constructed by people in a variety of ways (Crotty, 1998, p. 9) by interacting with others (Neuman, 2003, p. 76). Some qualitative research uses interpretivism as the theoretical approach to address how things are known and experienced (King & Horrocks, 2010, p. 11). An interpretivist approach is a useful way to gain an emic understanding (from the inside perspective) of the biosecurity knowledge and practices of farmers. An alternate concept that means to ‘understand from within’ is Weber’s verstehen (Yanow, 2006, p. 11). Central to interpretivism is ‘empathetic understanding or verstehen of the everyday lived experience of people in specific historical settings’ (Neuman, 2011, p. 101). This aligns with the work of other interpretivist researchers who believe that views of participants directly contribute to the meaning of their social action (Yanow, 2006, p. 19).
For these reasons, interpreting the interviewees’ experience is central to an interpretive theoretical perspective (Schwandt, 2000, p. 191). The research is presented from my interpretation of the farmers’ perspective because they are the experts of their biosecurity practice. This means an interpretive theoretical perspective is useful for drawing out farmers’ biosecurity experiences, which is central to achieving the research aims.

Understanding farmers’ biosecurity knowledge and practices from within their social world is crucial in addressing the study’s research questions. The wording of the research questions places farmers’ perspectives at the heart of the research inquiry, which builds upon previous social science biosecurity literature by addressing their absence in biosecurity studies (Enticott, 2008b). The following section outlines the data collection method used in this study.

**Data Collection Methods**

The primary data collection method utilised for this research was semi-structured interviews. This is consistent with an interpretivist theoretical perspective as interviews were used to gain insights into participants’ constructions of meaning (Denzin, 2004, p. 450). The findings from the interviews are presented in the analytical chapters. This section now divides into a discussion of how I recruited the sample and how the data was collected.
Sample and recruitment

Full-time commercial sheep farmers whose livelihood is reliant on successful meat and wool production were the targets of this research. The participants live and work in a location involved in farming activities (Maxwell, 2005, p. 88). Using an interpretivist approach meant that farmers were in their ‘specific context’, which made it possible to better understand their perspectives and interpret their world view (Creswell, 2013, p. 25). This links to the underlying interpretive principle that aims to explore individuals’ experiences and the associated meanings (King & Horrocks, 2010, p. 16).

I employed a mix of purposive (Maxwell, 2005, p. 88), accidental and snowball sampling (Sarantakos, 2013, p. 179), which provided flexibility (Hennick, Hutter, & Bailey, 2011, p. 85) in recruiting participants. Flexibility in qualitative research means that there is freedom in the design to move between the steps in the research. In other words, the research design is not linear. For example, the research can move in a flexible way between sampling procedures and data collection or data analysis (Sarantakos, 2013, p. 128). I was purposeful in my selection of participants that included both sexes, and a mix of commercial and stud businesses from different districts across the region. Initially, farmers were accessed through my personal networks; other farmers were met at regional field days I attended or through
the Graham Centre. I enjoy meeting people, therefore I had no problem initiating and developing conversation at these events, which helped to lead into my purpose of recruiting relevant participants.

I selected relevant participants based on their initial interest in my study (after discerning that they lived in the Riverina and ran a commercial sheep flock), and after a short verbal discussion to explain the background of my project. My attendance at field days does not constitute participant observation as this data collection method is not part of this particular study. The purpose of attending field days was to become immersed in the local farming setting, engage and build trust with farmers. Attendance also helped in informing the development of the semi-structured interview questions, and was instrumental to organizing interviews. An information sheet detailing the project was given to participants I met at field days and was included in the take-home material at the Charles Sturt University Graham Centre annual sheep forum (see Appendix B). At the end of the interviews, some farmers were asked – ‘Do you know anyone else who would be interested in participating in this research?’ Snowballing was useful because participants would contact their friends in advance, alert them to my upcoming call, and with their permission passed on their friends’ phone number. This approach was advantageous and I believe increased farmer participation through the

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4 The Graham Centre is an ‘Australian centre of excellence for cropping, livestock and systems of integration research and collaboration’ (Graham Centre for Agricultural Innovation). The collaboration is between CSU and the NSW DPI.
positive encouragement of peers (Hennick et al., 2011, p. 100). The implication of this is that farmers may have recommended other ‘good farmers’, or those believed to share biosecurity understandings or practices similar to themselves, to participate in this study. This means the data collected maybe from a narrower group, or skewed towards the ‘better’ farmers, of Riverina participants than originally intended, as a result of the snowball process.

Figure 3 Towns in the Riverina ("Riverina NSW Road Map," n.d)

A total of 23 sheep farmer interviews were conducted across the Riverina from August 2013 to March 2014. This number was also decided pragmatically, as it took time to recruit participants, organise interviews, drive to interviews (the Riverina is a small region within NSW that is approximately 77,183 km² (NSW Government, December 2012)), and transcribe them (Travers, 2006, p. 90). The interviews provided plenty of meaningful data and therefore it was decided following the 23rd interview that saturation point had been reached. Some of the last farmers, while having unique stories, did not
add dramatically different perspectives on their farming and biosecurity practices. Their stories were providing ‘diminishing returns’, which occurs when ‘theoretical constructs fit with existing data and the comparison of theoretical constructs with new data yields no significant new insights’ (Gasson, 2004, p. 86). This was the saturation point, when these later interviewees were confirming similar experiences (Sarantakos, 2013, p. 372) that earlier farmers articulated. Prior to commencing the interviews, the participants read and signed the consent sheet (see Appendix C). Interviews were audio recorded and on average took at least one hour. One interview was conducted as a pilot to test the questions in the interview guide (see Appendix D).

The farmers and their farms were characteristic of sheep properties in this area of NSW. Commercial sheep farmers from across the Riverina were interviewed from Gundagai to Moulamein. They were typical of farmers in Australia in terms of age, education, farming career and family business unit (Australian Bureau of Statistics, 2012). The average age was 53. Farmer qualifications ranged from Year 10 through to PhD. Some had Agricultural Science degrees; but the most common qualification was the wool classing certificates from TAFE. Most were mixed enterprises with an average farm size of 8,970 acres, and an average of 3,627 sheep, plus progeny, farmed across an average of 5,350 acres (a preference for measuring in acres exists

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5 TAFE is the Australian equivalent to Polytechnic College. It is an educational institution where students gain vocational qualifications using a competency based grading system.
due to the age of the farmers). The mixed enterprise farmers mostly farmed cereal crops, and some ran cattle alongside the sheep. Two of the interviewees ran straight sheep enterprises. Most of the sheep were Merinos; however cross-breds are becoming more popular. The majority of farmers were born on the property, upwards to fifth generation farmer. From succession planning, the average year that farmers took over management of the property was 1987. The word farmer is gender neutral as wives who also participated in the interview worked part-time or full-time on the property. The wives who were part-time farmers worked in the nearest town as nurses. Of the 23 interviews, three interviewees were female farmers without their husbands present, four were farming couples, and one was a husband, wife and son team. Three farmer interviews took place at their full-time off-farm place of employment. The rest of the interviewees were male commercial farmers. The following sub-section describes the use of semi-structured interviews for this research.

*Semi-structured interviews*

I employed semi-structured interviews as the primary data collection method, as a way to gain an understanding of farmers’ biosecurity knowledge and practices. The purpose of interviewing is to understand others’ experiences (Seidman, 1998, p. 3) and perspectives (Patton, 2000, p. 306). It involves meeting participants and recording their stories, to capture how they
make sense of their lives (Gobo, 2011, p. 25). The insight I was able to access was a result of the time I spent with the farmers, I gained an understanding of why and how they ‘do’ biosecurity and the meanings they associate with their practices. Interviewing ‘provides the greatest opportunity to find out what someone thinks or feels, and how they react to various issues and situations’ (Bouma, 2000, p. 180). Additionally, ‘interviewing provides access to the context of people’s behaviour and thereby provides a way for researchers to understand the meaning of that behaviour’ (Seidman, 1998, p. 4). How farmers see the world, and their individual values and priorities are crucial to understanding their on-farm management choices.

The major advantage of using semi-structured interviews is that I could listen to the participants’ perspectives, which enabled me to collect data to address the research questions. This is imperative because the participants are the experts in this particular research inquiry. Another strength to interviewing is the depth of understanding that is gained through this data collection method (Babbie, 2013, p. 324). Knowledge and meaning were co-constructed between the participants and myself (Hennick et al., 2011, p. 109). The following section discusses how I analysed the data.

Data analysis
Audio recordings were personally transcribed so that I was familiar with the data. During transcription, and between the interviews, preliminary data analysis took place as part of an iterative cyclic process. This process involved a continuous streamlining and refining of questions between each interview (Hennick et al., 2011, p. 111) as my knowledge of on-farm practices increased. Data analysis of the interviews presented patterns that were clustered together (Sarantakos, 2013, p. 379). The patterns were aligned with the themes presented in the literature review (see Chapter 2), as well as what farmers saw as important (see Chapter 4, 5 and 6).

Manual coding commenced once transcription data were available to place into categories (Hughes & Sharrock, 2007, p. 103). Manual coding was used to afford the ability to spread out, beyond the size of a computer screen, and see the data. This meant I could easily move and place categories and themes together. It was a way to immerse myself in the data. The initial analysis consisted of placing raw data into themed categories, which is common into an interpretive approach (Grbich, 2013, p. 17). The findings were organised into thematic categories, and with the open dialogue there is a greater chance of participants’ meanings being reported as they were intended (Hughes & Sharrock, 2007, p. 101).

The first round of coding is referred to as open coding. This involves initially placing texts into the ‘what’ and ‘how’ categories (Clayman & Gill, 2004, p. 595) as a way to understand the context, behaviours and verbal findings (Silverman, 2005, p. 105) and summarise the data (Miles, Huberman,
& Saldana, 2014, p. 86). The process of open coding involved reading the transcripts and labelling phrases (Corbin & Strauss, 2008, p. 198). The inductive code list generated in the first round of coding was driven by the data (Hennick et al., 2011, p. 218).

<table>
<thead>
<tr>
<th>Learning</th>
<th>Management</th>
<th>Knowledge</th>
<th>Attitudes</th>
<th>Biosecurity defined</th>
<th>Governments role</th>
<th>Trust</th>
<th>Positive practices</th>
<th>Pests</th>
<th>Sources of information</th>
<th>Fences</th>
<th>Responsibility</th>
<th>Diseases</th>
<th>Weeds</th>
<th>Barriers</th>
<th>Current concern/risks</th>
</tr>
</thead>
</table>

All of the transcripts were cut up with scissors, from which the broad categories of the open coding list emerged (see Figure 3). As per Figure 3 there were 17 categories were created in the first round of coding.

The second round of coding, or pattern coding (Miles et al., 2014, p. 86), involved refining the categories – practices, attitudes and knowledge – and each category had a multitude of subcategories. Related thematic categories were placed together, which was done during axial coding (Corbin & Strauss, 2008, p. 198). The second code list was theoretically driven from the themes in the literature (Silverman, 2005, p. 173). The cut up transcripts were reshuffled into the subcategories (for example see Figure 4) to make locating quotations easier during writing. The quotations were then cut and pasted from transcripts into Microsoft Word.

<table>
<thead>
<tr>
<th>Current concerns/risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biggest risk</td>
</tr>
<tr>
<td>Existing problems</td>
</tr>
<tr>
<td>Likelihood of outbreak</td>
</tr>
<tr>
<td>Future worries</td>
</tr>
<tr>
<td>Risk justification</td>
</tr>
<tr>
<td>Areas to improve</td>
</tr>
</tbody>
</table>
The data was put into themes as a way to make sense of them (Creswell, 2014, p. 186). The patterns that emerged from the coding process formed the basis for the core themes presented in the findings in Chapters 4, 5 and 6.

The next step in the process was to use the coded material to conduct a thematic analysis. Thematic analysis is the process of identifying ideas, implicit and explicit, that are present in the transcript text (Guest, MacQueen, & Namey, 2012, p. 10). The ideas or themes are developed by grouping together similar ideas that the researcher interprets as relevant. This is consistent with the chosen interpretive approach because as the researcher I am part of the process and my role was to interpret the data and translate it in a way that contributes to addressing the study’s research questions (Armstrong, 2008, p. 54).

I used an iterative approach to manage the data analysis phase, which means that I cyclically processed the data to make meaning from it. This means it involved continuously consulting the academic literature to identify similarities and differences in meaning between my data and the literature. The iterative approach links to the interpretive theoretical approach of constantly reviewing the data and making improvements based on findings.
Due to the iterative process, the set and order of questions in later interviews was variable. This variability means different wording of the questions may have been employed (Denzin, 2009, p. 125). In practical terms this means that for later interviews terminology presented by past participants was used that varied the question phrasing but not the meaning. For example, ‘how often do you do worm tests?’, became ‘how often do you do FECs?’

One recognised limitation of thematic analysis is that the meanings drawn from the data are the result of the researcher’s interpretation (Grbich, 2013, p. 7). The world view of the researcher influences the meanings of the social action in the findings (King & Horrocks, 2010, p. 22). Thus, the reported social actions of farmers in the results and discussion are shaped by the researcher because she is a feature of the way the findings are interpreted. I implemented ‘an exploratory orientation’ (Hammersley & Traianou, 2012, p. 28) to understand the social world of these farmers. It was exploratory in the sense that I had few preconceived ideas about farmers’ biosecurity practices because there is little literature from the farmers’ point of view to draw upon, and in addition I am not from an agricultural background.

A crucial dimension of an interpretive approach is researcher reflexivity. From this perspective, the researcher is part of the research process (Maxwell, 2005, p. 82), and this has implications for the findings. Being reflexive means to acknowledge how my background and values influence my interpretation of the data (Creswell, 2003, p. 8). For example, the organisation of the data into relevant themes, discussed below, is done in a way that made sense to me.
Others could interpret the data and categorise the themes differently. In the analytical chapters I made choices to categorise the data that was logical to me because of my worldview. My worldview is different from the participants because of a different cultural and social background; I have different life experiences. The thematic choices I made in Chapter 4 are linked to remaining viable and the perceptions of being a good farmer, whereas Chapter 5 themes were driven by the literature on risk and trust, and Chapter 6 was divided into farmers’ formal and informal sources of learning. These could all have been different if there was a different set of eyes on the same research inquiry. This reflexive approach to social inquiry is consistent with an interpretive theoretical perspective (Denzin, 2004, p. 458).

Coding, further analysis, writing commencement and final interviewing occurred simultaneously and proved a useful method to reinforce data gathered and clarification of the meaning behind particular biosecurity practices to which earlier farmers had alluded. In the following chapters farmers are differentiated by number, 1-29. This is based on the chronological order of interviewing, which only I am privy to and has helped farmers remain anonymous. Identifying features have been removed from the quotations used in this thesis (Hennick et al., 2011, p. 71). The next section considers the ethical issues for this research.
Ethical considerations

Ethical consideration is significant in qualitative research as people are involved. Specifically, the relationship between the researcher and the interviewees must be addressed. The relationship is one of power (Richards & Schwartz, 2002), and using an interpretivist approach to address the exploratory research questions enables the interviewees to hold significant power as they are the biosecurity experts in this particular research. Ethical clearance for the project was obtained from the School Human Research Ethics Committee before commencing the data collection phase of the research (see Appendix A). This section addresses the main ethical concerns for qualitative research, which are informed consent, confidentiality and anonymity (Bouma, 2000).

At the beginning of the interviews, the participants were asked to sign a consent form that outlines the ways in which their anonymity is maintained (See Appendix C). Informed consent means informing the participants of the research and giving them a choice to withdraw from the project at any stage (Ryen, 2011, p. 418), as their participation is voluntary (Bouma, 2000, p. 198).

To ensure participant confidentiality means to protect their identity (Ryen, 2011, p. 419). I maintained confidentiality by keeping field notes, and interviewees’ names and contact details locked in my office at the university (Hammersley & Traianou, 2012, p. 123). The audio files from the interviews
were stored on a password-protected computer on the university campus. Further, hard copies of the transcriptions and coded transcripts were kept in a locked filing cabinet that only I could access, in a locked office on campus.

Anonymity is the third relevant ethical consideration and to ensure participants were unidentifiable, I differentiated farmers numerically. Participants’ anonymity could not be guaranteed, however, it is protected by transcribing interviews myself, ensuring the transcriptions were only seen by me and pseudonyms (in this case numbers) are used in this final version of the thesis (Seidman, 1998, p. 56). No deception was involved and the topics discussed were no different to those that the farmers would discuss with their neighbours. To alleviate these issues of informed consent, confidentiality and anonymity, care was taken to protect the identity of the farmers.

**Conclusion**

This chapter has provided an outline of the methodological positioning of this research, which is suitable for addressing the research questions. The research questions align with choice of an interpretivist theoretical perspective, which underpins this research. This perspective was most appropriate to gain an in depth understanding of sheep farmers’ biosecurity knowledge and practices. The reason is that it enabled the researcher to understand biosecurity from the farmers’ perspective. This chapter also discussed the
research methods used to complete this study. Data collection consisted of semi-structured interviews in order to gain farmers’ insights into biosecurity. Over 2013/2014, a total of 23 semi-structured interviews were conducted with commercial sheep farmers. From the interviews a thematic analysis was then carried out and the content is present in Chapters 4, 5 and 6. The research design enabled the collection of relevant empirical data to address the research questions. The following chapter is the first that explores some of the collected data relevant to these farmers’ experience of practicing on-farm biosecurity. The following chapter addresses the first research question and explores how farmers learn about biosecurity.
Chapter 4 – Farmers’ sources of biosecurity knowledge

Introduction

In this chapter I will show through various examples of farmers’ sources of knowledge how they came to possess substantial tacit knowledge of recommended biosecurity practices. This contrasts with the epidemiological literature where livestock farmers are argued to have a knowledge deficit that impacts their willingness to implement recommended biosecurity practices. In order to address the first research question, what farmers know about on-farm biosecurity and how they learn about it by discussing the various formal and informal sources of farmers’ biosecurity knowledge, this chapter makes explicit use of the data collected from the semi-structured interviews with Riverina sheep farmers, as described in Chapter 3. Part of the theoretical framework, the notion of good farming, is that farmers have an extensive network of people that they use to assist with their on-farm decision-making (Naylor & Courtney, 2014). These farmers use their network to obtain biosecurity knowledge, in addition to their tacit knowledge. The findings in this chapter build on the good farming literature, specifically farmers’ tacit knowledge, which has not previously been applied to biosecurity. These farmers have access to formal and informal sources of knowledge that are used to inform their current biosecurity practices. These farmers have been doing biosecurity
throughout their farming careers and therefore have experience to apply knowledge to their farming practice. Despite claims that tacit knowledge is unable to be made explicit (Collins, 2010, p. 85), these farmers are able to articulate where their biosecurity knowledge was gained6.

Local knowledge is often overlooked as the deficit model continues to dominate on-farm biosecurity research. In the epidemiological literature, livestock farmers are argued to have a knowledge deficit that impacts their willingness to implement recommended biosecurity practices. For this reason, several studies call for increasing farmer education (Noremark et al., 2010; Simon-Grife et al., 2013), which in turn is assumed to change behaviours (Naylor & Courtney, 2014; Sarrazin, Cay, Laureyns, & Dewulf, 2014), and increase compliance and the implementation of biosecurity practices. However, this chapter illustrates the variety of knowledge sources these farmers currently use to inform their biosecurity practices, which adhere to the recommendations as encouraged by governments and industry. Although the sample size is representative of a qualitative study, it does not discount the usefulness of this data for interpreting these farmers’ sources of biosecurity knowledge. This chapter does not attempt to be evaluative in the same quantitative data could be, instead the focus is to present an analysis of relevant data to farmer learning and local knowledge.

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6 In Chapter 5 and 6 there is demonstration of their knowledge through their biosecurity practices they participate in on-farm.
Farmers’ sources of biosecurity is categorised into either formal or informal, which align with what is already known about how Australian farmers learn. Other Australian studies (Bamberry et al., 1997; Kilpatrick & Johns, 2003), found that farmers prefer to engage with physical information and interact with knowledgeable others face-to-face, whether it be other farmers or local biosecurity professionals. These categories provide a new way to appreciate farmers’ biosecurity knowledge, and show farmers as active participants when learning about biosecurity.

This chapter draws upon data from the interviews with Riverina sheep farmers to highlight the limitations of a deficit model and show the diversity of ways in which farmers’ knowledge of biosecurity practices is learned from formal and informal sources. Finally, it discusses these farmers’ preferred sources of knowledge and the implications for seeing farmers as knowledgeable biosecurity actors.

**Formal sources of biosecurity knowledge**

Most of the following formal sources of knowledge are events that enable farmers to engage with other farmers, which re-enforces existing social relationships and networks. Farmers learn through interaction (Kilpatrick & Johns, 1999, p. 15) with those in their social networks (Fonseca, 2001) and by participating in networking activities (Hassanein & Kloppenburg, 1995, p. 733),
which is the key to adult learning (Allan, 2002). Other farmers have been called the most useful form of information (Vanclay & Lockie, 1993, p. 59) and industry sponsored events offer farmers localised opportunities for networking. Beyond the networking opportunities, there is a link between education and training and farm profitability (Kilpatrick & Johns, 2003, p. 152). Some of the interviewees went to university and completed agricultural science degrees and this input to their knowledge demonstrates their adaptability and innovation and may have contributed to a reason why they are still in business after years of droughts. Drawn from the Australian farmer learning literature my analysis has modified the concept of formal learning (compared to Bamberry et al., 1997) to include more than educational qualifications. Kilpatrick and Johns’ category of ‘education and training activities’ better reflects my inclusion of recognised qualifications and field days (1999, p. 101). The category of ‘formal sources of biosecurity knowledge’ recognises the variety of other sources of knowledge that also feed into farmers’ biosecurity knowledge without the parameters of crediting skills towards a certificate.

Formal learning opportunities for sheep farmers in the context of this study are primarily in the form of extension, which is usually marketed on the promise of profitable outcomes. For example, the theme of the 2013 Graham Centre sheep forum at CSU was ‘efficiency of production’. Within this context farmers are exposed to new ideas presented on the day, which may conflict with ‘existing forms of knowledge, views, ideals and interests’ (Eshuis & Stuiver, 2005, p. 139). This may impact their ability to adapt the new
knowledge to their specific on-farm situations. This is where learning by doing (Bamberry et al., 1997, p. 40) becomes relevant, and the current extension is offered in line with this format.

Other extension is offered through industry bodies, and the Sheep CRC\textsuperscript{7} (Sheep CRC) is one example where funds are drawn from the national government and outputs are measured through various projects. The Sheep CRC, set up similar to other CRCs, has limited extension activity and produces scientific findings in a published format that is distributed through state DPIs and industry bodies (Hunt, Birch, Vanclay, & Coutts, 2014, p. 133). Examples of the Sheep CRC extension projects are the BredWell FedWell course and Lifetime Ewe Management, which are aimed at farmers. Some of the interviewees in this study have participated in these courses\textsuperscript{8}. More commonly, these short courses would be located under informal sources of

\textsuperscript{7} The Sheep CRC is co-funded by the national government and 40 other industry and supply chain participants who support a variety of extension events across the country.

\textsuperscript{8} Farmers' want field days to be run as an extension activity, which was previously offered by governments (Vanclay & Lockie, 1993, p. 62). Industry is providing funding for some regional extension opportunities that these farmers are participating in, and as a result of attendance they have applied some of the new knowledge on-farm. Industry funded events that farmers mentioned most often were BredWell FedWell and Lifetime Ewe Management. The primary goal is on-farm productivity and profitability (Sheep CRC), but biosecurity is an implicit feature of these programmes. Traditionally government funded extension was one source of information provided to farmers (Pannell et al., 2006), however with neoliberalist shifts industry bodies are providing links between farmers and government. Relevant industry bodies such as AWI, MLA, Wool Producers, the Sheepmeat Council, the Sheep CRC and NSW Farmers are attempting to fill the extension gap left by withdrawal of government funding (Hunt et al., 2011). Although there is limited information around the value of extension for farmers (Hunt et al., 2011), extension reaches farmers who are open and receptive to the messages being delivered (Pannell et al., 2006). Participants who have attended industry funded field days and extension activities have gained a lot of knowledge, some of which is evident in their production returns upon implementing ideas presented on those days. An example of such an event is the BredWell FedWell day I attended, which is co-funded by MLA and AWI.
learning (Kilpatrick & Johns, 1999, p. 20), as there is no recognised qualification gained from attendance. However, they are regionally relevant examples of farmer learning events that implicitly include biosecurity as part of the programme. This is similar to these farmers’ experiences of tertiary study, where social networking occurs alongside learning about biosecurity. Although it is often not labelled as such (especially back when these farmers studied), it features in many parts of the curriculum and is knowledge they acquired during this time.

**Agricultural studies at university**

Some of the farmers who attended university demonstrate early adopter behaviour through their innovative on-farm management practices. Early adoption behaviours stem from Roger’s diffusion of innovations theory, and can be identified by characteristics such as, strategic, economically successful and socially connected (Rogers, 2003). Roger’s criterion is applicable to this discussion, as these farmers show how they have adopted biosecurity practices from aspects of their university study into their business. Some of the sheep farmers interviewed attended Agricultural College (now CSU) and gained Agricultural Science degrees. Undertaking formal learning in this manner has given these farmers the skill set to seek information, or learn how to learn...

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9 At the BredWell FedWell day practices like FEC were encouraged in both the take away material and by presenters.
(Bamberry et al., 1997, p. 7) and perhaps take on more innovative practices on-farm. The fencing practices mentioned below were not carried out intentionally for biosecurity purposes, but they feed into strategies that have helped to minimise pest incursions. For example, Farmer 15 demonstrates how his university experiences have helped him minimise pest incursions on-farm.

Farmer 15: ...our boundary fences are now been built up as pig proof. That’s fine netting all the boundary fences...with barbed wire underneath and on top to stop things coming under and over.

Interviewer: How did you know the barb wire on the bottom and the top would be the best?

Farmer 15: When I went through Ag College at Wagga which is now CSU [laughs]...there were free range pigs and surprise surprise they had pig netting and I remember it was barb wire on the bottom. Otherwise they’ll start, so their tender snouts hit the barb and they give that up. So that was unheard of here until I started doing it probably 10 years ago. Now it is starting to catch on and it works well...Well nobody’s thought of it apart from I just observed it...but that’s how in the old type free range piggery that’s how they control the pigs to stop them getting out.

This approach was observed in another industry and guided his fencing decision-making, which has proved to be successful on-farm. It is an example of farmers selecting elements they have heard about and adapting them to suit their individual circumstances (Chambers, Pacey, & Thrupp, 1989, p. 5; Enticott, Franklin, & Van Winden, 2012).

A further example using Roger’s model of early adoption behaviour in regards to biosecurity was from the cropping side of Farmer 3’s business that he attributes to going university.

Farmer 3: I can relate more to those things with my cropping than my livestock to be honest. But I’ll just give you a quick example when I was
at college a guy [name] a soil scientist, I actually spent a couple of days doing practical work for him. When I came back farming on this property the paddock just down the front here was presenting some real production problems to me and I rang [name] up and he came out and said you’ve got to lime it. Lime was talked about but everybody said no you can’t put lime on it, it’s too expensive, he said to me lime it, you’ve got to lime it. So we limed half the paddock and the result was so spectacular that the district agronomist came out here and had a look at it. He was against lime, said no you can’t do it, they got a CSIRO soil scientist down the following year and did all these tests on it and were dumbfounded about the results I got from that lime. Luckily I did half the paddock. Every week there was a bus load of people coming to look at it and now there are millions and millions of tonnes of lime that is put on this countryside and it still comes in semi-loads every year. That pretty much all came from that paddock in front of this house, so that was an innovation10.

This farmer’s approach to lime on-farm assisted with improving the production capacity in his paddocks. Each of these farmers used their research skills gained at university, in addition to ingenuity, to design an on-farm trialling phase that proved to be successful and they then implemented these changes, which led to production improvements. These farmers ‘do’ incidental biosecurity (see Chapter 5), and their educational background is a contributing factor in their ability to produce robust livestock, and this includes biosecurity management. The impact of education and biosecurity practices was also found among poultry farmers in Indonesia, where older, educated farmers were more likely to implement on-farm biosecurity (Susilowati, Patrick, Iqbal, & Jubb, 2013). Other research has also found more educated farmers are

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10 This story pertains to the 1970s. This farmer attended CSU (then technical college) and received his equivalent of Bachelor of Agriculture degree, therefore he had connections to both the local farming extension community and the university to help in the acquisition of knowledge and subsequent on-farm decision-making.
more likely to seek advice for current problems (Fearne, 1990, p. 379). In contrast, Australian horse farmers’ levels of education did not impact their knowledge of biosecurity practices (Kung et al., 2013, p. 2).

Another feature for these farmers of possessing formal education is the increased network of people they can draw upon who can assist with on-farm biosecurity management decisions. Having access to high achieving farmers has previously been identified as a useful source of information (Sligo & Massey, 2007, p. 177). One of the interviewees has his PhD in a biosecurity topic that is relevant to the local sheep industry and as such he was able to increase local interest and the topic was discussed at multiple meetings attended by all farmers in the district. At the time, high attendance rates were unheard of. The importance of having this farmer network in place assisted with increasing the awareness and knowledge of a particular biosecurity threat at the local level. Another one of the interviewees is a Nuffield scholar. He believed that the scholarship increased his network of good farmers11 and gave him the opportunity to seek knowledge abroad on a particular topic relevant to his sheep business. Nuffield scholarships are funded in part by industry and the purpose is to give farmers the opportunity to travel abroad to ‘increase practical farming knowledge and management skills and techniques generally’, and upon return to Australia disseminate knowledge to interested parties.

11 This particular farmer assessed good farmers by the Roger’s bell curve: ‘That’s the thing, I can’t sit at a dinner party with a group of friends without assessing where people [are] in the bell curve with regards to whatever we are discussing’ (farmer 5).
(Nuffield Australia, n.d). Both of these farmers spoke of how the network they developed from participating in these experiences has continued to positively impact their business.

**BredWell FedWell**

BredWell FedWell is an extension activity designed to give farmers hands-on experience at using Australian Sheep Breeding Values (ASBVs), which will help them make more informed choices when buying rams. It is an example where farmers can master a complex scientific system and apply the learned knowledge to their own business (Roling & Jiggins, 1994, p. 33). The opportunity to socially interact with good farmers (for good farmer definition see Chapter 4) and local biosecurity professionals is a contributing reason to high attendance at short courses (Kilpatrick & Johns, 1999, p. 21). The format of successful farmer field days uses adult learning techniques of the interactive nature that include hands-on sections and facilitated discussions (Larsen et al., 2002, p. 267).

I attended the full day event at Barham, NSW in 2013. It was held at a local sheep farmer’s property and we sat in a marquee erected for seating next to the shearing shed. The day was divided into book learning in the morning and hands-on demonstrations in the afternoon of how to apply the new knowledge. Presenters demonstrated how to read ASBVs, as during ram sales each ram has a set of figures attributed to them, such as yearling weight
(YWT), eye muscle depth (YEMD), and yearling fibre diameter (Yfd). Ideally, farmers who are positioned to buy rams should acquire these figures pre-sale to study and ear-mark which rams are most attractive to them based on an assessment of the ASBVs. Then on sale day, farmers go around the pen and conduct visual assessments of the chosen few. A combination of both ASBVs and the traditional visual assessment should be applied when choosing rams, which the following farmer confirmed.

Farmer 8: The old ways were just observation and I think that skill is...might be being lost a bit because of the figures. Not so much the emphasis on figures, you’ve got to take both, you’ve got to have both I reckon. Still got to look pleasing to the eye and still got to have the right traits as well as the science to back it up. They’ve got to be able to stand up and get around the paddock and serve the animals and not break down and all those sorts of things as well as have all the other desirable traits that you want.

Interviews conducted with farmers I met after this field day unfortunately did not coincide with ram sales. However, they were enthusiastic to use their new found knowledge when the time came.

I attended a ram sale in late 2013 and before the auction began I went around and asked buyers what they were looking for (See ). None were able to explain the ASBVs to me and were still reliant purely on observation\textsuperscript{12} with which to select their rams, rather than combine this technique with available ASBVs. This shows a need for extension events like BredWell FedWell to continue, as it arms farmers with the knowledge of how to apply new

\textsuperscript{12}Visual assessment is used by farmers to identify faults in rams, such as how they stand, length of the wool, teeth and broad shoulders. This process is subjective as every farmer has different farm objectives, for example, some may also consider the wool quality.
One part of the BredWell FedWell day I did question from a biosecurity risk standpoint was how all participants drove onto the local farmer’s property with no steps being taken by the farmer or presenters to clean boots and tyres. This curiosity to see farm hygiene in practice comes from the extension literature aimed at farmers from state agricultural departments and industry posters (see Appendix F). Additionally, in the afternoon we walked among rams that had been driven over from another farmer’s property (who became
This farmer explains his risk justification in potentially opening his own property to weeds and diseases.

Farmer 6: I was the only one that had rams with figures at the time. I have not taken my rams to a BredWell FedWell day before and they rung me up and said can you do it and I said yes. Interviewer: But because it was on someone else’s property? Farmer 6: I know [property owners], and...they walked onto sand, sat in a pen and then put back on the trailer and didn’t go outside of the shed and it’s a similar climate hopefully similar...ah disease risk or low disease risk and yeah. You can’t do it without having some risk. You can’t just shut yourself off from the world or why would you even let people onto your farm to have a look at your sheep. You don’t know what mud is on their tyres or where their boots have been. You’ve just gotta. Interviewer: So you wouldn’t have isolated them when they came back? Farmer 6: They’re isolated anyway in their ram paddock.

The sharing of knowledge outweighs the risk of weed and/or disease transmission for this farmer. It is an example of ‘action [that] is instrumentally rational’ (Weber, 1978, p. 26). This farmer has weighed the secondary consequences of possible transmission of unwanted weeds and diseases and is willing to accept risk practices are part of the farming business. For this farmer, contributing to local events in this way shows he is a good farmer, because he was the only one with ASBVs available for his rams. It shows that he is embracing best practice and encouraging his clients to do so, also encouraged by industry (as BredWell FedWell is an industry funded event), by combining visual assessment with new technology when selecting rams.
**Lifetime Ewe Management**

Another industry-funded course where many farmers spoke highly of the positive outcomes they are able to appreciate on-farm is from attending Lifetime Ewe Management. Farmer 23 recognises the impact to his business by attending such events, which contributes to his ongoing learning.

Farmer 23: So you’re just learning all the time really. Well it’s all about...being more productive I suppose. As costs increase we’ve gotta, our way to counter that is to become more productive. So you’ve gotta get more lambs on the ground and keep your ewe condition. For us it’s more wool than obviously lambs on the ground. We’ve just gotta be more productive.

This example shows this farmer’s attitude towards making more from his sheep and by attending courses he will learn more ways to be productive.

Lifetime Ewe Management is a one-year, time-intensive course, funded by the Sheep CRC, that involves visiting participants’ properties to learn ways to improve productivity and profitability (Sheep CRC). The slogan is ‘more lambs, better wool, healthy ewes’, which suggests what farmers will learn throughout the year. Each month farmers do on property visits to one of the members and discuss topics like weaning, joining and pregnancy (Sheep CRC), and apply what they learn on their own farm as Farmer 7 did:

It’s spread out over a 12 month period or something to match the timing of when you go through your breeding cycle of your sheep. So you can look at what you should be doing in a workshop and then go home and practice it on your own sheep.

Farmers see the value in attending these types of courses – ‘I know it’s a very good course’ (Farmer 20) - the information becomes locally relevant, other good farmers are participating, and it offers the ability to network. By having
a format where locally situated knowledge and practices are shared, rather than the generic and standardised farm hygiene practices, positive biosecurity behaviours are more likely to be exhibited on-farm (Enticott et al., 2012, p. 327).

As part of the iterative process, one farmer I interviewed in 2013 told me about walking around other properties at each Lifetime Ewe Management meeting, and I was able to ask subsequent farmers about their cleaning and disinfecting routines after visiting others’ farms.

Farmer 28: No, but having said that those cats heads, Bindi, we will clean our car tyres if we drive somewhere and we know that there’ll be Bindis in the tyres before we come back.

Farmer 26: If it’s wet you wear gumboots. In this area there’s nothing to worry about, if we went into the Mallee or something like that then they’d be more on your tyres you might pick up than your boots might pick up. Things like Gentle Annie stick really well to rubber tires. She’s a very nasty little burr. Quite painful, there’s plenty of that out in the Mallee.

Local weeds do not present a risk to these farmers, but they have an awareness of what does. This means that the value of attending extension events with like-minded farmers outweighs the localised risks of bringing home weeds they may not have on-farm. Attitudes are learned over time from ‘socialisation and internalization of experiences’ (Vanclay, 1992b, p. 98) and these quotations above are evidence of the good attitudes towards farm hygiene practices for weed management.

The formal sources of knowledge that these farmers access and assist in their decision-making are tertiary education, attendance at BredWell FedWell
and Lifetime Ewe Management. I now consider the informal sources of knowledge farmers’ use.

**Informal sources of knowledge**

The category of informal sources is documented in Australian farmer learning literature (Bamberry et al., 1997; Kilpatrick & Johns, 1999; Kilpatrick & Rosenblatt, 1998; Reeve & Black, 1998). However, it has not previously been applied to farmers’ biosecurity knowledge. Informal sources of knowledge provide farmers with snapshots of content on biosecurity issues that could affect their enterprise. The snapshots that farmers mentioned during the interviews were local media, and other resources are used to follow up any concerns they may have and these include: other farmers, vets, agronomists, farm consultants, and the NSW Farmers’ Association. Farmers also draw upon their life experience, which includes knowing best management practice and their perceptions of the usefulness of an industry biosecurity plan. All of these sources are discussed in this section.
Learning from life experience

Farmers have ‘contextualised expertise’ from life experience and local knowledge (Riley, 2008, p. 1278). Life experience is linked to the notion of good farming as farmers learn throughout their farming careers and apply this knowledge to their practice; through this process good farmers may improve livestock production, which includes biosecurity practices. Other studies (Enticott, 2001; Wynne, 1992a) have shown where local knowledge, if acknowledged, would have been useful to the scientists who were examining biosecurity breaches on-farm. Outside experts do not recognise the value (Wynne, 1992a, p. 36) of farmers’ specialised local knowledge (Wynne, 1996, p. 66) that they have built over their lifetime (Garforth, 2011, p. 60). Farmers’ localised knowledge has developed over their farming careers and makes them the local experts. They have local knowledge of their paddocks and are a type of master of their land (van der Ploeg, 1993, p. 212).

Farmers’ life experience of managing biosecurity on-farm means that they are armed with tacit knowledge. It is acknowledged that ‘farmers knowledge offer a different form of understanding that is often tacit, experience led, and embodied’ (Riley, 2008, p. 1291). Tacit knowledge accords with good farming as farmers have a local understanding of their properties and contributes to their ability to produce robust livestock. In Australia, farmers traditionally learned how to farm by growing up on the land (Bamberry et al., 1997, p. 61). The majority of farmers interviewed have this relevant life experience because they were born into farming, including most of
the wives of the farming couples. Other farmers, in partnership arrangements, are brothers from farming families. There is significant value in having a lifetime of sheep industry experience, as farmers know how to manage endemic issues from living through various biosecurity problems. Farmers know how to keep disease out through regular testing, fence maintenance, running a closed herd (or flock in this case) or buying from known vendors (Enticott & Vanclay, 2011, p. 297). They know many specifics of biosecurity practice because they have been ‘doing’ prevention for a lifetime.

One specific piece of biosecurity knowledge that farmers mentioned, and has been learned over their farming careers, was how ‘undesirables’ can arrive on their property. These farmers were able to articulate the range of ways pests, weeds and diseases are spread:

Farmer 13: Airborne...introduced stock...birds, I suppose that’s what I mean by airborne really you know seeds and stuff...trucks, tyres and boots

Farmer 12: Weeds can blow for miles. The weed, the seed must be that minute because you can’t feel it in the air so it just appears, just like any other weed. Where did that weed come from? Did you bring it in on your [boots], did you walk across your next door neighbour[s paddock]?

Farmer 1: Neighbour sheep and stray sheep.

Farmer 20: When you buy first cut lucerne and it hasn’t had the weed sprayed out of it, it will have a bit of junk in it. Pests, well, pests can come through fences. Diseases come through fences too in the form of say Brucellosis in the ram and that sort of thing.
These farmers know from their knowledge and experience the various transmission pathways. This means farmers know where potential risks lie on their properties and they can employ appropriate surveillance activities. This is the same knowledge of the main ways that diseases are spread, as presented in the graziers’ manual (Animal Health Australia, August 2012, p. 6). This knowledge forms part of a farming script, one that is socially perceived, and that has developed as part of the subculture through ‘anomalies and failures’ (Vanclay & Enticott, 2011, p. 257).

Another example of tacit knowledge these farmers possess is transmission risk, which related to being aware of neighbour’s practices, as they could have differing priorities and standards of pest, weed and disease management. Biosecurity problems can spread easily between neighbouring properties and most farmers agreed that ‘you must be’ (Farmer 3) aware of your neighbours’ health status. For example, this farmer knew his neighbours were less concerned with pests, specifically feral goats, which presents an ongoing risk to the boundary fences:

Farmer 2: When the goats come piling in out of the scrub, national parks often, and then these blokes muster them up and that funds their internal or their development programmes, big time! Some of these blokes probably get 20,000 goats a year, pretty good dough. So here I am trying to keep goats and pigs and neighbours lousy sheep out, and their rams, and here are these other characters have their developed areas and their undeveloped areas or developed in a certain way that the goats can get in.
This farmer’s perception of goats being pests differs from his neighbour’s because of the money to be made, and means he must be vigilant in protecting his farm boundaries at certain times of the year.

Another farmer described his awareness of a neighbour’s attitude towards the removal of weeds: ‘all my neighbours don’t seem to care much about weeds, but I do’ (Farmer 22). Because you have what your neighbours have this negatively impacts his potential to rid himself of weeds on his property. Neighbours also present a risk in regards to diseases, and in this region the number one problem is lice. Farmers can label who their lousy neighbours are:

Farmer 18: We’re surrounded by lousy sheep, one over here and one out the back here he puts sheep in there for agistment and where they come from they’re lousy too.

As a result of this knowledge, and finding neighbours’ lousy sheep on their property, some farmers have now prioritised improving fence lines.

Farmer 7: I’ve got neighbours on either side and I always used to leave my back gate open because I’d quite often go in and out there for various reasons but now I don’t...and I have been doing some work on some of my exterior boundary fences to try and make it more sheep proof.

This form of knowledge means that farmers can increase surveillance on those ‘risky’ areas, which is one prevention method they know to use.

Some farmers were less concerned with the risk neighbours’ biosecurity practices presented to their business and Farmer 6 said ‘if I really wanted to know the health status I could just ring up and ask. It’s really none of my business though’. This shows Farmer 6’s risk assessment, that at the current
time these neighbours’ practices are not impacting their business enough to be a priority, and their relationship is open enough to make enquiries when the need arises. All of these examples demonstrate the extent of biosecurity knowledge from farmers’ life experience, which they know to use and assess on-farm risks.

**Best practice**

Farmers know from life experience what best practice is for endemic pest, weed and disease problems. Doing ‘biosecurity is part of best practice’ (Donaldson, 2008, p. 1555). Interviewees perceive foxes are the number one Riverina pest for sheep farmers and therefore all of them participate in the fox baiting programme run through the LLS. Baiting is known best practice for minimising fox populations and this method is encouraged by state governments (Norris & Low, 2007). Farmer 15 reported that weed best practice is disseminated through expert information channels because ‘it’s accepted knowledge through science, Departments we’re told by...agronomists, advisors, scientists. The weed CRC...it used to exist, probably still does’. One example of best practice for internal parasites is to isolate and drench new stock upon arrival to the property.

Farmer 20: Best practice says everything that comes onto your place, barring none needs quarantine drenching onto your place. So that’s just um best practice, that’s what you should be doing. Most people don’t. Well, most. That is number one of internal parasite management control

Interviewer: Best practice how do you know this?
Farmer 20: Because it’s industry standard basically.

While stock are in the yards after drenching, farmers can use this opportunity to monitor livestock for signs of ill-thrift. Monitoring is also best practice that farmers employ (Wilkinson, 1996, p. 6). Any of these practices are well known and have not changed much over the course of their farming careers. Best practice methods are learned through life experience, practised through chemical management and information about particular practices are distributed by chemical companies, agents, stock merchandisers, other farmers and governments.

If farmers need further clarification of current on-farm biosecurity best practice the grazier’s manual provides an overview. Most of the content of the manual consists of preventative steps farmers can follow to secure their farm. Recommended practices are divided into the ways disease is spread and many are steps farmers are already doing for example, ‘follow the NLIS requirements specific to species and jurisdiction’ (Animal Health Australia, August 2012, p. 8). Others require farmers to take further steps, which may include costs – ‘Ensure appropriate signage is available to inform visitors of your biosecurity requirements and what you want them to do on arrival’ (Animal Health Australia, August 2012, p. 9). Overall, these recommendations focus on general farm hygiene and the inception of possible risks, which will be mitigated by cleaning and disinfecting equipment, machinery and people and keeping out the unwanted. Because this document was produced by AHA it shows industry involvement (the Sheepmeat Council and Wool Producers
Australia) as they assist with funding. Even though the manual is produced for farmers to assist with biosecurity knowledge dissemination, my study found that farmers are already doing a lot of the content found within. However, one area that could be improved in the regional sheep industry for preparedness against exotic threats is an industry biosecurity plan.

*Industry biosecurity plan*

The purpose of an industry biosecurity plan is to have a written guideline in place that details actions to prevent incursions, and their creation is promoted by quasi-governmental organisations. Currently, industry biosecurity plans are promoted by Plant Health Australia and their website gives a template of the particulars that could be included in one, such as on-farm practices, training and surveillance (Plant Health Australia). Animal Health Australia had a sheep and goat industry plan that during my candidature was removed from their website (Farm Biosecurity, 2003). This could mean that industry plans are more popular for weed management than animal health management. As it currently stands, the Australian sheep industry does not have a biosecurity plan. Instead, as for all Australian livestock industries the Emergency Animal Disease Response Agreement (EADRA) is in place for exotic diseases; it is managed by AHA, and co-funded by industry and governments. It is another example of governments being crisis managers with a one-size-fits-all approach (Enticott, 2014b). This
approach shows change over the last decade as a 2004 article stated Australian state governments ‘each developed and promoted’ biosecurity plans to farmers (Conkey, Penrose, & Donaovan, p. 48).

Now governments and industry are encouraging regional biosecurity plans, rather than at the national level. Some districts within the region have developed OJD biosecurity plans, which assist with best practice when farmers trade sheep. A regional biosecurity plan is voluntary in NSW, but its use is promoted by industry (Sheepmeat Council of Australia & Wool Producers Australia, 2013). The old Riverina LHPA district had a biosecurity plan, called the Riverina Sheep Biosecurity Group, that producers wanted and the district vet was a useful player in its establishment (Salmon, 2013). In this particular region hundreds of farmers formed a group that committed to following guidelines, such as using an SHS form when sheep are traded from outside this district. The purpose of the plan is to minimise disease risks associated with OJD, footrot and Brucellosis (Searle, n.d), that need to be considered when buying in sheep. Some of the farmers I interviewed are members of the Riverina sheep biosecurity group. Each of these farmers runs a closed flock so membership to the group has had no effect on their business. This plan is still in effect, even though the Riverina LHPA boundary no longer exists.

To understand farmers’ perceptions of industry readiness when exotic threats emerge I asked the farmers how useful an industry biosecurity plan would be. All were not aware of such a plan. Some farmers commented that there may be an industry biosecurity plan, however, they did not know how to
access it. Farmer 13: Probably very useful, do we have one? Generally, their perception is that they would like to have an industry biosecurity plan, as it would act as a guideline for when an incursion occurs.

Farmer 12: Very, very useful, yeah they need it. One day something is going to go wrong. We will get Foot and Mouth, not if, we will get it in the country and we’ve got to get it under control before it wipes us out. I don’t know how it’s going to get here but it will get here. It’s only just upstream of us.

Farmer 12 provides the example of an exotic threat that will come to Australia and believes that a plan would be a good way for the industry to prepare for an incursion. Others were more explicit in their strong feelings that in their experience plans often fail because they are ignored, or there is no one to ensure they are followed through. Parts of these feelings are linked to staffing losses due to the recent amalgamation of local organisations and the creation of the LLS. This kind of life experience combined with less government funding available to farmers, means that many of them are aware that when an incursion occurs, regardless of any existing biosecurity plans, they know they will have to manage themselves.

*Rural media*

Local media, either via the radio, TV or newspaper, is a current source of information for most of the farmers interviewed, particularly the rural media. The media plays a role in disseminating expert knowledge to the population
(Joffe, 1999, p. 92). Many of the farmers interviewed said they listened to the ABC Country Hour on radios, either in the ute or in the kitchen over lunch. The Country Hour is a radio show broadcast between 12-1pm weekdays and it provides the rural news and regional market reports. On Sundays at 12pm the ABC television network broadcasts *Landline*, which reports rural news from across Australia. Some of the farmers subscribe to weekly newspapers, specifically *The Land* (NSW) and/or the *Weekly Times* (Victoria), to obtain written reports of rural news, market prices and available services. Interestingly, one farmer was against these forms of media and claimed it is bad for one’s health.

Farmer 11: It’s just absolute full of crap...And when things are bad it just tells you it’s worse and worse. It’s really bad for people’s health. Best thing people can do if they want to fix up their mental health is hop in their vehicle and drive to town and back and they’re usually feeling better when they do that. The worst thing they can do is pick up The Land or something like that. Or listen to Country Hour, but we won’t get onto this.

The facts presented in the media may be in a dramatic fashion that could cause the reader stress.

One issue with using media as an information source is the way in which it dramatises situations and represents them with non-verbal images that can cause stress to consumers. Stress may result from meaning drawn from the media stories that is demonstrated with both verbal and non-verbal symbols. These symbols are represented in stories of epidemics overseas, and they show threatening events (Joffe, 1999, p. 96). If biosecurity messages ‘inspire a sense of fatalism’, then it may leave farmers feeling as though no
preventative practice is worth conducting (Enticott & Wilkinson, 2013, p. 97). In an Australian study of environmental practices it was discovered that images of environmental degradation are not useful for farmers. It would be more useful to have access to visual warning signs of incursions, rather than the dramatic, worse-case scenario visuals (Vanclay, 1992b, p. 110). An example of this in the sheep industry is associated with visuals of OJD. OJD is a difficult disease to diagnose visually as there are no clinical signs. Therefore, abattoir surveillance is one method of detection that has been employed. However, the chosen way to disseminate knowledge of the signs of OJD to look for in the paddock is through dramatic, non-verbal images (see Appendix H). When OJD was a major disease concern in the Riverina the media was used to update farmers. This suggests that the media will be an important source of information for farmers when the next biosecurity outbreak occurs.

These farmers stated that the media would be one of the main ways they would learn of new threats to the region.

Farmer 25: I would have thought if it was a major thing like foot and mouth or something, it would be pretty well highlighted. Look at how much publicity Hendra gets.

These farmers were able to keep abreast of Hendra news through the rural media, which concerned them because they are active pony club members, and despite dramatic images they placed value on the information they received via this source. During the FMD crisis in the UK farmers wanted to be informed regardless of the positive or negative images (Poortinga, Bickerstaff,
Other farmers

Neighbours that are good farmers\textsuperscript{13} are an invaluable source of information. This is an example of legitimating ‘alternative forms of expertise’ (Enticott & Wilkinson, 2013, p. 96), as farmers talk to one another at the pub and ask advice of neighbours. The main weed, pest and disease problems faced on-farm are most likely to be shared with your immediate neighbours. Although one cannot choose their neighbours it is pure luck if they have a vision to produce good, healthy products, as this means that they possess high standards of animal health and farm hygiene. Alternatively, it can be good or bad luck if neighbours have different livestock production, as different pests, weeds and diseases may or may not be a problem. In Australia ‘other farmers are a major source of information and influence’ (Kilpatrick & Johns, 1999, p. 19). Further, having access to an extended network of like-minded farmers in the district is useful for being able to host knowledge-sharing events. For example, when I attended the BredWell FedWell to find contacts, those who chose to participate in my study were neighbours. During the interviews it was discovered that these farmers were all attending the local Lifetime Ewe

\textsuperscript{13} Good farmers and good farming are defined in Chapter 2.
Management course. Despite these courses being sponsored by industry, they offer farmers the opportunity to increase ‘horizontal information exchange’, which means between the group, rather than top-down from universities or corporations (Hassanein & Kloppenburg, 1995, p. 722). Top-down state government extension used to be commonplace in Australia (Bamberry et al., 1997, p. 41). However, since the 1990s there has been a shift away from this model, which means that farmers are now driving localised knowledge and practices in groups such as Landcare (Bamberry et al., 1997, p. 42). At these events, farmers are networking and thinking of ways to adapt the information gained to their own situation (Hassanein & Kloppenburg, 1995, p. 728). The following section of informal learning sources considers membership to the state farmers association.

**NSW farmers association membership**

Membership to NSW Farmers is one way farmers are helping their voices be heard on important issues. Farmers pay an annual fee of $399 plus GST and for the livestock side of their business NSW Farmers is ‘representing members on identification systems, animal health, welfare and biosecurity, market access, predation and access to research, development and extension’ (NSW Farmers, n.d-b). A few of the interviewees belong to NSW Farmers and could not see many positive examples of learning that was borne through their membership rates.
Farmer 26: Not a lot, mostly [wife’s name] cause she does all the pays and things. Constantly got to be up to date on pay scales and things. NSW Farmers doesn’t do too much for us I don’t think, that way.

Farmer 28: Not a lot [laughs]. Um that’s why we’re sort of questioning what the value for money is.

This finding is similar to that of another study which also found that farmers have limited awareness of NSW Farmers’ promotions and campaigns (Vanclay & Lockie, 1993, p. 63). Over the years good farmers have built upon their tacit knowledge through their engagement with livestock diseases and vets.

**Farmers self-efficacy and the use of vets**

Participants have a strong sense of self-efficacy, which means that they are able to self-diagnose a multitude of endemic problems they have previously encountered and therefore have little use for vets. A definition of self-efficacy is ‘people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives’ (Bandura, 1994, p. 71). These farmers have demonstrated self-efficacy as they and will use veterinary expertise for problems beyond their experience. A good way to achieve self-efficacy is through ‘mastery experiences’ (Bandura, 1994, p. 71), which these farmers have obtained over the course of their farming careers. A recent Australian sociology thesis on biosecurity also considers self-efficacy, however, it is limited to identifying an emergency disease (Palmer, 2009). This sub-section adds to this literature by arguing
that these farmers’ self-efficacy for managing endemic problems is strong because of their tacit knowledge. Farmers’ tacit knowledge of endemic livestock diseases contributes to the notion of good farming as these farmers aspire to produce robust livestock, which requires biosecurity management.

Vets are known to play a crucial role in post-border biosecurity, from surveillance to knowledge dissemination of animal health. The rise of veterinary expertise and their imperative role in animal health (Enticott et al., 2011; Enticott & Wilkinson, 2013) is a result of changes in government policy over previous decades. Vets are best placed to continue to suggest improvements to the management system and share knowledge of risks (Simon-Grife et al., 2013, p. 229).

Studies that have surveyed farmers found that vets are listed as the most important, influential and useful source of information (Fearne, 1990, p. 376; Garforth, 2011; Garforth et al., 2013; Heffernan et al., 2008; Hernandez-Jover et al., 2012; Laanen et al., 2014; Toma et al., 2013; Windsor, Young, Hernandez-Jover, Rast, & Bush, 2015). Farmers recognise the specialist knowledge vets possess (Sligo & Massey, 2007, p. 175) and use vets to run information past and in return, they contextualise it and provide relevant advice (Garforth, 2011, p. 65).

Farmers in the Riverina region have a choice of vets to call when sheep are presenting signs of ill-thrift, and the decision is based on the nature of the problem. LLS vets are free because of the rates that farmers pay each year, whereas a private practice vet incurs a separate cost. The cost of bringing a
vet on-farm is an important consideration (Palmer, 2009, p. 348). This present study adds to this Australian literature from a regional perspective by demonstrating the importance of mixing farmers’ localised expertise gained through life experience and veterinary expertise to manage biosecurity problems. For example, one farmer showed me the local rural media pamphlet that he receives every month and that features a column authored by the LLS vet. It gives a brief summary of the regional problems for livestock farmers to watch out for. As a result of the continued contact through this medium Farmer 26 would contact the author ‘just cause of his knowledge and experience. And out here we’re more likely to get him to come rather than a private vet’. A few of the farmers prefer to seek information and assistance from the vet employed by the LLS for a combination of two reasons: a) they are free, and b) they have built up a personal relationship with the vet over time and therefore trust their knowledge and expertise.

Across interviews the role of vets often revolved around them conducting autopsies on sick animals.

Farmer 10: So that’s how we spent New Year’s one year. Puttin’ a dead sheep in the car and bought it into Tony. Tony said ‘bring it into me’. Here we were behind the shed somewhere cuttin’ up a sheep [laughing].

Farmer 6:...when you have an animal health problem or issue they can come on and do autopsies and find out what is wrong...give you advice on... programmes to help improve the health status. Last time I used the LHPA vet was when we had a bush fire on [property name] and 180 sheep ended up losing their life because of it.

Farmer 7: It doesn’t cost you anything. Pay rates to them, got to get something back. Always the first port of call if I’ve got disease that I’m not sure of is Gabe from the PP Board, I get her to come out and do a
post mortem on any suspect animal that I have an unusual death or something. She’ll come out and say yes I’ll do that and I’ll do some tests.

Using vets comes down to cost, which is justified by how many sheep are of ill-thrift. Also it can be determined by a disease event occurring outside of farmers’ experience.

Farmer 1: I’ve had him out occasionally, but there’s not much that goes wrong. I got lungworm years ago, didn’t know why they were dying, got Dan out, cut a sheep up and found it’ full of lungworm. So I drenched them in the middle of winter, because I never drench in winter, so I just drenched them because I had to they were dying like flies. But I don’t go near vets.

This farmer knew to call the vet and justified the expense because so many sheep had died in quick succession. This is an extreme event, and most of the farmers do not use vets very often beyond diagnosing benign or virulent footrot. Some claimed that it is easier and cheaper to shoot one sheep instead; shooting is therefore used as a management tool to avoid this expense.

Without prompting, participants mentioned that vets were only brought out to deal with other livestock issues, like cattle, which differs slightly from findings in other vet related studies. Palmer’s study of biosecurity behaviour and the use of vets in WA shows that vets are used for disease reporting (2009). Similarly, this was found in an Australian poultry study where older farmers were found to not use the support of a vet very often (Hernandez-Jover et al., 2013). A combination of a lifetime of experience and self-efficacy
in their ability to self-diagnose endemic problems is also weighed against the cost of a vet visit.

One issue with vets and biosecurity is that they may not be modelling good biosecurity practices. Vets have been found to not promote biosecurity to farmers because they have no interest or they lack available funds and time (Sayers, Good, & Sayers, 2014, p. 264). One challenge with vets is that they are also potentially ‘vectors for disease transmission’, because part of their working life involves moving between diseased livestock (Morley, 2002, p. 134). For these farmers this means they have to look to other biosecurity professionals to model good biosecurity practices.

Governments have placed vets in a unique position of authority to dispense biosecurity advice to farmers (Enticott et al., 2011). Epidemiological studies also point towards vets as the information disseminators, who are well positioned to provide the education farmers supposedly need (Casal et al., 2007; Gunn et al., 2008; Laanen et al., 2014; Permin & Detmer, 2007; Sayers et al., 2014; Simon-Grife et al., 2013). ‘Constraints to adequate uptake of on-farm biosecurity outlined by vet practitioners’ have been identified (Gunn et al., 2008, p. 317). However, in the Australian context, the vets themselves do not always adhere to good biosecurity behaviours. One example comes from a study of Australian vet practices to prevent zoonosis and a questionnaire was conducted at the annual Australian Veterinary Association conference. It showed that private practitioners are less likely to use personal protective equipment (PPE), which is an industry guideline (Dowd, Taylor, Toribio,
Hooker, & Dhand, 2013, p. 17). Vets’ perceptions of their ability to control disease movements is demonstrated in the behaviour and is ultimately a ‘failing in their duty of care’ (Dowd et al., 2013, p. 23). If the preventative measure of using PPE is not utilised by all vets, to protect their own health, it suggests that there may be other biosecurity practices that are also being overlooked. Vets may also be aware of the limited published data on the effect of changing boots and clothing in preventing disease (Sahlstrom et al., 2014, p. 63). Vets are best placed to be biosecurity role models post-border. However, vets may also need to change their behaviours, and targeted education for them is recommended (Dowd et al., 2013, p. 23). The following sub-section considers the role of agronomists and farm consultants that these farmers use that contributes to on-farm biosecurity decision-making.

Agronomists and farm consultants

For weed management local agronomists are utilised by these farmers to determine local weed trends and how to manage them.

Farmer 22: Through the agronomist who you met last week, he’s very very good. Oh just word of mouth I’d say between other farmers. There’s a weed going round here now and it’s called, some people call it Apple Sodum. That might be just the slang name for it. It started to get people spraying for it and we spray every plant. The plant is that big underneath the ground year round and if you break it off, every root that gets exposed, shoots. It’s got a little berry on it like that, must have hundreds of seeds on it, cattle spreads it because it grows in cow poop. So um, that’s a big one. But just word of mouth. Also the local district weeds fella, that works for the shire, he keeps us informed. And all my neighbours don’t seem to care much about weeds, so, but I do.
This farmer mentions the shire weed worker, and it should be noted that the shire is only concerned with managing those plants on the noxious weed list. In this region an example is Spiny Burr grass. Shires are responsible for managing both environmental (those that threaten biodiversity) and agricultural (those that threaten crops and pastures) weeds. There is a difference between the plants that farmers consider weeds depending on the type of industry (for problem weeds for sheep farmers see Chapter 4). However, public sector agronomists, like other extension officers, have been in decline since the early 1990s. Australian farmers commented in the 1990s that agronomists were difficult to access, and they wanted more of them to be available on-ground (Vanclay & Glyde, 1994, p. 24). A consequence of this is that some farmers utilise their own knowledge to assess the current weed situation.

Farmer 10: It’s been ideal. It hasn’t rained and no frost, yeah beautiful for weeds growing. It’s just been the rain and the nice warm winter and yeah, beautiful for the weeds. Want to see my spray bill? [laughing]

This finding is similar to that of Ilbery et al who found that farmers and agronomists use a combination of scientific and local knowledge and intuitive feelings to manage plant disease (2012, p. 306).

Professional farm advisors are also a source of information who help farmers make on-farm decisions. The rise in the use of farm consultants is a result of the reduction of government extension services and they are ‘important sources of management learning for farmers’ (Kilpatrick & Johns,
1999, p. 18). Three of the interviewees pay a farm consultant to assist their business. Farmer 18 explained the role of his sheep consultant as follows:

Farmer 18: He’s like an agronomist except he talks about sheep instead of crops, yeah [my] livestock consultant...Oh a few people have got, a lot of people wouldn’t have one, yes. Most studs would have them
Interviewer: To help you make decisions?
Farmer 18: Yes, yes...make decisions and set programmes up to try and do better breeding.

They have created a decision-making team whereby they have sourced experts in their field to give advice. Farmer 18 credits the farm consultant with encouraging his business to adopt electronic tagging for his flock. One farmer referred to his farm consultant interchangeably as a nutritionist and a vet and gave the example of when his lambs contracted pleurisy, he called the consultant, who diagnosed it over the phone. Another farmer who runs a mixed enterprise recognises his passion for sheep and employs a consultant for the cropping side of the business.

Farmer 5: He’s a good bloke, oh you pay for them and he’s good, that’s what he does. It’s just filling the gap with my weaknesses basically by employing him to do that.

These three farmers suggested that employing a farm consultant to help with their business is not common practice in the sheep industry.

High performing farmers are known to have a team of experts as part of their business. For example, as part of MLA’s service to farmers and in recognition that outside support and resources are useful they, for the first time, ran the MLA Challenge from July 2013-2014. The challenge for six participating farmers was to ‘improve business performance’ including
productivity and profitability\textsuperscript{14} (Meat and Livestock Australia, 2014a). Each of the participants were provided mentors throughout the year to assist with on-farm decision-making (Meat and Livestock Australia). The access to professional farm advisors or mentors helped farmers to improve their productivity. This has also been appreciated for south-eastern Australian woolgrowers, who for four years were given access to farm consultants in an attempt to move beyond an awareness of wool growing genetics and implement their knowledge into existing business-making decisions (Larsen et al., 2002, p. 266). The results of this project saw farmers’ incomes rise exponentially.

The informal knowledge sources mentioned above are utilised by farmers and contribute to their business decision-making. The sources mentioned by farmers were rural media, other farmers, NSW farmers, vets, agronomists and farm consultants. These sources contribute in varying degrees to on-farm biosecurity practices. I now turn to how farmers prefer to seek knowledge.

**Preferred sources of knowledge**

This section considers how farmers prefer to learn from the formal and informal sources articulated above. To keep informed, farmers over the years

\textsuperscript{14} The 2014 winners were sheepmeat producers from Tasmania.
have used a combination of both formal and informal sources of knowledge and those most often mentioned were:

- Talking to other good farmers in the district
- Attending Lifetime Ewe Management
- Talking to the vet
- Reading publications that come in the post
- Listening to the ABC

The decision on the order of farmers’ preferences was based on the frequency they were mentioned by the interviewees.

Seeking outside advice is a management tool in itself. Farmers have preferred people, either other farmers or those in agribusinesses from whom they seek animal health information and advice from. These preferred people have often provided excellent advice previously and therefore the relationship continues. For example, all farmers that I interviewed mentioned that they would seek practical weed management advice from their agronomist, who they have known for years. For example, Farmer 22 prefers the local agronomist, who gives practical advice, compared with the LLS, who he thinks “they’re too theory orientated”...I’d just rather go to [name of local agri merchandiser with agronomist on staff] cause they’re more practical and that’s the way I operate’. Agronomists have a facilitative role because they recognise the value of farmers’ local knowledge (Ingram, 2008, p. 412).

Although there are many examples of local knowledge being overlooked, both my study and Ingram’s show the interpersonal skills that agronomists need to have in order to maintain fruitful relationships with their clientele (Ingram, 2008, p. 416).
Vets are often mentioned as a preferred source of learning in other livestock studies (Brennan & Christley, 2013, p. 3; Windsor et al., 2015), because there are years of built trust with the local vet. The participants gave the impression that vets are a preferred source that they know are available when situations present themselves beyond the farmers’ expertise. These sheep farmers are similar to poultry exhibitors in Australia who consider information from government agencies less useful than that of industry, vets and the internet (Hernandez-Jover et al., 2013). The next sub-section discusses farmers’ preferences for receiving information.

*Hardcopy vs. the Internet*

The delivery methods, either electronic and hardcopy media, of biosecurity messages are ideally designed to enhance adoption of recommended practices. In American livestock industries biosecurity information is found on websites and in state department publications (Moore et al., 2008, p. 249) and Australia appears to follow this model. Current biosecurity messages aim to raise awareness and the assumption is that behaviour change will follow. It is noted that for behaviours and attitudes to change ‘biosecurity messages need to be reframed with greater attention paid to delivery’ (Heffernan et al., 2008, p. 370). For governments and industry to appreciate an increase in biosecurity practices it would pay to present relevant information in a format that is conducive to farmers’ preferences.
Considering the age group of the farmers interviewed it is not surprising that they prefer information to be presented in a hard copy format rather than a website and this finding aligns with other Australian rural studies. In the early 1990s in rural NSW a study found that newspapers and magazines were the most useful source of information to farmers (Vanclay & Glyde, 1994, p. 25). In another study farmers found biosecurity risk information in newspapers, on the radio or television (in descending preference order) (Barclay, 2005). Although Australian farmers are increasingly using the internet to locate relevant information to assist with on-farm decision-making (Bamberry et al., 1997, p. 3) hardcopy information in the mail is still the preferred format for farmers (Denney, 2007; Hernandez-Jover et al., 2013). Most farmers indicated that they use either print or electronic media as a way to learn (Kilpatrick & Johns, 1999, p. 88). From the Australian Hendra virus outbreak it is recognised that a better understanding of farmers’ preferences will positively impact the delivery of biosecurity messages (Schemann et al., 2011, p. 35). Post-border biosecurity information that is aimed at farmers is freely available on the Farm Biosecurity website; it is the location of the grazier’s manual. One issue with the website is the lack of awareness of its existence as none of the farmers interviewed mentioned it as a source of information.

These farmers were no different in their preference for consuming farming literature in hard copy to read at their leisure.

Farmer 18: Hardcopy. You don’t read things on the computer.
Farmer 19: I mean I do a little bit but...hard copy you know is something like you know you have a magazine rack or you know if I think it’s important I’ll leave it on the table so when he comes in for a meal he’ll just have a look or if I’m not here, he’ll have a browse or something like that if it’s in the house. If it’s sort of sitting in front of you or you know a night in front of the TV or something like that you know, just pick something up.

Farmer 29: Yeah I like to sit at breakfast and read. Good thing about the internet is it’s easy to believe things. But internet is good for, say there was some disease, say it was OJD or something, although that’s probably not a good example is it? But you want to look up a bit of information on something you’re not sure about. They have a bit of info, just to find out something. You mightn’t find the answers you want, but you get at least some information on what you’re wanting to check out. It’s a starting point. It’s handy for lots of things. If they took it away life would so different.

Some farmers mentioned hardcopy newsletters they receive from the Kondinin group. Newsletters were also used in a Tasmanian wool industry extension activity, which resulted in practice change (Hunt & Coutts, 2009, p. 49). Farming magazines and newsletters are one way farmers keep updated on information (Garforth, 2011, p. 63). For the delivery of future biosecurity messages policy makers and industry should consider farmers’ preferred methods of receiving information. The following section considers the implications of formal and informal learning sources on farmers’ biosecurity knowledge.

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15 The Kondinin group has set themselves up to provide services that were previously government supported (Hunt et al., 2014, p. 130).
The implications of learning sources and biosecurity knowledge

In contrast to the veterinary epidemiology literature, which argues that farmers lack biosecurity knowledge, the findings in this chapter draw attention to the range of ways that farmers develop and maintain their biosecurity knowledge. The findings suggest that these farmers’ biosecurity knowledge is extensive and that perhaps further education should not therefore be the primary focus of governments and industry extension efforts. It is also worth considering the design of current biosecurity programmes. Farmers are supposed to be the target of these programmes. However, the delivery of information is primarily through the internet. Interviewees’ preference for learning in this study is face-to-face, which is similar to other Australian findings (Bambery et al., 1997; Kilpatrick & Rosenblatt, 1998; Kruger, Thompson, Clarke, Stenekes, & Carr, 2009). Thus, the choice of governments making biosecurity information available for farmers primarily online is perplexing. Despite governments’ declining resources and the use of web-based information to address it, farmers’ preferences of receiving information must be acknowledged.

The primary focus of government and industry has been on increasing farmers’ biosecurity education and considerable amounts of public money and effort has gone into biosecurity extension material. However, the outcomes of education on farmers’ biosecurity practices are far from clear. Scientists, governments and industry are currently promoting biosecurity education as a
solution to low rates of biosecurity engagement and adoption by farmers. In 2009, the national government advised that improvements to on-farm biosecurity will occur ‘through careful communication and engagement of these [rural] people and communities’ (Kruger et al., 2009, p. 1). At the national level, Animal Health Australia’s 2013/14 budget for the Farm Biosecurity programme amounted to $201,959; the activities of this project included monthly e-newsletter production and distribution, improving content on the Farm Biosecurity website and the development of promotional materials (Animal Health Australia, 2014b). Additional to this are the biosecurity materials developed and distributed by DAFF, AWI, MLA, Sheepmeat Council, and Wool Producers. State biosecurity funding in 2013/14, which included RD&E, totalled $1.1 billion (NSW Farmers, n.d-a). This expenditure is for the production and dissemination of biosecurity information with the aim of increasing on-farm implementation, which is government and industry’s ultimate goal.

One way for governments to better understand the link between biosecurity education and on-farm practices is to monitor and evaluate the current programmes. Currently, post-border biosecurity programmes have a lack of monitoring and evaluation of on-farm practices as a result of government financed farmer education (Kruger et al., 2009). However, there is some level of collaboration between agencies to increase biosecurity practice. One outcome of the collaboration of knowledge distribution resulted in the state level organisations failing to articulate the existence of the various
weed and pest programmes of other regional biosecurity programmes (Kruger et al., 2009, p. 5). The current limitation of measuring the impacts of distributed material is based on website hits and distribution numbers of hard copy material (Kruger et al., 2009, p. 5). Consistent with the literature, there are limited measurable outcomes of behaviour change that can be appreciated as a result of extension efforts. Currently AHA measures the number of users on the Farm Biosecurity website and uses surveys to assess the level of practices undertaken by farmers (Animal Health Australia, April 2014).

The design and accessibility of biosecurity knowledge transfer is somewhat problematic. This current approach assumes scientific authority, which in agricultural studies overseas has been shown to undermine the role of farmers’ knowledge in efficiently resolving problems (Enticott, 2001; Wynne, 1996). In Australia, Landcare is a successful model of local group facilitation for NRM concerns. Thus, perhaps there is space to learn from the strengths of Landcare, which has less of a top-down focus on knowledge dissemination, and to adapt them to programmes for biosecurity. Currently, the design of biosecurity knowledge transfer in Australia is a top-down approach (Kruger et al., 2009, p. 25). Governments and industry are currently funding the graziers’ manual and decide on website content.

Further, there are a few biosecurity personnel with whom farmers can engage (Kruger et al., 2009, p. 8). It is difficult to count biosecurity personnel because they have a variety of job titles, such as agronomist (Coutts, Roberts, Frost, & Coutts, 2005, p. 9), and from mid-2014, biosecurity officers who are
employed at the LLS. The limited opportunity for face-to-face contact presents a barrier to the accessibility of biosecurity knowledge. Additionally, the current trend from national and state governments and industry collaborations is to rely heavily on the internet to disseminate generic biosecurity knowledge, specifically the graziers’ manual. In 2009, criticism was made of the use of this platform as a main way to transfer biosecurity information (Kruger et al., 2009). Six years later very little appears to have changed. The potential consequences for generic information are that farmers may not engage with it. Farmers prefer to see and read examples from their local area.

Biosecurity knowledge is often embedded in current programmes, which may contribute to farmers not explicitly recognising messages as related to biosecurity. There are few local extension opportunities where biosecurity is explicitly a key message, which limits the possibilities for farmer input and feedback. The examples from this study are taken from BredWell FedWell, where FEC tests were encouraged, as well as the importance of visually assessing rams; however, biosecurity was not discussed explicitly nor was the term used. Also at the 2014 Graham Centre Sheep Forum, worm control and best practice of managing stock in drought periods was discussed, and again not explicitly referred to as biosecurity (Graham Centre for Agricultural

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16 During BredWell FedWell farmers learned (and it was available in the take home material) rams are to be assessed for features like how they stand, width of shoulders and micron. However, during such an assessment farmers can also appreciate any lameness, which may lead to footrot, heavy lice burden, and vegetation matter caught in the wool, which could devalue the fleece and may pose a transmission risk of unwanted weeds.
Innovation, 2014). These examples are at the local level and distributed by trusted professionals, which accords with the literature as messages are best if transmitted by local people because their experience is contextualised to the environment (Kruger et al., 2009, p. 15). Additionally, local contacts are known to have more influence on farmers (Garforth et al., 2004, p. 28). This study confirms the findings of Kilpatrick and Johns 2003 and Bamberry et al 1997 that farmers prefer the face-to-face contact from trusted others when learning. Kruger et al recognise ‘current biosecurity information is cluttered and messages are sometimes inconsistent’ (2009, p. 10). This ultimately does not help farmers in their practice. It is also a contributing reason for farmers not being able to articulate definitions of biosecurity, as it is discussed just as part of what they do.

These implications leave one questioning whether biosecurity education is the best way forward since the current design, accessibility and targeting of messages appears to not meet the intended audience of farmers. The findings have demonstrated farmers are knowledgeable about biosecurity. This contrasts with the predominantly quantitative findings of veterinary epidemiologists on farmers’ poor and inconsistent biosecurity attitudes, beliefs and practices. Farmers are depicted as needing education on biosecurity, which will improve implementation rates. Vets are under added pressure to encourage biosecurity at the farm level. There are some successful examples of regional vets alongside farmers using initiative to manage biosecurity with knowledge of the local conditions (Gunn et al., 2008; Mather, 2012).
However, my study challenges the need for further education as farmers are already in possession of tacit knowledge and are actively seeking out localised opportunities from which to draw further knowledge from. Therefore it is perhaps more useful to consider how and where, within the existing sources of knowledge, biosecurity practices can be better modelled (further considered in Chapter 7).

**Conclusion**

This chapter has discussed the various ways in which farmers construct their biosecurity knowledge. It has addressed the research question of how farmers learn about biosecurity practices, and has found that other farmers are the preferred source of knowledge, as they possess local knowledge of the environment and have a wealth of lived experience of managing biosecurity on-farm. Also, biosecurity professionals play a role in sharing knowledge about biosecurity practices. This reinforces the importance of trust at the local level. Knowledge may be obtained from outside sources such as the media, however there is a process of verification with known, trusted people in the local farming community. Trust in knowledge sources demonstrates farmers actively filtering the information they receive, which is an example of good farming. The chapter has described the formal and informal sources of
knowledge that contribute to where farmers locate, develop and maintain their biosecurity knowledge.

These findings support what is already known about how farmers learn and challenges existing literature on what we know about farmers’ biosecurity knowledge. It has challenged the scientific studies that call for education to improve biosecurity practice because of farmers’ knowledge deficit. However, this study has found that farmers have a wide knowledge of biosecurity practices, which is demonstrated through the breadth of biosecurity practices they undertake, as shown in Chapter 5. Identifying these farmers various formal and informal sources of learning has shown they are good farmers who proactively seek localized best practice to apply to their properties to minimize biosecurity threats. Through these sources of learning farmers have gained a tacit knowledge of their local conditions. This means that farmers are equipped with localized biosecurity knowledge to secure their farms by practicing pest, weed and disease management. Identifying sources of biosecurity knowledge is a new way to view good farming. Part of good farming is having the tacit knowledge to produce robust livestock. This chapter has shown the various ways in which farmers use to continuously add to their tacit knowledge. The notion of good farming applied to biosecurity provides new insight into what we know about farmers’ knowledge by demonstrating the breadth of ways farmers’ access and utilize localized biosecurity information.

This chapter has added to the current social science biosecurity literature by demonstrating the various ways in which farmers access their information.
Farmers prefer to learn using locally relevant sources of knowledge from trusted providers. Information is presented by governments and industry, but farmers prefer to trial and see how it works on other properties and consider whether changes are appropriate to their management style. This chapter has also added richness to what is known about how biosecurity practices are social practices. An increase in the uptake of biosecurity practices may occur if there is greater visibility in social situations between farmers and biosecurity professionals, where good biosecurity practices could be modelled. Role models of good biosecurity behaviours could further enhance farmers’ ability to secure the food supply. A major implication of my findings is that farmers and biosecurity professionals are reliant on each other to model the ‘good’ biosecurity practices. The next chapter addresses the second research question and explores farmers’ knowledge of incidental biosecurity practices.
Chapter 5 - Incidental biosecurity: Preventative practices in play

Introduction

This first analytical chapter presents the findings in relation to farmers’ prevention and management of biosecurity boundaries on-farm, which addresses the first research question. In order to address the research question this chapter makes explicit use of the data collected from the semi-structured interviews with Riverina sheep farmers, as described in Chapter 3. This chapter aligns with the literature on biosecurity boundaries and spatialities, as discussed in Chapter 2. Agricultural spaces have been defined by what is ‘in’ and what is ‘out’, and farmers’ maintain the boundary through various pest, weed and disease management practices, examples of which in the Riverina context are discussed here.

During analysis the term ‘incidental biosecurity’ was coined. Incidental biosecurity is defined as the practices that farmers use to control endemic pest, weed and disease problems, and in doing so establish biosecurity boundaries on their farms. Many of the farmers’ biosecurity practices align coincidentally with governments’ recommended biosecurity practices. This contrasts with the current narrative of farmers not participating in biosecurity (Gunn et al., 2008; Hernandez-Jover et al., 2013). Incidental biosecurity shows a different and more complex picture by demonstrating the breadth of
pest, weed and disease practices that these farmers are participating in to increase productivity and profitability, rather than only for biosecurity. Describing their practices as ‘incidental’ highlights those activities that contribute to broader biosecurity objectives, and which are viewed by farmers as crucial in the construction of boundaries on their farms, but which they do not necessarily view as ‘doing’ biosecurity.

Governments have created the new umbrella term of biosecurity, but everyday life practices have not altered. This has produced the current situation whereby on-farm biosecurity takes place in particular ways but governments fail to appreciate the knowledge and experience in what farmers are already doing. As a consequence biosecurity is only meaningful to farmers in the context of their existing practices, which are motivated by notions of ‘good farming’ and wanting to remain financially viable.

The incidental biosecurity practices detailed in this chapter are a response to, and are driven primarily by the imperative of financial viability and the desire to be a good farmer, rather than for biosecurity purposes. First, doing incidental biosecurity is ideally to minimise outstanding problems, such as the presence of lice, which have negative financial ramifications on their production. Second, farmers are motivated by aspirations to be viewed by others as a good farmer. A good farmer is one who is seen to do the right thing (Vanclay, 2011) and who has a good reputation in the district. Identifying farmers’ biosecurity practices and characteristics builds upon the existing Australian sociological literature on the notion of being a good farmer.
Incidental biosecurity defined - ‘Unconsciously you are doing biosecurity’ (farmer 25)

Incidental biosecurity refers to farmers’ on-farm pest, weed and disease management practices, which incidentally align with government and industry recommendations. Farmer 25 articulates it best: ‘Unconsciously you are doing biosecurity’. Biosecurity practices contribute to animal health and preventative measures and are carried out as part of everyday farming functions (Delabbio, 2006). Farmers’ understanding of biosecurity practices is interpreted through their lived experience. Lived experience is a notion that is found primarily in qualitative research, which provides insight into people’s experiences of ‘living through something’ (Manen, 2004), in this case their practice as farmers. Each farmer could articulate knowledge of endemic pests, weeds and diseases, but as a holistic term, ‘biosecurity’, these activities are rarely collectively referred to as such by the participants. It was found that these farmers ‘do’ biosecurity as part of their farming business; therefore, their activities are best captured by the term ‘incidental biosecurity’.
Incidental biosecurity covers all the activities that these farmers mentioned relating to minimising the risk of pest, weed and disease incursion by having high animal health standards. High animal health standards can be appreciated by farmers because they are crucial to running a productive and profitable business. In order to produce robust stock farmers know that having good animal health is key. Such standards are also reinforced at field days and in extension material (Animal Health Australia, August 2012; NSW Industry and Investment, n.d). The endemic biosecurity management practices that were discussed during interviews are listed below.

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<td>1080 poisoning</td>
<td></td>
<td>Only buying in seed stock</td>
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<tr>
<td>Commercial shooters</td>
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<td>Vaccinating</td>
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<tr>
<td>Bottom wire netting</td>
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<td>Faecal egg counts (FECs)</td>
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<td></td>
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<td>Brucellosis accreditation</td>
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<td></td>
<td></td>
<td>Not buying in feed</td>
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<td></td>
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<td>Abattoir surveillance</td>
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<td></td>
<td>Crutching</td>
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<td>Signage</td>
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Fence maintenance, co-ordination with neighbours, stock isolation

Figure 7 Farmers incidental biosecurity management practices
The labelled practices in Figure 5 show the variety of management practices used by participants. They demonstrate farmers’ continued commitment to animal health and running a financially viable business. The practices farmers identified in Figure 5 are all quite labour intensive, but they are good biosecurity practices. Good biosecurity is defined as ‘...reduc[ing] the risk of an individual farm suffering a disease incident’ (Simmons, 2012 p349). While some definitions are predominantly concerned with livestock disease, incidental biosecurity is holistic in its inclusion of pests and weeds.

Pest, weed and disease prevention and management are the focus of Australian governments (Beale et al., 30 September 2008). Incidental biosecurity practices occur regardless of governments’ changing agendas and the programmes implemented to assist farmers. The following discussion of on-farm pest, weed and disease practices contributes to a farmer’s economic viability or the notion of being a good farmer. A farmers’ ability to maintain a sustainable business is reliant on the sustained use of biosecurity practices to produce healthy, robust sheep.

**Commercial advantage**

A key theme that emerged from the data and appeared in many of the listed biosecurity practices (see Figure 5) was the farmers’ motivation to generate profit. The endemic pest, weed and disease problems farmers face place limitations on their ability to run their business sustainably. This
demonstrates why biosecurity practices are important and why farmers see them as necessary to carry out. Farmer 24 articulated this best when he noted: ‘they [pests, weeds and diseases] actually reduce the carrying capacity of your country and they contaminate your products’. Many of the practices are an attempt to mitigate stock losses and increase productivity, both of which affect farm income. This suggests that economic motivations are crucial in influencing the incidental biosecurity practices that farmers adopt.

Pests are the main cause of stock losses that can be controlled by farmers, and stock losses are a problem primarily because of their impact on returns. Government report findings suggest that pests are not well managed. For example, in 2007-2008, losses to the Australian sheep industry from wool and lamb combined as a result of pests totalled $91.3 million (AUD) (Gong, Sinden, Braysher, & Jones, 2009 p1). The pest problems as described by farmers are foxes, kangaroos, pigs, rabbits/hares, wild dogs and eagles. An Australian report found that ‘the main impact of stock losses is financial, and this loss can be significant when a farm is organised and structured for sheep’ (Fitzgerald & Wilkinson, 2009 p22).

A 2009 case study in the Upper Hunter region of NSW on the social impact of pests to farmers revealed many of the same issues and outcomes are faced by farmers in this region.
<table>
<thead>
<tr>
<th>Pest animal</th>
<th>Main issues</th>
<th>Main social outcomes</th>
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<tr>
<td>Foxes</td>
<td>Prey on sheep and poultry.</td>
<td>Reduced farm income.</td>
</tr>
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<td></td>
<td>Prey on indigenous animals (biodiversity loss).</td>
<td>Psychological distress.</td>
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<td></td>
<td>Cause road accidents</td>
<td>Reduced quality of the living environment.</td>
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<td>Physical injury to motorists.</td>
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<td></td>
<td>Higher motoring costs.</td>
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<tr>
<td>Feral pigs</td>
<td>Physically damage pasture, crops and farm infrastructure.</td>
<td>Additional farm work and expenditure.</td>
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<td></td>
<td>Possible vector for animal diseases.</td>
<td>Reduced farm income.</td>
</tr>
<tr>
<td>Rabbits</td>
<td>Consume pasture intended for farm grazing stock.</td>
<td>Reduced farm income.</td>
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<td></td>
<td>Physically damage the land.</td>
<td>Additional work for land managers.</td>
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<tr>
<td></td>
<td></td>
<td>Reduced quality of the living environment.</td>
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<tr>
<td>Wild dogs or dingoes</td>
<td>Prey on sheep and other farm animals.</td>
<td>Reduced farm income.</td>
</tr>
<tr>
<td></td>
<td>Induce fear and uncertainty among stock managers</td>
<td>Financial stress.</td>
</tr>
<tr>
<td></td>
<td>Undermine sustainability of sheep farming.</td>
<td>Additional farm work and expenditure.</td>
</tr>
<tr>
<td></td>
<td>Responsibility for and cost of control are a source of social conflict.</td>
<td>Psychological distress.</td>
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<tr>
<td></td>
<td></td>
<td>Loss of community cohesion.</td>
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As shown in Figure 6, farmers in the Hunter region are affected by wild dogs, foxes, pigs and rabbits, and Riverina farmers face similar issues and social outcomes. These pests have similar negative impacts on farmers, their workload, mental well being and the farms’ financial viability. Interestingly when Fitzgerald and Wilkinson’s data was collected in 2007-2008 kangaroos were not mentioned as pests, but they are the second biggest problem faced by Riverina sheep farmers. The following pest, weed and disease management practices are examples of on-farm incidental biosecurity that are carried out through the motivation of wanting to remain financially viable.

Pest management

Foxes are currently classified as nuisance animals, not declared pests by the LLS (Local Land Services, 2014b); however, farmers view them as pests because they steal lambs when the ewes go in search of food. Farmers know what devastation foxes do to their lamb survival percentages and this impacts both their economic returns and causes psychological distress. As a result
they manage foxes aggressively. The LLS\textsuperscript{17} assists farmers with on-farm fox management by organising and distributing baits that are laced with 1080 poison. It is one service that every single interviewee participates in because foxes are so problematic and this practice is of commercial advantage.

Some farmers use additional control methods for foxes, such as ‘doing the burrows’, shooting, employing fox lights or running alpacas in with lambing paddocks. Although the evidence is anecdotal rather than scientifically based, the farmers that utilise these methods believe that they achieve positive results and lose fewer lambs as a result of the lights or alpacas. Farmer 1 believed that his lambing percentages were higher as a result of running alpacas alongside his lambing mobs (see Figure 7).

\textsuperscript{17}The LLS (previously known as the LHPA) was renamed in 2014 and provides assistance to farmers beyond that of the state agricultural department in the form of vets, biosecurity officers and rangers. It is unique to the state of NSW. At the time of interviewing farmers stated that the LHPA is funded by farmer’s rates.
Fox management is incidental biosecurity; it is conducted through coordination with the LLS and neighbours, and it is not recognised as a biosecurity measure by farmers. Much of the concern relating to foxes is through anecdotal evidence; farmers do not have any numbers to support their claims of lamb theft from this particular pest.

Wild dogs are problematic because they threaten fence integrity, lambing percentages through stock losses, and cause stress to farmers because of their limited ability to control the problem (Wicks, Mazur, Please, Ecker, & Buetre, April 2014 p36). In other Australian states wild dogs are declared pests
(Wicks et al., April 2014 p36) and state agricultural departments assist with their management. In the Riverina region, however, farmers have greater issues with town dogs, who access lamb paddocks and ‘just go and bite their faces off’ (Farmer 17), and can cause over 100 lambs deaths in one night. This farmer manages the dogs by laying poison.

Farmer 1: I do a lot of fox baits around the boundary and a lot of fox baits on the town side because I’m only just out of town and that’s just to keep the town dogs out of my property. I have killed town dogs before on purpose because they were coming out from town, so I’ve laced the town side and I heard on the grapevine the dog went home afterwards and died.

Similar control methods to fox management are employed for wild dogs, where baits poisoned with 1080, in a co-ordinated approach to achieve results (Local Land Services, 2014a).

Rabbits have historically been problematic for farmers since colonisation and have been managed by a combination of biological controls, poisoning and rabbit-proof fencing. A consequence of these practices also affect kangaroo populations. Wild rabbits are problematic for farmers because of the economic losses and damage to crops, pasture and soil (Local Land Services, 2014a). One solution to the rabbit problem was the installation of the rabbit proof fence in the early 1900s, which acts to exclude pests (rabbits, vermin, emus and kangaroos) from farming areas. After the early success in Western Australia and subsequent design improvements, farmers in other states also adopted the use of rabbit wire netting at the bottom of fences to prevent pests from moving across farmland. Unfortunately, the netting has not been maintained
and kangaroos now push through the rusting rabbit wire that is present on many farms at the ground level. Holes in fences are a biosecurity concern because they create breaks in farmers’ systems until they are fixed, which opens the property to greater levels of risk. Kangaroos cause management issues for sheep farmers as they compete with livestock for food (Viggers & Hearn, 2005 p105) and their presence places limitations on how many stock can be run efficiently.

Pest management is incidental biosecurity because farmers implement best management practices to minimise pest impact on productivity and infrastructure, rather than for biosecurity reasons. Farmers know that the best practice control methods are to bait at the same time as neighbours because this will achieve the greatest reduction in pest populations (Local Land Services, 2014b). However, co-ordination with neighbours is difficult, because foxes are only problematic for sheep farmers. Therefore, it is challenging to encourage other farming enterprises to participate in the baiting programme because there is no direct benefit. Given the negative financial impacts of pasture and fence maintenance, poisoning and shooting are the preferred methods for the successful management of pests affecting sheep farmers. Best practice for pest eradication is poisoning with 1080. This has been recognised with the success of the fox baiting programme (Local Land Services, 2014a) and impacts on wild dog populations (Wicks et al., April 2014). ‘Monitor and manage vermin, feral animal...’ is one recommendation in the biosecurity manual (Animal Health Australia, August 2012, p. 11). From
the evidence above, these sheep farmers are participating in incidental biosecurity as they actively monitor and manage a variety of pests. Biosecurity practice consists of a multitude of control measures, which also includes those for the management of weeds.

Weed management

Weed management, like pest management, reduces farm income through the expenditure of trying ‘to keep on top of them’ (Farmer 14). Spraying for endemic weeds is incidental biosecurity as their presence encroaches on the pasture available for livestock. As a consequence, if there are too many weeds in a particular paddock, farmers are forced to run fewer stock, or feed out in compensation, and this affects farm returns. Farmers have an acute awareness of the spray bills and therefore take an active interest in limiting spread through this practice. Farmers have always had weed problems so already know the best control methods, which sometimes differs from popular spray management, such as chipping. They also have knowledge of the vectors in which weeds are spread.

From the interviews, farmers identified Burrs, Thistles, Cape Weed, Patterson’s Curse, Bindi Eyes, Hore Hound, Blackberries, Radishes and Khaki Weed as the major weeds affecting farm production in the Riverina18. Whilst

18 Some of the weeds mentioned in interviewed were crop specific, which reflects those farmers’ holistic view of their mixed enterprise.
interviewing Farmer 22 he took me to the shed and showed me a large amount of Bindi Eyes that he had collected off some hay recently and put in the rubbish, pictured in Figure 8.

From the participants’ point of view these plants are considered weeds, and spraying is best management practice, because they are interfering with pasture growth and ultimately affect wool quality. Farmer 8 reported reduced income because of his weed burden.
Farmer 8: The shearers don’t like shearing them because they’re all prickly and...it also does get the vegetable matter in the wool which devalues the wool to a small degree.

This shows the monetary ramifications of not being vigilant in controlling weeds. How weeds are managed is part of incidental biosecurity because farmers are spraying and chipping, which has direct implications on farm income.

Some farmers mentioned that weeds that grow in residential towns, such as Khaki weed, are not declared noxious and are therefore not managed with public money through shire councils. However, they can be problematic when weed spikes are brought in off town ovals on car tyres, or are blown onto their properties because they cause sheep and dog lameness. The farmers affected in this way would prefer that the responsibility be with the shire to manage the problem to limit the livestock income losses they are experiencing. Weed management contributes to good on-farm biosecurity, similar to managing diseases.

Disease management

Disease management practices are primarily employed to mitigate animal health issues in livestock that would impact investment returns. The main problematic on-farm diseases identified by these farmers are lice, footrot, worms and Ovine Johne’s Disease (OJD).
The commercial advantage of maintaining a clean flock free from lice is the higher price that is offered for having a good quality wool clip. Lice afflicted fleece affect the quality of the wool clip, which directly equates to a lower profit. Lice are the prevalent endemic disease that the majority of flocks suffer from, and which all farmers mentioned as the number one sheep disease. Farmers reported that in the past the Rural Lands Protection Board (RLPB)\textsuperscript{19} would quarantine lousy flocks. However, there are now no regulations on lice management practices and this makes the higher wool price the only incentive for carrying a clean flock.

Farmer 2: The ranger tells me that he goes out to places for only a social visit because he has no teeth to actually quarantine you until you bring your lice up which is what the case used to be. Now it’s not like that at all, it’s all wishy washy, so you do your own thing.

The relaxing of this regulation has created the current situation whereby:

Farmer 20: Our best information is that about one in three flocks has lice. [pause] Basically, I tell everyone when you’re buying sheep you get the lice for free. You just assume that they’ve got it, that’s your best management practice is just to assume they’ve got lice and then make your management decisions around that.

The removal of on-ground staff has meant that the control of such problems, has been handed to farmers to manage. Clearly management of the lice has not gone well; all farmers have management programmes in place which suggests that lice are rife in the Riverina.

One reason given for the apparent inability to manage lice is not Australian farmers’ lack of knowledge, but ‘the attitude and ability of the

\textsuperscript{19} Predecessor to the LHPA, now known as the LLS.
manager to implement an effective control program’ (Sackett, Abbott, Jephcott, & Barber, April 2006, p. 65), which is suggests that farmers remain the problem. However, these farmers participate in best management practice for lice as articulated in industry extension material (Australian Wool Innovation, 2011). For example, flock lice treatment is best conducted post-shearing, either by backlining, shower or plunge treatment, which is more commonly done by contractors than the farmers themselves. Plunge dipping provides the best treatment against lice as the sheep walk up the ramp and into the dipping unit and are fully immersed in the dip chemical and walk out the other side. The sheep emerge out of the plunge dip machine a different colour, saturated in chemical, which has the appearance of treatment. The visual presence of lice makes it a more difficult problem to dismiss and farmers know the financial ramifications of a lousy wool clip. Therefore, lice management via dipping is primarily conducted to improve financial returns. This is an example of incidental biosecurity, as this practice also contributes to good biosecurity. The ultimate motivation behind ‘getting on top of the lice’ is to help with financial returns on bales of wool.

Footrot presents a similar issue, as this disease negatively affects returns, albeit in meat rather than wool and chemically treating this disease and the associated potential losses, worry and labour are the largest costs. Each sheep with footrot present is lighter and therefore affects productivity causing approximately $30 AUD less per head (Farm Biosecurity, 2013). The two strains of footrot, benign and virulent, require active management to
minimise stock condition and/or losses. Participants remember the management of footrot from outbreaks in the 1970s, 1980s and 1990s, where farmers were assisted by the Pasture Protection Board (PP Board) to rid the region of this disease. The region was mapped into footrot free zones that impacted trade, and the region was signposted to raise awareness of the zoning.

![Figure 11 Remnant of old footrot zones on the side of the Olympic Highway A41](image)

Although zoning has been removed (despite signage still in place in 2015, see Figure 9) this influences farmers’ management decisions, such as not buying in stock from unknown sources. Farmers’ experiences with footrot during the course of their farming careers means that they know what to expect and how
to manage the disease. The proactive strategies that farmers employ to keep footrot out align with incidental biosecurity because both aim to minimise disease transfer. The steps farmers are taking seem to be out of fear of the steep eradication costs rather than for biosecurity purposes.

Farmers make management decisions with caution because some reported lost income from choices made during the stressful drought years from the mid-1990s to the 2000s. A cause for conservative behaviour is a result of trusting others and ‘having been burnt by a situation where at some stage someone has obviously known they’ve had sheep with bad feet and they’ve still sold them’ (Farmer 28). In this example, purchasing footrot-infected sheep during the drought, which happened to some of these farmers, has in turn led them to change their on-farm biosecurity management and become a closed flock. This choice presents a better alternative than placing themselves again in potentially vulnerable, and expensive situations.

Farmers interviewed for this project also have experience of managing OJD. OJD was managed, similar to footrot, with the use of the now disbanded zoning system. OJD is a bacterial sheep disease where infected sheep waste away (Department of Agriculture Fisheries and Forestry, n.d), thereby reducing farm income. Previous governments managed the disease via quarantine. This gave rise to many farmers opting out of testing for OJD so that trade on the domestic market could continue uninterrupted because they could assert to the best of their knowledge that they did not have the disease. On July 1st 2013 the programme changed and these zones were disbanded in favour of
the use of sheep health statements (Sheepmeat Council of Australia & Wool Producers Australia, 2013). However, farmers still differentiate districts using the old terminology.

Best practice with OJD is now to use the sheep health statement (see Appendix E) and this purportedly empowers individuals to make informed buyer choices. Currently OJD affects 1 per cent of all sheep in Australia (Kennedy & Allworth, 2001 p482) and is best managed through vaccinating at lamb marking with Gudair. Vaccines cost around $1 AUD a head and usage varies widely in the region. The decision to use Gudair on-farm stems from an economic viewpoint; there is higher consumption of the vaccine in the old high prevalence zones as sheep are most likely to be sold locally, which drives demand for vaccinated livestock. This compares with old lower prevalence areas where farmers are currently making decisions over whether the extra $1 AUD per head, plus wages for an extra person to give the shot at lamb marking, will make their product more locally marketable. Farmer 24 remarked: ‘We probably should do that just for marketing’. Farmers may have mentioned OJD because of the ongoing media exposure that is often linked to the term biosecurity. Given its wasting nature it is recognised as a main endemic disease that affects sheep farmers’ profitability.

Unlike the aforementioned diseases internal parasites are less visually apparent, which perhaps led farmers to not as readily mention them. Nonetheless, the worm burden impacts profitability. Flocks with high parasite loads are problematic for sheep farmers because they cause reduced fleece
weight, fibre diameter, staple strength, liveweight of ewes, and weaner liveweight, all of which increase time and chemical costs to monitor and treat (Sackett et al., April 2006, p. 35). In the Riverina there are four common internal parasites: Black Scour Worm, Brown Stomach Worm, Barber’s Pole and Liver Fluke (Wormboss, n.d). Signs of ill-thrift in sheep due to high parasite load are unseen, therefore best practice is to conduct Faecal Egg Count (FEC) tests to assist with strategic drench decision-making (Lloyd & Playford, June 2013). Experience and knowledge mean that farmers know and understand a worm’s lifecycle and the drench and post-drench steps to take to attempt to control the problem. Worm control is incidental biosecurity because drenching is a disease management practice that is performed by the majority of these farmers. Through experience farmers know the best management of worms.

Healthy sheep are produced in part by adhering to on-farm biosecurity practices and minimising pest, weed and disease problems. For example, farmers minimise pests so livestock do not compete with kangaroos for pasture, or ewes are nourished and lambs are safe from foxes.

Farmer 6: If you have your ewes at condition score three at the point of lambing then the lambs are going to be healthy and the ewes are going to be healthy. If they have got feed in front of them they don’t have to wander off to go and get food, so the lamb’s not unprotected. They minimise weed incursions so pasture is plentiful and not full of weeds.

Farmer 17 noted that: ‘blackberries maybe a third of the [farm] turnover goes on spraying things’. Interviewees attempt to prevent diseases because healthy
sheep are worth more ‘over the hooks’, remembering that sheep with benign or virulent footrot earn less per head. If any pest, weed or disease is present beyond minimal levels then farmers are reducing their profitability. When asked, *Do you think doing biosecurity is more cost and time efficient than treating disease on-farm?* All farmers remarked with a resounding ‘yes’.

Farmer 13: Oh yes! Most definitely but I’m biased because I’m a registered nurse [laughing] prevention is always better than cure isn’t it.

Farmer 7: Oh by far and away...an ounce of prevention is worth a ton of cure.

These farmers know the value and importance, through experience, to their business of ‘doing’ on-farm biosecurity. Their knowledge and preventative action is an example of incidental biosecurity because, they are already participating in on-farm biosecurity without the influence of government and industry recommendations.

Another example of farmers ‘doing’ incidental biosecurity is a result of their experience of losing money and time. Many have their individual stories of management shortcuts they have taken that were subsequently cost them to fix the problem:

Farmer 24: We lost 200 there cause I took a shortcut. Lost 200 ewes and had to spend a fortune. In our operation we used, quite a few ago now, we used two wethers to excite the ewes before we put the rams in. And we selected these wethers and one mob for some reason our dipping procedure didn’t do 100 per cent job, we selected the weathers out of this lot. And we scattered them through ALL our ewes. Six months later we had a BIG problem. We had to treat all the sheep with a long wool treatment to get rid of the lice. Don’t know what it cost us. Probably about $1 a shot, $12,000 worth, all because of one little fly, bought us undone. When we lost the 200 ewes I took a shortcut, which I had used this method before, so I was pretty confident and it didn’t work. And
then we got what I call ‘lice induced flies’. They got lice and it rained and they start to scratch, they’ve got flies and then they’re dead. So I thought I was being smart saving money the first round, nope.


This story illustrates, through the experience of not following through with biosecurity practices, that farmers know it is commercially advantageous to do incidental biosecurity.

These farmers disease management of lice, footrot, OJD and worms, are practiced not for biosecurity reasons, but for the financial viability of their enterprise. This farmer recognises the commercial advantage to doing the above mentioned on-farm biosecurity practices.

Farmer 23: Basically because they affect your productivity. Unfortunately...it always comes down to the bottom line. You know, the bottom line is that you actually have to make money to survive or to live...You know a lot of these diseases affect your productivity of your flock.

There is a perception of additional costs if they were to include more biosecurity activities than their current practice requires. This means that farmers’ risk perceptions are linked to foreseeable problems they have in front of them today, next week, or next month, rather than around problems they may face in the future. There are other on-farm activities that through individual risk assessment have been deemed higher management priorities. Therefore until a biosecurity threat occurs and these farmers need to renegotiate their priorities it appears they will go unchanged.

Other priorities stem from the experience of surviving through the droughts in the mid-1990s and 2000s. Due to the longevity and severity of
the droughts on these farming businesses motivations to change behaviour are conservative; farmers tend to take fewer risks. One reason for this is the certainty that another drought will occur in their farming careers, compared to the uncertainty of a biosecurity outbreak.

Farmer 11: A drought, it’s going to happen once every 5-7 years. It’s a $70,000 event, guaranteed to happen. So it’s the 10 fold difference in priorities, mean that it’s so hard to raise level of awareness and justify the cost of raising the level of awareness. Um, the only thing that will raise the level of awareness is a disaster. And that’s unfortunate.

This viewpoint shows how difficult it will be to ‘sex up biosecurity’ with the aim of encouraging further practices. Drought impacts are on the minds of these farmers because they have direct experience of living through a drought. Knowing another drought is a certainty farmers are cautious to expand activities beyond what is known.

Farmers have a lifetime of knowledge and experience in dealing with endemic disease problems and they engage in chemical prevention to minimise risk incursion pathways. Prevention via chemicals is how animal health is sold to buyers in local merchandiser stores as per Figure 10.
Farmers know the importance and cost effectiveness of preventative practices, or in their words ‘an ounce of prevention is worth a ton of cure’ (Farmer 10). This phrase has also entered into biosecurity policy (Waage & Mumford, 2008 p868). Preventative measures such as Brucellosis accreditation, fly management and vaccinations are incidental biosecurity because they are
conducted to avoid the alternative of expensive treatment on sheep of ill-thrift. Hence, these animal health practices are carried out for the economic gain of knowing that the livestock are healthy.

Brucellosis is a bacterial disease affecting rams, and some stud owners have rams tested biennially by vets to achieve an accreditation free status. The accreditation status shows clients a stud owner’s commitment to animal health and also demonstrates that the business addresses biosecurity concerns through adequate fence maintenance. This stud owner recognises the significant financial impact that Brucellosis would have on the ram selling portion of his business.

Farmer 5: But if I was to get Brucellosis, footrot or something like that in my stud sheep flock would be a massive component of my business and income stream goes out the door because no one wants to buy a seed stock of rams from somebody with Brucellosis or um footrot or something like that.

The accreditation is common among commercial stud participants and is ultimately a marketable device, that is advertised on business websites and farm fliers. It is incidental biosecurity because farmers with Brucellosis accreditation free status are required to maintain fences as well as keeping their flock free from this disease.

Flystrike is another sheep issue that requires preventative management at particular times during the year. Farmers have the experience to know when management is required and to carefully monitor mobs as this farmer depicts.
Farmer 12: ...between September and December and then it’s just a matter of keeping an eye on the sheep and looking after them as far as flies and different things go. From January through till whenever. So it’s a mixed bag, but we taper off a little bit from now on as far as management of sheep go between...say now what is it? October and Christmas, we taper off a fair bit. How we do, we control everything by chemical...We’ll put Click on ‘em and different things like that to control the flies. Because flies is number 1, that’s the only reason why you have to worry about them between now and Christmas is because of flies. The flies are coming and in saying that, this might be going back a few steps now. Because with the egg cycle...they tend to die and it’s not really a great problem over the summer.

From experience farmers know how to control the spread when sheep are afflicted by maggots and they know the conditions when flystrike will occur, as well as the necessary management to implement for optimal sheep welfare. The chemical application is preventative biosecurity and the cost of application is lower than treating flystrike. This practice is considered incidental biosecurity because farmers who control flystrike are incidentally contributing to the broader government and industry goals of maintaining good animal health, thereby preventing the risk of a disease outbreak.

The widespread use of chemicals to control sheep diseases are of particular incidental biosecurity interest. Farmers have knowledge and an understanding through their experience with vaccine programmes. Every farmer could accurately detail their vaccination programmes, which follow the same general guidelines. These guidelines are:

Farmer 2: We usually do our lambs, lamb marking day and give them not six weeks but when we wean, so that’s probably eight weeks, 10 weeks. And we do the mother before she lambs. When we give her, well we give her a fluke drench and a long acting worm drench and a 5 in 1 before she lambs. Say three weeks before she lambs. She only gets one a year, the mother.
Booster shots of the 6 in 1 (or 5 in 1, 7 in 1, 8 in 1 variety) are usually given at weaning approximately 6-10 weeks after lamb marking, although adherence to this follow up shot is variable. This procedure for vaccination is well known by farmers as they have experience and knowledge from their entire farming careers giving vaccines in this manner. Chemicals are the predominant prevention with most disease-related incidental biosecurity practices.

Farmers already possess a strong working knowledge of endemic disease management. Management of the aforementioned diseases are classified as being conducted for commercial advantage. Some farmers have experienced the negative financial results of not carrying out these biosecurity practices which makes the choice an economic one. In 2006, internal parasites and flystrike were named as diseases that inflict the highest cost on the national sheep flock\(^\text{20}\) (and therefore presumably NSW) (Pattison et al., February 2015, p. 54), however this study shows farmers report lice to be their biggest disease problem. Reasons given for the high cost of disease to the national flock are ‘either failure to implement known technology or absence of cost-effective technology that could manage or prevent the disease’ (Sackett et al., April 2006, p. 68). All of the incidental biosecurity practices mentioned above assist the farmer to remain a profitable enterprise. The practices are carried

\(^{20}\) In 2006 the diseases that cost the most to the Australian sheep industry in descending order of approximate costs: internal parasites $369 million, flystrike $280 million, lice $123 million and post-weaning mortality $76 million. Also to note this study retrieved its data from ‘an expert workshop and literature review’ (Sackett et al., April 2006, p. iii), rather than include the farmers perspective.
out to mitigate the more expensive alternatives of treating pest, weed, and disease outbreaks. The other reason for ‘doing’ incidental biosecurity is to be a good farmer.

**The notion of good farming**

Good farming is a socially constructed concept, and its definition is dynamic as it is defined by individuals within a social group. Good farming became a relevant theme and a way to view some of the biosecurity practices of these farmers. More specifically, these farmers demonstrate good farm management by adhering to best practice through their individual efforts to manage pests, weeds and diseases on-farm. Additionally, they possess an awareness of potential threats to the district. The notion of good farm management has previously not been applied to biosecurity. However, during analysis it emerged that these farmers’ incidental biosecurity practices and ability to run a viable farm business contribute to the characteristics of good farm management.

Being seen ‘doing the right thing’ is a strong motivating factor for a good farmer (Vanclay, 2011, p. 53). A good farmer can be recognised by the following characteristics:

- Long success run
- High quality crops and pastures
• Good livestock
• Good farm presentation – fences and trees
• The visible things about land health
• Sustainable lifestyle (Dunn et al., 1998 p106).

Dunn et al’s (1998) categories for good farming provide a useful framework in which to discuss the motivations behind some incidental biosecurity practices. The remainder of this section addresses each of these points in turn and shows how incidental biosecurity and running a commercially viable business is applicable to the notion of good farm management.

One of the interviewees personified the social construction of good farming, specifically in regards to a long success run. From my first visit to his farm as part of an organised field trip with agricultural science students in 2013, the shearing shed was transformed to accommodate a group visit with stadium seating (see Figure 11). This is relevant to incidental biosecurity because farmers who produce profitable sheep, which is achieved by participating in good biosecurity practices, have the capital to inject into their business.
Upon returning in 2014 with the same field trip a new, second shearing shed with raised boards had been erected (see Figure 12).
This shows the positive financial returns associated with a ‘long success run’, and ‘good livestock’ that are shorn twice yearly and therefore he can afford to invest in a second shearing shed. This example demonstrates a good farmer. Characteristics of a good farmer are those who produces quality livestock (Burton, 2004 p201) and are seen to re-inject funds into improving the farming business rather than spent on the family (Hatch, 1992 p116).

Those who are known throughout the district as being good farmers, that is those with ‘high quality crops and pasture’, ‘good livestock’, and ‘good farm presentation’ are likely to open their farms for events as meeting places for
on-farm demonstration and learning. A recent on-farm meeting is the BredWell FedWell initiative, sponsored by Meat and Livestock Australia (MLA) and Australian Wool Innovation (AWI). This was where I first met some of the interviewees. The meeting was advertised through local networks, and the sheep farmers meet in a farmer’s shed who had volunteered to open his property for this event.

Farmer 6: I have not taken my rams to a BredWell FedWell day before and they rung me up and said ‘can you do it?’ And I said ‘yes’.

This farmer was chosen because he is known in the district as a good ram producer.

Another course in which some farmers participate is Lifetime Ewe Management, which involves visiting local properties over the course of one year. This farmer commented on his visual appreciation of the health of the sheep at the event.

Farmer 24: His mules is effective. We were there with the Ewe thing the other day. I said ‘who does your mulesing?’ He said ‘I do’. I said ‘you want to keep doing that, better than ours’. He actually achieves pretty close to what you need to be achieving.

This comment is confirmation of good farm management (Vanclay & Hely, 1997 p109), which centres around general farm appearance, the look, shape and condition of stock (Silvasti, 2003 p14). Those who volunteer their time, livestock and properties have confidence in their pasture and livestock management to show others what good things they do to produce healthy sheep.
To help ensure that ‘good livestock’ are produced farmers employ general farm hygiene practices that are industry and government recommended, which aligns with the term incidental biosecurity. Farm hygiene practices are not particularly popular among these farmers due to the perceived time, cost and effort needed to carry them out. One recommended practice is to ‘clean and disinfect clothing, equipment and vehicles’, and to focus on visitors’ footwear (Department of Agriculture, n.d-a), however, some farmers assess the risk of incursion through this vector as minimal and take a relaxed approach.

Farmer 9: No, we’re not that strict [laughs]. Taking boots off is a bit harsh.

This contrasts with the practices of another farmer, who has a proactive policy in place to manage this potential area of risk.

Farmer 28: if they [shearers] are known to be coming from a flock that is potentially scratchy as in lice they’re asked to wear fresh clothes and microwave their booties.

Some farmers see the benefits of conducting farm hygiene practices and choose to do them. Farm hygiene is part of being a good farmer due to the visibility of the practice, and appreciated in this instance through producing sheep that are not afflicted by lice. Showing others, farmers and/or contractors, one’s attitude towards biosecurity through visible practices provides a place for redefining good farming. It is an example of incidental biosecurity because good farm hygiene is a recommended practice.
Neighbours are assessed as being good farmers by running ‘good livestock’. The presence of lice is an easy sign by which to gauge good animal health management, and while it is the sheep that are lousy the terminology to identify the offender is attached to the property owner, they are a ‘lousy neighbour’. Unlike lice, worm burden is difficult to appreciate, therefore other characteristics such as quality of pasture, fence integrity and livestock condition are some of the visual criteria that are used for ongoing assessments of determining a good farmer.

Across Australia, self-replacing flocks are less popular nowadays. However, in contrast, these farmers limit potential breaks in the system and only buy in rams from known and trusted sources, which contributes to the ‘good livestock’ aspect of being a good farmer. Self-replacing flocks are a way for farmers to protect their properties against incursions because there is no transmission risk. This practice also means that farmers are limiting their engagement with sale yards. Sale yards present ‘a high biosecurity risk’ (Animal Health Australia, August 2012, p. 8) and these farmers only sell their stock to them, they are not buying from them.

The participants’ careers are framed as ‘pre-drought’ and ‘since the drought’ because whole farm management has been overhauled to cater for these disruptive years. Some farmers moved their business into cattle and crop productions, while others coped by agistment and feedlotting sheep left on-farm. This disruption resulted in a need to buy in replacement sheep once
the drought was over in order to rebuild flock numbers. Some were afflicted by footrot as a result of this practice.

Farmer 7: I’ve had issues in the past. We’ve had issues with footrot, when we were buying sheep...I’ve gone back to, and the only sheep I buy now is seed stock. So I don’t buy any, I don’t buy sheep anymore.

Among my participants, issues with footrot motivated their decision-making to run closed flocks. Their experience with other producers, who demonstrated lower animal health standards, by not being open about their footrot problem, has damaged once trusted relationships. Ideally, a trusted neighbourly relationship entails a farmer making others aware of their disease status, which is a contributing characteristic of what makes a good farmer.

Farmer 1: Well you get very defensive, ‘oh there’s nothing the matter with my sheep...You must’ve had it and not told me’. So it’s not something that people come out and advertise, but if you think if you had a true blue good neighbour you would say ‘look I think I’ve got footrot just be careful’. Generally you would be a man about it and own up to and at least give a warning. But the times that we got caught there was nothing said and when we mentioned it to others, or the people involved, ‘no my sheep haven’t got footrot nooo, I’m a good farmer’.

Exposure to biosecurity breaks, subsequent costs to fix the problem, and a lack of communication made Farmer 1 redefine a good farmer. This example shows farmer 1 re-classifying his neighbours as a result of managing foot rot he bought in. Buying in replacement stock opens farmers to risks in terms of potential disease exposure (Bottoms et al., 2013 p65), therefore running a closed flock is a sign of good farm management.

Clear signage for contractors and visitors is a best management practice (Animal Health Australia, August 2012, p. 9), which some good farmers adhere
to and shows ‘good farm presentation’. The purpose of signage is to make clear the standards a particular farm holds and the procedures that are in place for visitors to the property. For example Farmer 17 commented: ‘It’s for the power company and stuff, people like them who are coming on and off’. Of the properties I visited the fox baiting signs were most prominent on farm gates upon entrance, as per Figure 13. These signs are in place to alert visitors to the presence of 1080 poison. As Farmer 17 said, ‘Yeah that’s biosecurity, warning the rabbits not to come [laughs] or foxes, that one’.
Figure 15 Fox baiting sign
Fox baiting signage that is visible to visitors upon arrival into the property is an example of incidental biosecurity, because it aligns with government and industry recommendations.

Only one farm had a biosecurity sign, and in this case it is not classified as incidental biosecurity because of its current location. However, as argued below, it provides an interesting case for the non-adoption of biosecurity recommendations and the understanding of why these farmers choose not to follow this practice. The sign is available for purchase for $40 through Animal or Plant Health Australia.
The sign was in a shed (see Figure 14), rather than on the farm gate entrance, but it had been brought into the living room during the interview because these farmers felt uneasy about the wording and chose not to display it as it was intended.

Farmer 16: ...but the sign is so hostile
Farmer 17: It’s a very aggressive sign
Farmer 16: Really resistant to put it up...it’s really unfriendly

These particular signs are new since the creation of the term biosecurity and on-farm adoption is not currently widespread. Interestingly, even though a sign was purchased, and its purchase will be reflected in Plant Health Australia’s (PHA) records, the implementation of this practice may be considered incomplete because it is kept in a shed. Signage is incidental biosecurity because it is a visible channel that others can use to assess good farming.

Good farmers show ‘visible things about land health’ (Dunn et al., 1998 p106) and one measure of this is the lack of weeds present on a property. Farmers know they have been successful with spraying for weeds when they have ‘clean’ paddocks.

Farmer 10: Over one property we bought with Silver Nightshade in it. We bought it with a lot in it, just come from, they sowed it going back. We’ve been just doing it, we have to spray it over the summer time and we’ve nearly, we’re getting, there’s still a lot there but we’ve nearly got all the paddock clean.

Farmer 22: No doubt, they drive through here and say how clean my place is, it’s only hard work. If you keep doing it, it’s not hard work. We probably only have a week a year doing it because we’re on top of it. For years, when I bought this place here, it was covered in Briars, like a
wild rose bush, there were millions of them, but we just chipped away at them.

These farmers know they are good farmers as they have ‘clean’ paddocks. Additionally, they receive recognition from other farmers regarding their successful weed management. Both of these are characteristics of being a good farmer, which continues to be redefined.

Another example of good farmers having ‘visible things about land health’; is that most of these farmers produce enough feed for the stock they run.

Farmer 9: No, we do our own hay. We do our own grain if we need it.

Farmer 10: ...we always cut hay...We haven’t bought feed, not in my lifetime that I’ve been here. We’ve been married nearly 40 years.

This preventative management practice is incidental biosecurity because farmers are minimising the risk of foreign weed incursion by not having to transport feed in. To survive during the drought, biosecurity risks were taken and feed was brought in. In non-desperate times, farmers revert back to growing their own feed, but they still recognise that ‘you can never have a buffer enough for a 10 year drought that we went through’ (Farmer 5). This choice of minimising the need to buy in feed shows good farming management.

Being a good farmer involves neighbourly communication with those in the district to greater ensure a ‘sustainable lifestyle’. One such example of neighbourly communication was in regards to pests seen on a neighbour’s property.
Farmer 25: [husband] has been coming home late at night on the highway and he’s been aware of pigs in the neighbours. So he’s rung and told them ‘there’s pigs there’.

This type of neighbourly openness and contact creates long lasting relationships, which can hopefully transcend future problems. Should an incursion arise these farmers desire their neighbours to be as transparent and forthcoming with relevant information. Farmer 23: Well you’d hope they’d let you know, neighbours, that they’ve got a problem. In Australia, neighbours are perceived to be the greatest risk to farmers’ properties (Barclay, n.d). This is also why neighbours speak to one another about district problems to raise awareness and improve local surveillance and monitoring. One farmer noted such a recent exchange at the pub in regards to lice.

Farmer 7: I was only talking to [some name] McDonald on Friday and he was just saying that he caught two lousy sheep, one on the road near his property and one that actually got in on the property.
Interviewer: Not his?
Farmer 7: No they are not his. He wasn’t too sure where they come from. He didn’t recognise the ear tag number and he hadn’t researched it when I was talking to him Friday.

This example shows good farmers who ‘keep a watchful eye’ on endemic problems (Heffernan et al., 2008 p370) in an attempt to keep out localised issues. Although good farmers are not exempt from having disease incursions (Enticott et al., 2012 p331) the localised communication network between good farmers who have an interest in doing the right thing share awareness of potential system breaks.

The final point concerns good farming and ‘sustainable lifestyle’, which assumes that following best practice contributes to the security of knowing
they have done everything to ensure a successful livelihood. Animal health best practice for lice and worm management on new stock is to assume that the sheep arrive infected, therefore, quarantine drenching and either long wool dip or isolating until shearing and then dipping should be followed (Lloyd & Playford, June 2013). Following best practice is part of being a good farmer. While following best practice does not exclude farmers from attracting biosecurity problems, it is believed to minimise the severity and longevity of them, thus creating conditions that are conducive for a sustainable farming lifestyle.

All of these incidental biosecurity practices are identified as feeding into the notion of good farming. Now I turn to practices that traverse both themes of good farming and commercial advantage.

**Fences** - ‘Fencing is your number one, is my number one defence I guess’ (farmer 5).

Good fences are one practice that feeds into both themes of commercial advantage and good farming as the incidental biosecurity outcome is a useful defence against disease and pest transfer. Fences give farmers a level of control in the form of a physical boundary. Farmer 5 states the importance of the boundary fence: ‘Fencing is your number one, is my number one defence I guess’. Given that fences were mentioned by all interviewees the importance of maintaining a robust boundary fence contributes to biosecurity standards.
Good fences control livestock movements and are designed to keep neighbours’ sheep out. However, the frequency of this occurrence presents a break in the system where potential diseases could be transferred. For example, one farmer’s wife questioned the need to build a particular fence, and her husband gave his reasons for having good boundaries.

Farmer 3: If I put sheep in that paddock I A) don’t want them getting out and B) don’t want others to get in. So yes I’ve got to build that fence and that’s a biosecurity practice.

Neighbours’ sheep are a risk because of the diseases they can carry, but the agreed reality is that they share the unwanted problems with those they share the same fence line. A good and expensive biosecurity measure is double fencing boundaries, which only one farmer currently has but he sees the benefits.

Farmer 14: Cause the neighbour on this side it’s still gotta get through a double fence and can’t do it cause we’ve gotta avenue of trees down there. So it’s double fenced.

Monitoring of boundary fences is an ongoing issue, and farmers recognise the need for and importance of, diligent surveillance to ensure that fences remain sheep proof.

Pests also present a threat to fence integrity and continue to create holes that provide sufficient space for sheep to move through.

Farmer 11: Yeah and wombats...Certainly they’re just wrecking the fences. If we didn’t have kangaroos or wombats then you wouldn’t get lice, or I wouldn’t anyway. I know, I know for a fact, cause I know my neighbours sheep. Oh only if a limb fell over the fence, but I would say 99 per cent of our diseases, come under the fence from me neighbor [’s farm].
It is recognised that maintaining a robust boundary fence will minimise pest and disease incursions. Kangaroos, wombats, rabbits and wild dogs are deterred from entering properties with good fences (Wicks et al., April 2014 p21).

These biosecurity behaviours are typical of other studies in other livestock industries (Barclay; Casal et al., 2007; Firestone et al., 2011; Mather & Marshall, 2011; Nampanya, Suon, Rast, & Windsor, 2012; Taylor, Dhand, & Lee, November 2011) in that some preventative practices are occurring on-farm. However, the extent to which on-farm biosecurity practices are currently implemented appears to be unknown by governments. Instead governments are busy standardising biosecurity (Enticott et al., 2012 p327) and conforming to narrow approaches to animal health (Mather & Marshall, 2011 p163). Regardless, a number of these farmers have a positive attitude towards the importance of on-farm biosecurity and are certainly ‘doing’ preventative biosecurity practices.

**Challenges of engaging in incidental biosecurity**

Farmers engaged in incidental biosecurity practices face social challenges, both from neighbours and public perception. The perception of how farmers are seen to conduct their business and how they follow incidental biosecurity practices are linked more closely to notions of good farming than
commercial advantage. Farmers do not always make economically rational choices (Vanclay, 1992a), therefore, these practices can be described as challenges because of the perceptions held by other post-border actors. In this section the challenges have been categorised by the various pests, weeds and diseases that farmers are faced with managing, including foxes, fences, blackberries and mulesing.

Most farmers know what their neighbours are doing and make risk assessments based on where potential breaks can occur. Commonly the challenges with neighbours are fencing issues and other farmers’ land use which can restrict efforts to best secure farms. There is a reliance on neighbours to do the right thing when it comes to animal health, but competing goals and priorities present challenges. One example of such a challenge is the success of the fox baiting programme. Fox baiting is best if district baits are laid at the same time (Local Land Services, 2014b) across the district. However, because, the practice of fox baiting is only of commercial interest for sheep farmers, and the fox is not a declared pest, it is difficult to persuade those in other land use businesses to participate. Fox control may not have a commercial impact on other farmers’ land use.

One challenge with boundary fences is the ongoing maintenance costs. In fairness, costs should be split between neighbours, but finances and other competing priorities mean that the cost often falls to one farmer. These farmers have unwillingly borne the fence replacement costs.
Farmer 11: Trouble is your neighbours should go halves in fencing costs...Forestry is the same they should put something in...they don’t care what the fence is like.

Farmer 6: So you’ve got to deal with so many different neighbours and it’s a 50 per cent responsibility of theirs to replace the fence if it becomes not stock proof.
Interviewer: Does that actually happen though?
Farmer 6: Down here yes, half the neighbours yes, half the neighbours no, they just refuse and by the time you take them to court and muck about you just put a new fence up yourself and be done with it. Because they just don’t care...sheep and cattle and goats and everything else, jump fences and gets about so you’re always an uphill battle.

Some farmers have been affected by natural disasters that ruined their fences, and the efficient replacement also requires negotiation between neighbours.

Fire and flood provide equally compelling examples of situations where natural disasters have required speedy repairs.

Farmer 20: ...like that bush fire we lost some country there a couple of weeks ago. We’ve got very smart sheep and they went and stood in the right spot. They’re ok, they’re probably a bit hungry, but apart from that they’re fine, a bit shaken.
Interviewer: Are your fences ok?
Farmer 20: Yeah, no, we um...probably worked out we lost 6 or 8 kms of fencing.

Farmer 5: After all the floods a big cropper down here, I said oh we lost a fence down there we’ve got to repair it, he said ‘oh I’m a cropper I don’t run sheep. I don’t need it back, I don’t want to spend the money on trying to replace it’. I said ‘but it’s a boundary fence’ and he said ‘I don’t run sheep’. I said ‘I do and I’ve got every right to put sheep in my paddock and I own half the fence’ and I said ‘oh I don’t know how this is going to work but I’ll tell them as they come off the truck not to cross into your paddock into your crops’. He said ‘you’re not going to put sheep in there’ and I said ‘I’ve got every right, I own that land to put sheep in there and I will go and tell them to stay in their paddock and where they are allowed to go and not go and but I can’t give you a 100 per cent guarantee that they might wander into your crops and things. So if you want to protect your crops we’ll need to go halves in this boundary fence’. And he compromised and we went 50/50 and fixed it up. But he couldn’t even see that he needed to compromise.
These farmers know that good boundary fences underpin successful livestock management and incidentally achieve biosecurity outcomes of keeping out endemic threats.

In some areas of the Riverina, where native forests border farm properties, blackberries are problematic because their growth is not controlled by forestry authorities. Farmers know that blackberries are spread by kangaroos and birds, but forestry authorities do not control kangaroo populations within forestry boundaries. However, success is limited because of the uncontrolled spread in adjacent National Parks. Spraying blackberries is the most effective way of dealing with the problem.

Farmer 8: Ah, the weeds are pretty constant...we’ve got a big problem with blackberries and they’re bought onto the place by birds because neighbouring country, particularly some land holders, but mostly the Forestry Commission they’re a bit over the back. You know it’s full of blackberries. You know they’ve got thousands of acres of it and they don’t do much to control these and the birds eat the seed and fly over and just [motion for dropping seed]. That’s a very constant one, blackberries. Probably costs $10,000 a year I reckon, just on blackberry control.

These farmers appear discouraged as they are spending thousands of dollars on reducing the amount of blackberries on their farm. Blackberry problems are an example of what happens when neighbours are not proactive in minimising weeds.

On the other side of weed control is the positive outcome from neighbours being and remaining weed diligent. One farmer has inherited the results of the previous generation’s interest in being ‘on top of the weeds’.
Farmer 28: it just happened that in the 50s and 60s the families that lived on both made a pact that they were going to get rid of all the Patterson’s Curse and so they worked together and they got rid of it in this area. So we don’t have any neighbours with Patterson’s Curse. Everyone in this little patch here doesn’t spray for Patterson’s Curse and it’s not on the roadsides.

This enables this farmer to have a low tolerance policy for weeds that are commonly found in the district, such as Bathurst Burr and Saffron Thistle, in addition to zero tolerance for Patterson’s Curse. Spray bills are minimised, which means that farmers can focus on other areas of their business, like fences.

A farmer usually has what the neighbours have, which makes it difficult to maintain a boundary of ‘clean’ and ‘dirty’, especially in regards to lice management in flocks. This is where the incidental biosecurity practice of maintaining boundary fence integrity is particularly useful. Lice are a problem for farmers because it raises treatment costs and affects the wool clip, both of which reduce the profit to be made from wool growth on their sheep.

Neighbours with lousy sheep are an ongoing concern and one farmer has generously attempted to address this:

Farmer 19: And then we’ve even offered to the neighbours when we’ve had the plunge dip come in ‘bring them over we will pay for them’ and no [laughs]. Farming is easy, its great fun [laughs].

It is difficult to change others’ practices and lice is an example of a problem where one farmer changing practices has a limited impact because they are reliant on the neighbours’ practices.
A recognised challenge to engaging in more on-farm biosecurity practices is the lack of labour, which plays into both time and money restraints.

Farmer 25: That’s what we’re all missing is labour. 100 years ago you could get someone, but you can’t anymore.

The high costs of labour units these days combined with a lack of experienced, available people who could be locally employed means that some biosecurity practices are not implemented, or not fully implemented. This relates to how farmers assess the risk and choose where to cut corners because they do not have access to the manpower needed to complete all on-farm practices. For this reason some parts of a biosecurity practice may not be implemented, such as the booster vaccine shot at weaning.

The final biosecurity practice that faces challenges is mulesing. Mulesing is one preventative practice relevant to the management of the biosecurity threat of flystrike. Mulesing ‘involves the surgical removal of wool bearing skin around the breech and tail to mitigate against flystrike in Merino sheep’ (Ferguson, Schreurs, Kenyon, & Jacob, 2014, p. 479). The practice has received much public scrutiny, and the negative perception is fuelled by animal rights activists. Despite criticisms the practice is still widely used because ‘Nobody wants unmulesed Merino ewes’ (Farmer 7). Mulesing is a preventative measure against breech strike, which left untreated causes an inhumane death. Flystrike impacts the productivity of sheep because they have reduced fleece weight, staple strength and fertility, and causes industry losses of approximately $280 million per annum (Sackett et al., April 2006, p.
38). Despite rumours of decreased mulesing practice, a higher percentage of Australia’s flock is mulesed compared to the 1970s (Sackett et al., April 2006, p. 37). Mulesing has been commonplace in Australian Merino flocks for decades and although the wrinkle has begun to be bred out of the Merino flock, farmers still practice mulesing. This is a boundaries issue as public pressure may incite governments to take a greater stance in encouraging farmers to move away from this practice.

The vast majority of these farmers participate in mulesing, which is an incidental biosecurity practice as it mitigates against flystrike disease. Only one of the interviewed farmers had stopped mulesing in the past seven years and noted that their management requires careful monitoring during the season; during wet summers ‘we definitely had more fly issue than I think everybody did. And you do have to crutch more often and you have to have nice shearers’ (Farmer 28). Mulesing is conducted as part of the process at lamb-marking, when lambs are in the cradles and farmers or contractors cut the wool and skin from the tail and breech area. More recently, in attempts to appease public concerns over mulesing, the use of a numbing agent, Tri-Solfen, has become available. Some farmers use it, although mostly for the appearance of doing the right thing.

Farmer 7: Oh yeah I use, have done since it first came out, um...sometimes you need to do the right thing and sometimes you need to be seen to be doing the right thing. So...I don’t know whether it makes any difference in the...when you’re selling your wool but there is a space to fill out. Now there’s a declaration you send with your wool to say whether you mules whether you use pain reduction, so you know I don’t know whether it helps or not. But yeah I do. There’s a brand I can
brand my bales with, Better Choices, which is what the company send out when they see the Tri-Solfen, whether it makes any difference or not.

Interviewer: Maybe it’s more marketable?
Farmer 7: Oh well who ever sees a bale of wool...nobody does do they? Buyers don’t even see the bale of wool. They just see the samples in the boxes. I don’t know if they even look at the declaration thing that you’ve got to send in...And there’s this other thing about mulesing and you can put ceased mulesing if you no longer mules and that shows up on the catalogue I think. So if there’s people there buying wool who specifically want to buy wool from non-mulesed sheep they can buy that wool. I don’t know if there’s a premium in the market for it.

Using Tri-Solfen costs around $1 a head, and potentially no one will know if it were administered. The choice to use Tri-Solfen is a measure some farmers do which feeds into the notion of being a good farmer.

A consequence of the current neoliberalist agri-governance model, which is influenced more by markets and consumers, provides space for consumers to contribute to regulation initiatives (Haggerty, Campbell, & Morris, 2009 p767) and TAFE certification of mulesing is an example of this. This regulated qualification gives farmers and contractors regulated competence in best mulesing techniques and safe practice in an attempt to appease consumer concerns over the practice. Only one farmer holds the mulesing certification and vocalised his approval for regulation because of the variety of techniques he has witnessed over his farming career.

Farmer 24: There’s mulesers and mulesers, and some of them should not be allowed. Bloke we use is accredited. I think it’s a very good idea having seen a guy there saying I could mules...When it’s done properly you should not touch the muscle. There’s a film of skin, can’t remember what they call it, and then there’s the muscle underneath that. You should only take the skin you shouldn’t even break that film. When you’re getting accredited you’ve gotta get 90 points or you don’t get your ticket. I actually believe mulesing for the general public is horrifying
and I can appreciate that. But they don’t appreciate how it’s done and having done the accreditation course I believe you should be accredited before you mules.

Those that are accredited appear to be positive of the certification processing creeping further into the rural space. Nevertheless, certification was uncommon among these farmers and employed contractors.

In addition to hearing farmers recall their mulesing experiences, I was fortunate to have the opportunity to work during lamb-marking and do my part for on-farm biosecurity in the Riverina. I have experience tailing in NZ, but mulesing a lamb was a totally new, added step for me. Despite the warning, when the farmer announced ‘let’s get the blood flowing’, as he sharpened his blade shears, I was not prepared for how much blood there would be. As the other contractors did not know of my tailing experience, I was given the easy job of injecting the 6 in 1 (see Figure 15).
As we got into a rhythm I alternated with tailing and ear marking. And ultimately had a chance to mules some lambs myself (see Figure 16).
In my mulesing experience Tri-Solfen was not used, and I was not aware of its existence until later interviews, when a farmer asked me whether it was used. First-hand experience of mulesing gives one a greater appreciation of the necessity of this particular biosecurity practice. This experience also contributes to breaking down some of the barriers of urban perceptions of mulesing; when I returned to the city and told others it began to dispel some of the myths even within my social circle.

The categories of pest, weed and disease challenges these farmers face has identified that the incidental biosecurity practices are carried out regardless of the challenges presented by neighbours and the public. Despite
public opposition, particularly in regards to mulesing, the examples given above are of farmers preventing and managing on-farm biosecurity threats. Farmers have defined the on-farm boundaries and determined that these biosecurity practices will assist in their goals of having a ‘clean’ space. However, there are implications for on-farm practices as a consequence of government involvement.

On-farm practices and government involvement

Incidental biosecurity has implications for government and this new way to view farmers’ practices could be useful for future extension messages. Government biosecurity recommendations cut across all agricultural industries. It is argued that farmers are already engaged in many of the encouraged practices. The recommended practices that have not been implemented are in relation to farm hygiene, such as cleaning and disinfecting boots, tyres and machinery. At this time these practices have been assessed as not a priority because either they are unnecessary, or because they are expensive in terms of time or money. In addition, some farmers are fuelled by fears of discouraging or upsetting shearers sufficiently that they may not return. Farmers prioritise according to which practices have the most significant effect on production, and the consequences of addressing that particular problem will have on the viability of their business. These practices are carried out because
their impact on income is deemed large enough to take preventative steps to mitigate.

Incidental biosecurity plays a vital role in current management of on-farm animal health concerns. Knowledge of good on-farm practices has been built over the course of farmers’ working lives (Enticott & Wilkinson, 2013 p97). This localised knowledge has played an important part in incidences overseas where tacit experience has been ignored by governments to the detriment of finding ways to organise and alleviate problems (Toma et al., 2013; van der Ploeg, 1993; Wynne, 1996). Farmers’ knowledge and experience is key to understanding the local conditions (Oladele, Antwi, & Kolawole, 2013 p127), as they are the vanguards of biosecurity. Farmers’ biosecurity behaviour is greatly influenced by the economics of running a business. Additionally, because Australia has not experienced significant sheep-related disease outbreaks, animal health management manifests itself in practices that relate to producing products in the cheapest and most efficient way possible. Until the situation changes, the way that on-farm biosecurity practices are carried out will not change. It has been important to identify current practices so that recommendations for improvements can be made (see Chapter 7) (Heffernan et al., 2008; Susilowati et al., 2013). Current government best practice biosecurity recommendations treat on-farm activities as a one-size-fits-all irrespective of enterprise, especially in regard to farm hygiene. This creates a barrier for sheep farmers receiving biosecurity messages, as they are concerned with how to manage living with endemic
problems, or what they face now, rather than the uncertainty surrounding unknown incursions.

Farmers recognise areas of improvements they would like to make on their farm, with the goal of being a good farmer. However, they require a balance of time and money before they can achieve their goals.

Farmer 1: Stop cutting corners, oh just better timing, better inoculation programme, drenching programme. Oh the drenching programme is pretty down pat. But just yeah properly inoculating. Not much else I can improve. Better feeding.

On-farm biosecurity practices are not always fully completely because of time, labour, other priorities and cost restraints. Nevertheless, farmers are already adhering to many biosecurity best practice management practices (Denney, 2007; Enticott & Vanclay, 2011).

There have been a significant number of quantitative biosecurity studies that have checked through each biosecurity practice and then produced a ranking system to suggest good, poor or high and low levels of implementation (Firestone et al., 2013; Gunn et al., 2008; Nampanya et al., 2012; Schemann et al., 2011; Toma et al., 2013). Other studies have found that farmers’ lack of belief in biosecurity practices means that they did not actively implement them, (Heffernan et al., 2008; Schemann et al., 2013) because of perceptions tied to economic feasibility, social networks and the industry (Brennan & Christley, 2013). In contrast, this thesis shows that farmers are actively participating in a range of biosecurity practices that cut across each category of pest, weed and disease. This chapter has shown that farmers have positive
attitudes towards biosecurity. These practices help to secure their future livelihoods through commercial advantage, which links to the notion of being a good farmer.

**Conclusion**

This chapter has discussed the biosecurity practices that farmers currently engaged in, and this addresses the research question pertaining to farmers’ prevention of threats, and management of biosecurity boundaries on-farm. By gaining an understanding of on-farm preventative measures it can be concluded that farmers ‘do’ practice biosecurity. The pest, weed and disease practices outlined above are categorised into two motivations: commercial advantage and being a good farmer. This study shows that knowledge and awareness of biosecurity is based on farmers’ lived experience. Participants’ knowledge and experiences discussed in this chapter builds upon the existing literature by identifying the ways farmers have found to live with the endemic problems that affect the economic returns of their enterprise. Farmers prevent threats through precautionary biosecurity measures such as weed spraying, dipping, drenching, vaccination programmes, fox baiting and shooting. These biosecurity practices contribute to the notion of being a good farmer and are primarily undertaken for prevention purposes to minimise outbreak costs, but they also incidentally apply to biosecurity outcomes.
Farmers and governments have defined the boundaries of ‘clean’ and ‘dirty’. They also both participate in managing the rural space. One of the ways agricultural space is managed post-border is through farmers adhering to localised notions of good farm management. Academic links between good farm management and biosecurity have received little consideration, and the analysis in this chapter has shown the various ways in which farmers practice appeals to the dynamic definitions of good farm management.

A key finding from the farmers’ perspective is the importance of neighbours and fences. What the neighbours are doing or are not doing affects the business, and fence maintenance to distinguish boundaries is one such ongoing issue. At present, there would appear to be no commercial advantage to increasing the current levels of biosecurity. Further, because Australia is in non-outbreak conditions perceived need for increasing biosecurity is low compared to other farm priorities. Incidental biosecurity will likely remain as such until there is an exotic outbreak or an equally unwanted pest, weed or disease incursion that will provide a catalyst for farmers to then reactively consider appropriate behaviour change. This chapter has shown that farmers prevent and manage biosecurity threats, and the following chapter examines the relationship between risk, trust, and surveillance for on-farm biosecurity practices to address the second research question.
Chapter 6 – Farmer experiences and ‘shared responsibility’ of risk, trust, and surveillance

Introduction

The previous chapter acknowledged the vital role of farmers participating everyday in on-farm prevention and biosecurity management practices. Farmers participate in prevention and management for the two key reasons of commercial advantage and good farm management. This chapter identifies the concepts of risk and trust, which influence farmers’ biosecurity practices. These are relevant to post-border biosecurity because farmers’ management of risks are impacted by other actors in the rural space, such as governments, and levels of trust affect the relationship. This chapter addresses the third research question and identifies the ways farmers manage risks and how this impacts their uptake of government recommended biosecurity practices.

Australian governments aim to have ‘shared responsibility’ to manage post-border biosecurity risks. Shared responsibility is called for in the Beale report (2008) and this notion has been used to inform changes to biosecurity policy. Shared responsibility reforms have contributed to the redefinition of government roles, from funding extension to a combination of awareness raising and crisis managing. This means that the private sector must fill the gap.
Government have since reduced expenditure on research, development and extension (RD&E), and now a gap in extension services specifically exists that has not been met by the private sector, as policy originally intended (Hunt et al., 2014). Farmers are now expected to share biosecurity costs and responsibilities (Garforth et al., 2013, p. 457). The findings in this chapter show, from the farmers’ perspective, the changes to on-ground biosecurity management as a result of shared responsibility, and specifically the impact on trust. Trust between farmers and government has been impacted, perhaps in part because one consequence of shared responsibility felt by these farmers is fewer on-ground staff to assist with biosecurity management. It is argued that governments’ and farmers’ preventative biosecurity practices, such as surveillance, should be complementary. However, in practice, farmers’ contrasting perceptions of, and trust in, governments’ abilities to manage risks threatens the sheep industry’s preparedness to minimise the severity of future outbreaks.

Firstly, I build upon social science biosecurity literature, specifically in regards to risk, by showing that there is a contrast in the prioritisation of risks between farmers and government that has implications for the implementation of shared responsibility. Farmers are concerned with climate, markets and endemic disease risks to their business that is, the known risks. In contrast, governments are concerned with exotic risks. With reduced extension services available, governments are attempting to increase farmers’ biosecurity roles and responsibilities. This creates a challenging and potentially vulnerable state
for post-border biosecurity, because farmers prioritise risks that impact their productivity and profitability, only some of which include biosecurity risk.

The section following risk investigates tensions that exist between farmers and government because there is a lack of trust in each actor’s ability to perform their biosecurity roles and responsibilities. The critical issue is that farmers have first hand, negative experiences with authorities as a result of (a) the recent Ovine Johne’s Disease (OJD) outbreak, and (b) personal observations of lax biosecurity in airport surveillance. As a result farmers are less trusting of government agencies to fulfil their role in animal disease management.

Finally, I discuss surveillance, which is one biosecurity practice that has been significantly compromised by the withdrawal of extension services; governments are increasingly placing trust in farmers’ ability to exercise on-farm surveillance of biosecurity. Farmers’ surveillance role is to monitor their properties and their responsibility is to notify authorities of suspicious symptoms of unknown incursions and the governments’ role is to step in as crisis managers. However, previous Australian research has revealed that farmers’ reporting behaviour is indicative of them not necessarily taking on such responsibilities (Palmer, Sully, et al., 2009). With fewer state-funded, on-ground personnel this has left the land beyond the farm gate as a risky space. This chapter adds to the social science biosecurity literature by identifying these farmers’ management responses to shared responsibility through their on-farm biosecurity practices.
**Risk** – ‘that’s what farming is, a risk’ (Farmer 11)

The theme of risk is relevant to farming and biosecurity as both farmers and government are taking steps to minimise agricultural risks. Farmers’ understanding of risk was best articulated by Farmer 11 ‘that’s what farming is, a risk’. Social science biosecurity literature has mostly followed Becks’ useful notions of risk (1992) to assist with farmers’ understanding of disease risk (Enticott & Vanclay, 2011, p. 294). The four characteristics of Beck’s approach are that risks are man-made, can occur in a variety of locations, the damage can be economically immeasurable, and governments have limited scope with which to manage new risks (Matten, 2004, pp. 379-381). This approach is applicable to disease risks as governments and other actors roles (including farmers) are featured on opposing sides of the same issue, which has implications for the practice of biosecurity management. It is argued that ‘risks lie across the distinction between theory and practice’ (Beck, 1992, p. 70). With risks there is a sense of knowing ‘the odds’ (Yearley, 2000, p. 112), and the shift to intensive production models of farming increases the potential for risk transmission (Morley, 2002, p. 133).

Biosecurity practices seek to limit potential risks (Palmer, 2009, p. 9); they are a mix of scientific recommendations and individual farmers’ choices to apply the recommendations in ways that are conducive to their current goals and practice. ‘Risk is perceived to have increased’ (Sligo & Massey, 2007, p. 170) and ‘biosecurity problems are getting worse’ (Ilbery et al., 2013; Maye,
Ilbery, et al., 2012, p. 339). This increases the pressure on farmers’ everyday decision-making to implement risk minimising strategies. Tensions exist because of contrasting perceptions of risk management between farmers and governments. Farmers are obliged to control and notify authorities of any sightings of declared pests, weeds and diseases (Local Land Services, 2014b), which align with shared responsibility policies. Governments’ roles are centred on awareness-raising and crisis-managing. Governments are encouraging individuals to know the risks and associated norms, and self-regulate their behaviours (Lupton, 1999, p. 25; Palmer, 2009). Risks are categorised into how farmers perceived and justified them to understand how they manage risks, which in part addresses the third research question.

Farmers’ risk perceptions

Farmers’ perceptions of risk were gained through the interviews, and government perspectives were found in government documents. From these sources two differing sides of managing and prioritising biosecurity are articulated. This aligns with research on risk, which has found a gulf between expert and public perceptions (Douglas, 1992, p. 11; Maye, Ilbery, et al., 2012; Renn, 2008). The current challenge is that policy often ignores the risk knowledge that farmers perceive to be the most important (Leach et al., 2005; Morris, 2006, p. 114) and biosecurity is yet another domain to add to this list. The shared responsibility policies mean that farmers’ participation and
compliance with recommended biosecurity recommendations will become centre stage as government-subsidised extension drifts to the backstage of biosecurity risk management. However, this contrasts with governments’ interpretations of risks, which are scientifically focused, driven by international standards and therefore tend to overlook the complexities that exist within the sheep industry. The focus of this sub-section is farmers’ risk perceptions as their perspectives have limited consideration in the literature.

Managing biosecurity risks is part of a farmer’s decision-making, and based on the data collected in this project, the management of such risks holds no priority over any other risk. The risks that farmers identified as most concerning can be grouped into climatic, markets and disease-related. They considered these risks important perhaps because they have previously experienced them, and they all have very real and potentially devastating consequences for the farming business.

Climate risks stem from the actual lived experience of flood, fire and drought, which are prevalent in the Riverina region. As recently as 2011 when Wagga Wagga and surrounding areas were flooded, some of these farmers were left with ruined fences, swampy paddocks and potential footrot. A summer fire outbreak also means destroyed fences, burnt paddocks and often the need to agist some of their flock. Agistment for some sheep is also a management strategy employed during drought conditions. Each of these climate risks present farmers with unique management challenges. Their impacts are expensive to manage and assume priority during and after the
event. As these risks are known and farmers have experience in managing them, they are considered of most importance, as Farmer 11 asserts:

The biggest risk is drought, that’s the biggest risk is poor rain and that’s the biggest risk because it occurs frequently and has the biggest impact on my business.

Drought is part of every Australian farmer’s career. Compared to an exotic outbreak these types of events are likely to occur on a regular basis, which perhaps increases their risk prioritisation.

Farmers also readily mentioned the very real risks to their business surrounding disease. As demonstrated in Chapter 4, there are a variety of endemic diseases that present possible risks, including flystrike, footrot and worms. These farmers are predominantly concerned with on-farm endemic risks, as they impact their aspiration to run a viable business. Farmers know disease risks have increased because of the mobility of Australia’s sheep flock; this represents a new concern that has developed over their farming careers. With fewer self-replacing flocks, there is a greater chance for disease transmission. Farmer 5 noted that cropping farmers who run some sheep as a sideline, present risks with their purchasing behaviours:

Compared to 15 or 20 years ago the risk is a lot lot higher than it has ever been. Used to be a lot more self-replacing flocks and people just breed their own replacement and they would stay on their farms and whatever. Now there’s a lot more focus on cropping and the big croppers and things like that become speculative sheep. People buying, selling and trading, a lot more just getting lambs in to put on their stubble over the summer to try and make $20 a head. And they just try and buy them cheap and they don’t care we’ve got bigger trucks and bigger B doubles, so the lambs now might be a good buy and they might be in Western Australia or they might be in South Australia or they might be in Queensland and they’ll put them on a B double. And get them here
because if there’s a drought in those locations they can buy them cheap and think they’ll have them for three months on their stubbles, then gone again for the next cropping year. So because the whole farming practice has changed around, that stability of closed flocks and this introduction now from other regions, it’s become a lot more serious.

Sheep and people movements increase the risk of disease transmission.

International market uncertainty was also a prime concern of these farmers because they are aware of the economic impacts of the global market place to their business. These farmers recognise that they have a lack of control over the market situation. However it still presents a concern to them as farmer 3 details:

Obviously markets because we are export driven with our sheep production, so we rely on those who come and buy our wool, buy our meat. So there is always a concern about those markets.

They understand their vulnerabilities to the value of the Australian dollar and the impact this has on the commodities of meat and wool. In Australia, fluctuating wool prices have been the norm since the 1990 removal of wool price subsidies. Then for much of the 2000s, drought survival took priority. Farmers are just now beginning to experience the changeable global market prices for their wool, and they are employing price-risk management to counter the fluctuating market (Larsen et al., 2002, p. 271). Lack of access to markets is a possible risk these farmers will face in the event of an outbreak. Should there be an FMD outbreak, current market access will be restricted by three months when culling is used or six months if vaccines are used to manage the disease (Roche et al., 2014, p. 8).
Another risk that some farmers mentioned was me, as a visitor. I could potentially be spreading weeds and diseases on my footwear and car tyres. As I visited multiple farms across the Riverina over the course of the fieldwork component of my study there was a possibility that I could transmit unwanted organic matter between properties. This is a similar risk to any other travelling person, from stock agents, shearers to LLS workers. In the graziers’ biosecurity manual, it is recommended that facilities are provided for ‘visitors to clean boots and equipment on arrival and before departure’ (Animal Health Australia, August 2012, p. 9). Such precautions may be implemented during outbreak situations. However, in the absence of disease farmers tend to relax biosecurity practices, as per horse flu management (Rogers & Cogger, 2010, p. 64). This was also reported in a Swedish study of biosecurity behaviours in livestock farmers (Noremark et al., 2010, p. 233). Although I never saw, nor was asked to clean or disinfect anything, I cleaned my footwear between visits, knowing that it was the right thing to do. During the interviews this was discussed and one farmer said: ‘...in fact we have a policy of if you’re not invited you don’t get in. You’re an exception and the shearers of course, but yeah look we should have [more]...’ (Farmer 2). Another farmer, albeit jokingly, suggested that perhaps next time I would not be as welcome on their farm.

Yeah whether I will have to become more vigilant with visitors coming and going like you know next time I might have to meet you at the gate...yeah probably will have to (Farmer 7).
People, equipment and vehicles (Animal Health Australia, August 2012) are recognised by some farmers as risks, but not to the extent yet that they proactively ask unknown persons, like myself, to take preventative steps to minimise the risk of spreading weeds and diseases.

Perceptions of risks are most important to consider (Palmer, 2009, p. 9) because they differ depending on the actors’ risk responses, perceptions and behaviours (Renn, 2008, p. 93). Farmers’ perceptions are culturally shaped (Enticott, 2009, p. 327) and are influenced by self-efficacy, trust in others and decisions around susceptibility to unwanted threats (Palmer, 2009, p. 345). Farmers use their own experiences and knowledge to make risk assessments (Larsen, 2009, p. 338). Farmers’ risk experience and knowledge presented in this study demonstrate their own localised expertise and risk perceptions.

Among the participants, stud owners are perceived to be ‘doing’ more biosecurity than commercial farmers. Commercial farmers believe that biosecurity is more important to a stud owner’s business model, and they therefore should be implementing biosecurity practices. A stud’s business model is often based on the reputation of the owner to produce robust rams. It is recognised by commercial farmers that it is in a stud owner’s interest to produce healthy rams, as this will encourage repeat business and a trusting relationship that could last for years. This level of trust in the relationship between the producer and the consumer is built not only in the agreed price, but also in the knowledge of them doing on-farm biosecurity well to be able to produce robust rams. A consumer of one of the interviewed stud owners
stated: ‘Well that’s one of the reasons that I started buying rams over there because I like the way he does his job’ (Farmer 7). This demonstrates trust in the farmer because they appreciate the hard work and biosecurity management decisions that have produced the ram they are able to purchase. Most farmers are pleased with the level of biosecurity present in the stud they buy from and this is represented by the repeat business and trusting relationship they have built over time.

However, not all stud owners take the same strategic position, and some of the interviewees have faced buying in rams of ill-thrift as a result of poorer biosecurity practices from the stud. Unfortunately, the commercial farmers have lost money through this practice, and how the situation was handled has meant a loss in the trusting relationship to the detriment of both actors. This farmer demonstrates how he brought in footrot with rams, which resulted in the loss of income and loss of consumer trust.

Farmer 29: I bought some Dorper rams from supposedly one of the best Dorper studs in Australia, down just on the border through Echuca. And got the rams home, three of them, and whenever I buy rams I isolate them for a while, give them a double drench and isolate them, so you’ve got a bit of time in case there’s something wrong with them. Anyway a coupla [couple of] days later I see one of these rams just limping slightly, I thought ‘oh he’s probably hurt himself on the ute’. Watched for another coupla days and still sort of carrying on, so I got them in the yard, tipped him over and having seen footrot before. Now this bloke must have been early stages, they get sweaty in between the toes and you just smell it, and I thought, without being sure this is gotta be footrot. So I got the, well it used to be the Rural Lands Protection Board, LHPA whoever it was to come and have a look. And she took swabs and we got it tested and sure enough it had benign footrot. Which is probably better than virulent footrot. So I rang this bloke up and I said ‘I need to bring those rams back’. Anyway about half an hour later this old Italian bloke he was, rings up and he started abusing me from the
beginning. I said ‘look I’ve got these rams and it’s got footrot and it might be benign, but I don’t want it. I need to get rid of them’. ‘Oh, no, no, no, we don’t have footrot’ and all this sort of stuff and carrying on. I said ‘I’ve got two choices, either you compensate me and I’ll send them to Wagga to market, or I can I take them back’. ‘No, no you can’t bring them back’. The old bastard wouldn’t come get ‘em, like they were $1200 rams. I had to take them to Wagga and I got $90 a head for them.

This example shows the damage to a stud business that can be done through having less stringent biosecurity practices in place. The way the situation was handled and the power of word of mouth probably impacted the stud owner’s future business.

Farmer 29 continued: I’m pretty easy I wasn’t trying to be, I said ‘look if you compensate me I’ll say nothing’ and then he started carrying on. ‘Either take them back and I say nothing or I said I’ll bad mouth you to every breeder I know, I’ll tell them you’ve got footrot if you don’t compensate me’. He really got carried away then and stuck into me. So I didn’t say that much but I told a few other Dorper people in conversation, that was stupid. They reckon they sell about 600 rams a year and the last thing they would want is word being spread round that they’ve got a problem, well you would think so. Some people don’t see it like that.

It also shows the downfall of the level of trust that commercial farmers place in studs to do the right thing with regards to both economic and animal health concerns. Those commercial farmers who have been affected in this way decide to use their consumer power and move their business to other studs, such as this farmer.

Farmer 26: The only time I’ve ever seen worms was the last time we bought rams from Avenell. And just noticed some worms hanging out of a sheep’s bit of dung in the yards when we dropped them in the yards.
These decisions are made as a result of poor biosecurity from the stud. These behaviours on both sides, stud and commercial sheep farmers, can be viewed as risky.

Climate, markets and disease are perceived by the farmers to be the greatest risks to their business. These are the perceived risks at the local level, and are drawn from cultural understanding, rather than scientific knowledge (Irwin et al., 1999, p. 1319). Each of the thematic categories of risk as told by the interviewees ultimately feed into the economics of farming and farmers’ ability to run economically viable businesses. Farmers understandably, are more interested in managing the everyday problems that present immediate risks to production. The next section considers how farmers justify their current risk taking behaviour.

Risk justification

These farmers justify risks as a balance between the known and unknown events. At this time, from farmers’ experience, endemic event outbreaks are the known risks and the unknown occurrences are exotic pests, weeds and diseases. Farmers’ knowledge includes how endemic pests, weeds and diseases arrive on-farm, and they participate in risk behaviours to rid themselves of said risk to an acceptable level. Risk behaviours include, no isolation of introduced stock, buying in feed and no booster vaccination shots. Farmers assess risk based on ‘imperfect information’ which increases the need
to contextualise the farmers’ experience in order to understand their attitudes and the decision-making process (Hardaker et al., 2004; Maye, Ilbery, et al., 2012, p. 340).

Some farmers justified their risk-taking behaviour with constraints such as time, age, laziness and thoughts of retirement. Others were more honest and admitted that there is no justification to the risks they take.

Farmer 7: How do I justify the risk? Well I can’t. But like a lot of things, there’s a lot of risks out here in the farming environment and something you’ve just got to carry is that risk haven’t you? You can’t be 100 per cent prevention to every risk you’ve got to carry some risk in every part of your farm business. So it carries, you know I market some of my grain but some of that is risk because I just don’t know what my production is going to be. I insure parts of my business but I don’t insure all of it because I can’t afford to insure everything. So I carry that risk. So I guess in the animal sense I’m carrying some of that risk, yeah I’m vulnerable.

This farmer presents a reality that is consistent with the Beale report’s recommendation that a ‘zero risk’ policy should not be the goal (Beale et al., 30 September 2008, p. xvi). From the interviews it has been identified that farmers engage in all of the recommended practices, as outlined in the grazier’s manual. Those that were most often overlooked were farm hygiene measures, specifically the risks associated with people, vehicle and equipment movements. People as transmission vectors are often underestimated (Rogers & Cogger, 2010, p. 67). Interviews with farmers included questions about farm hygiene practices and most responded that cleaning and disinfecting machinery, visitor vehicles and boots was taking biosecurity too far at this current time. This is risk taking behaviour as governments would classify it.
However, these farmers deem the likes of contractors and stock agents to be a low risk to their overall business. For example, according to Farmer 7: ‘well I don’t take much notice when a stock agent comes out, I don’t ask him to wash his boots or anything’. They justify these risks as low because they perceive the benefit of the service to outweigh possible risks they may present. This shows that ‘growers’ risk perception plays a key role in risk management’ (Maye, Ilbery, et al., 2012, p. 339).

There also exists a feeling of powerlessness in regards to asking shearing gangs to adhere to farm biosecurity practices. Many farmers noted that they believe shearers would not come to their properties if they requested hygiene practices such as moccasin microwaving, clean clothes and tyre cleaning. As argued by Farmer 21: ‘...you tell your shearer to clean their shoes before he comes in and he tells you to get stuffed. You know and shearers are quite hard to come by. It’s a hard one that’. Lice transmission on shearers’ moccasins is a real risk that multiple farmers identified.

Farmer 22: The shearers don’t and they say lice can live in shearers’ moccasins, you know the moccasins they wear, can live I don’t know how long.
Interviewer: It’s not a risk for you?
Farmer 22: Well because I have lice it didn’t worry me. But for my shearers moving to the next shed, coulda taken them. Like sometimes they’ll finish your sheep at 11 and start shearing at another’s at 1 o’clock. So if he had lice on his boots he could easily transfer it.

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21 Some farmers told me that lice can live on shearers’ moccasins and that may be a way lice are transferred across properties. One way to overcome this risk is to ask the shearers to microwave their moccasins before they begin shearing to kill any lice that may have survived the journey. This practice is encouraged by AWI (Australian Wool Innovation, 2011).
If the next farmer has similar behaviour patterns and also permits shearers to work without insisting on utilising precautionary hygiene measures then this is one way lice continues to spread throughout the region. This demonstrates that the risk of losing shearers outweighs any lice they could potentially be carrying that could infect their flock. As per Chapter 4, lice is the number one sheep disease that Riverina farmers want to ‘get on top of’ as it affects their productivity and profitability. Other farmers complained that to dip for lice costs upwards of $20,000, which should be repeated annually. However, Farmer 22 is justifying this expense against the hassle and effort to locate a new shearing gang. It is an example of farmers behaving in a way that is economically rational to them, but that does not align with the biosecurity ‘rationality’ encouraged by government agencies. Whatever level of risk these farmers individually decide to take and the justifications they tell themselves, they are all able to sleep at night comfortably with their management choices, irrespective of government recommendations of a good biosecurity system.

The following section identifies the levels of trust in biosecurity governing organisations as reported by these farmers.

**Trust in governing organisations**

Traditionally extension information for Australian livestock industries flowed from the top-down (Vanclay & Lawrence, 1994), that is from science
and governments to farmers. This means that there was implicit trust in experts (Wynne, 1992a, p. 20). Farmers’ previous experience of dealing with governing organisations is fundamental to trust. Funding of Australian extension by governments is now limited to farmer education in the form of awareness-raising communications (Palmer, 2009, p. 6). The expertise and extension services in the Australian sheep industry were held by state agriculture departments and their related RD&E priorities. However, the expertise is shifting with diminished public funds being used on agriculture. A 10 year period ending in 2007 saw a decrease in Australian state spending on RD&E from 53 per cent to 30 per cent (Hunt, Birch, Coutts, & Vanclay, 2012, p. 16). Ideally the private sector would take over the extension activities gap. Instead, the current picture shows that the private sector is failing to match industry needs (Hunt & Coutts, 2009, p. 39; Hunt et al., 2011). What this means for interview participants are that they become increasingly reliant on limited organisational personnel who they know and trust to assist in the transfer of relevant information. The risk associated with this practice is that future biosecurity messages from other agencies may not be adopted on-farm.

The graziers’ manual – the national approach

One result of the adoption of neoliberalist policies is that extension activities are increasingly more likely to be distributed from distant national organisations. For example, the graziers’ manual is a management tool that
was developed and distributed by AHA, whose distribution method of extension is primarily focused on the Farm Biosecurity website\textsuperscript{22}. This distant approach goes against what we already know about how farmers prefer to receive information face-to-face (Kilpatrick & Johns, 1999). This may lead to biosecurity messages not being absorbed as farmers reported no pre-existing relationship with AHA. This distant approach demonstrates shared responsibility as a multitude of stakeholders share the cost of managing and distributing information. This occurs to the detriment of farmers, who are supposed to be targeted in receiving the biosecurity messages, although another agency exists that can help with dissemination.

For the sheep industry AHA has been useful in developing and distributing the \textit{National farm biosecurity reference manual: grazing livestock production}. In this one manual biosecurity best practice for all grazing industries is covered. The problem with having one manual for multiple livestock is that it tends to overlook the complexities that exist with running each type, in this case sheep. To alleviate issues specific to the sheep industry it would be more useful if the sheep industry had its own best practice manual, as AHA has done for seemingly every other livestock industry to date. In Australia there are industry biosecurity manuals with on-farm recommendations available for other livestock industries (dairy, chicken, duck, duck,

\textsuperscript{22} \url{www.farmbiosecurity.com.au} is one outcome of the Biosecurity services programme run by AHA (Animal Health Australia, 2014b, p. 20). It houses tips and advice in the form of manuals and YouTube clips, which aims to raise awareness of on-farm biosecurity for Australian livestock farmers.
egg, feedlots, horses, pigs and zoo animals). However, at this time a sheep specific biosecurity manual is unavailable. AHA’s role has been useful in bringing together industries and governments to ensure planning for the exotic threats is executed. Funding an outside organisation such as AHA to provide information and facilitate collaboration with the 32 members shows a commitment to agencies working together to help secure Australia’s food supply. Current biosecurity policy approaches in Australia categorise sheep farming as part of the broader grazing livestock industries.

Australian grazing livestock farmers can locate the government recommended practices in the *National farm biosecurity reference manual* (August 2012) (henceforth referred to as the graziers’ manual). This manual is useful for cattle, sheep and goat farmers. It was produced by Animal Health Australia (AHA), who distribute hard copies to relevant agencies and it is also available as a PDF on the Farm Biosecurity website. The graziers’ manual contains the following seven generic principles for livestock farmers to follow:

- **Principle 1: Livestock**
  Manage the introduction and movement of livestock in a way that minimises the risk of introducing or spreading infectious disease

- **Principle 2: People, equipment and vehicles**
  People, equipment and vehicles entering the property are controlled to minimise the potential for property contamination

- **Principal 3: Feed and water**
  Quality of stockfeed and water is fit for purpose

- **Principle 4: Feral animals/wildlife/weed control**
  Minimise the potential for wildlife and domestic or feral animals to introduce diseases to livestock

- **Principle 5: Animal health management**
  Prevent and control animal diseases on farm by regularly monitoring livestock health
Principle 6: Staff instruction
All staff and contractors understand the importance of the biosecurity requirements for the operation in which they work and can implement the agreed practices for which they are responsible.

Principle 7: Carcass, effluent and waste management
Disposal of dead animals and waste is managed to minimise the spread of disease (Animal Health Australia, August 2012).

These principles are used in this thesis to determine whether participants are following the government-endorsed recommendations.

There are industry specific biosecurity practices that cannot be covered by the broad principles featured in the graziers’ manual. Clustering of biosecurity recommendations suggests that there is limited understanding of the requirements specifically relevant to sheep producers. This study, however, argues that sheep farming needs to be considered as a distinct site of biosecurity practices in its own right, and that a one-size-fits-all approach to livestock biosecurity practices is ineffective for sheep farmers.

State biosecurity governance
In NSW, there is a unique governance structure for farmers beyond the state agricultural department and that is the Livestock Health and Pest Authority (LHPA). Farmers pay rates to fund the LHPA. During data collection, in January 2014, the LHPA experienced restructuring and amalgamated with the state DPI and Catchment Management Authority (CMA) to form a new structure - Local Land Services (LLS). This restructuring is framed as being useful for farmers as it now serves as a ‘one-stop shop’, rather than a
consumer having to visit three separate businesses. Alternatively, as stated on the LLS website, what they do is ‘bring together agricultural production advice, biosecurity, natural resource management and emergency management into a single organisation’ (Local Land Services, 2014c). Unfortunately, at the time of writing, on-ground personnel have been lost through this restructuring process.

During interviewing it became apparent new LLS services were unknown, as farmers could not articulate the effects of the amalgamation on their business. Farmers have the experience of previous name changes to the services currently known as the LLS. One farmer assumes nothing changes, but it is ‘good for the stationery business’ (Farmer 8). Previous name versions of the LLS are still used in the vocabulary of interviewed farmers; they are the Rural Lands Protection Board (RLPB), Pasture Protection Board (PP Board) and the Livestock Health Protection Association (LHPA). The trusting relationship the farmers have with the LLS are a result of years of built trust with certain personnel, usually the vet, within the organisation.

Farmers and governing organisation relationships have been tested as a consequence of the lived experience and there is a lack of trust because of the way farmers have experienced the management of outbreaks. For example, during the early 1990s OJD outbreak the LHPA was placed in a position of authority by the state and had the power to quarantine properties if the disease was found, as this farmer describes:
Farmer 9: In my lifetime when all that Johne’s stuff came out there was a big, around our area a lot of people had to get rid of sheep, like neighbours and that. They were killed. They did tests on our farm and we were the only farm around that they couldn’t find it on. But then they quarantine us because we were in the middle of it all, which was wrong, because we didn’t have it. [pause] So there was two or three neighbours that had it.

Because this experience of quarantine is still in the memory of these farmers they have learned not to report suspicious situations.

Other industries have experienced a similar loss of trust in their relationships with farmers in their region. A West Australian study found that trust in government was an important factor in reporting the suspicious unknowns (Palmer, Sully, et al., 2009, p. 32) and contributes to non-adoption of biosecurity recommendations (Palmer, 2009, p. 352). Also farmers have seen via the media, unless they owned horses, how the equine influenza outbreak in NSW was managed. The following farmers experienced first-hand the inconsistency with biosecurity surveillance during the horse flu because of their proximity to the Victorian border.

Farmer 24: When we went to get the inspection she said I had to spray the wheels. So she got out a little pump pack [motion for spraying tyres]. And I said ‘are you going to do the car too?’ She said ‘no I don’t have to do that’. I said ‘they’ve been parked together in a horse paddock’ ‘no I’ve only got to do the horse float’. I thought this is a joke. I’m serious.
Farmer 25: So that’s our opinion of biosecurity
Farmer 24: The reason it didn’t get into Victoria was luck

This quote shows these farmers’ lack of trust in the biosecurity procedures because of the experience they have with government agencies’ management inconsistencies. In the example of badger management in the UK, Enticott
(2008b) reports that trust was eroded through governments various attempts to minimise the transfer of Tb to cattle, that has to date been unsuccessful. Additionally, farmers’ knowledge was ignored by the scientific inquiry and governments alike, into removing Tb from the UK landscape (Enticott, 2008b, p. 1578). All these examples show farmers’ negative experience of authorities’ variable and inconsistent biosecurity management. This has contributed to the erosion of trust between farmer-government relations.

The erosion of trust

Trust also extends to information that farmers access. They prefer to receive hardcopy information rather than via email, which aligns with other rural social science findings (Denney, 2007; Jiggins, Huber, & Collins, 2000). Farmers are able to sift through information to discern its usefulness and relevance to their business (Kilpatrick & Johns, 1999) and this negotiation is complex (Tsouvalis, Seymour, & Watkins, 2000, p. 917). These farmers are trusting of information distributed from reliable sources.

Farmer 6: I take each information on its merits, whether it applies to me or not. If it applies to me and my area then you rely fairly heavily. If it’s Southern Queensland then you don’t really pay much attention to it.

Farmers determine reliable information by its relevancy to their business. This farmer sees no reason to doubt the information that is presented from a source with no alternative agenda.
Farmer 19: ‘Cause I mean they’re coming from what we see as reliable sources, yes um they’re industry sources.

This compares to a piece of promotional material from a chemical company that has a vested interest in you purchasing their product.

Farmer 23: You are trusting but then you are sceptical, especially if it’s a night been put on by somebody who is actually flogging products. And you try and think of the things that suit you, or work for you. But mainly the technical things that I find lice control, footrot, you have to be trusting, you’ve got experts who know what they’re talking about. When it comes to flogging a product they want you to use, that’s when you become a little bit sceptical, and you go ‘hey slow down a bit’. If it’s on the technical side then you have to be trusting of the experts who know what they’re talking about.

These examples show how farmers decide which information they perceive as being trustworthy and that if it is deemed as such they will openly engage with it. This suggests that farmers would trust electronic information if it came from a trusted source. Dependent on the level of trust, either positive or negative, will determine whether the information is accepted or overlooked (Eiser et al., 2002, p. 2425). Knowing this, general biosecurity that is available from AHA or through the Farm Biosecurity website may prove untrustworthy as these farmers at present have had no interaction with this organisation.

These farmers know from experience that should there be an FMD outbreak in the future they are on their own to manage it. The participants are concerned with the limited number of personnel, unlike during previous sheep disease outbreaks, who can provide management assistance. As per Chapter 4, during footrot outbreaks the PP Board (predecessor of the LHPA and
LLS) were very hands on to help individual farmers to eradicate the virulent strain from their property. So perhaps farmers who had that experience may be more open to utilise LLS assistance when FMD occurs. There is limited trust in governments in regards to how they will handle FMD, because of how they managed during the OJD and equine influenza outbreaks. One farmer has a solution for how he would deal with FMD.

Farmer 29: When we get Foot and Mouth will be the day I go total crop\textsuperscript{23} and I don’t want to do that. And I see it as an inevitable. It would be so hard to eradicate here.

Preventative activities are currently in place to minimise the impact of FMD, and one such activity is border control.

Farmers know that they must place trust in border/quarantine authorities to keep out the unwanted pests, weeds and diseases, but their own experiences with border control bring this trust into question. Border control can be viewed as an expert system, in which the public assumes trust and competence (Wynne, 1996, p. 47). Questionable interactions with border personnel make some of the farmers worry about the government procedures in place to protect farmers’ businesses.

Farmer 29: But when we came into Australia, you have to say whether you’ve been on a farm and that sort of stuff and we did and filled all that in. And they basically said ‘hello’ and away you go. To me that wasn’t good enough, like they should have at least checked your boots, they didn’t. Like we made sure they were clean before we came back. There could have been a disease, could’ve still had Foot and Mouth on them for all I know. To me I thought that was a bit slack...So to me that’s a

\textsuperscript{23} Currently, Farmer 29 has a mixed farm of livestock and crop. In the event of a Foot and Mouth outbreak on his property this farmer is expressing his choice would be to sell all his livestock and become a 100% cropper.
major problem. I’m not happy with what happens. We’re getting things in all the time over here. So in my view it’s not good enough.

This farmer views his own motivations for keeping out unwanted unknowns as being greater than those of border control actors, whose everyday job it is to protect the Australian border. Farmers perceive the governments’ deficit in this area and manage the risk themselves by taking extra steps to greater ensure limited transmission possibilities.

Farmer 25: So I really think the government should be doing more for it. And perhaps their officers aren’t as well trained because they’re not. Perhaps we should be doing the customs things ourselves because you know ...what could happen. Whereas a lot of people doing the customs jobs, aren’t aware of what could really happen. They’re told, but it’s a different story when you know that if something comes in you’re going to have to lose your animals or your trees, or your whatever, there’s your livelihood gone in smoke. To me the whole customs thing should be a lot tighter than what it is.

The farmers see value in the national government’s surveillance services. However, they do not believe the services are sufficient to really help to keep out the unwanted. Given that farmers have experience of going through the risk-based system of border security, they know they must do the right thing themselves because the governments’ agenda does not always align with their own. A similar finding is that farmers perceive national practices as ‘inadequate or incompetently performed’ (Palmer, Fozdar, et al., 2009, p. 367). Australia practices a risk-based system whereby not everything or everyone is checked (Beale et al., 30 September 2008). This has created a lack of trust in the governments’ ability to manage biosecurity beyond the farm gate (Palmer, Fozdar, et al., 2009, p. 368). Furthermore, it contributes to
farmer perceptions of organisations being unreliable in the face of incursions, which stems from their own experiences with a past ‘exotic’ outbreak.

Lost trust – the OJD case

Among these farmers, lost trust in government agencies is a result of how the OJD outbreak was managed. When OJD broke out across Australia in 1980 (Kennedy & Allworth, 2001), it was an unknown sheep disease and therefore treated as an exotic disease by authorities. Eradication programmes ensued, however, since only one per cent of Australia’s sheep flock was infected, containing and controlling the disease were the measures taken on a national scale (Kennedy & Allworth, 2001). The example of OJD shows one ‘mishap or mistake’ (Slovic, 1999, p. 184) that destroyed the fragile trust that exists (Slovic, 1993, p. 677). OJD management by authorities echoes similar errors to how FMD was handled in the UK, such as engaging in exotic incursion protocols of stopping stock movements and introducing mapped zones of disease severity. Through farmers’ collective memory of the OJD incursion, whether they were directly affected or not, have since caused them to have limited trust in the LLS.

Particular interventions were put in place and in this example the use of zones were established to minimise the risk associated with the spread of the disease. To counter the high risk, authorities enforced quarantine biosecurity procedures, such as protocols of halted stock movements. Further, a mapped
zoning system was put in place and every farmer knew which area they belonged to, high, low or no OJD prevalence. The boundary lines were decided based on rivers and locals towns. From the farmers’ viewpoint this was not useful because property boundaries were ignored, and this presented movement challenges as detailed by Farmer 5:

The bureaucrats when we look on a map we need to put that down to free or not protected into the control zone, because we’ve got a certain incidence of [indistinct] and they looked on the map and they saw the Lockhart-Urana Rd as the only, because there are no real natural rivers or anything else. So it’s the only thing they could do to put their line on the map was make the Lockhart-Urana Rd the line and then go down the whole way to Corowa then they made all that a control zone, which used to be a protected zone. So all of a sudden the points and system and things like that with all my biosecurity and everything on this side of the road, even though I’ve got a block on the other side of the road down here you’ve got to go to the lowest common denominator with the points system and everything so all of a sudden, here legally I couldn’t sell a ram to somebody that had been buying rams off us for 60 years on the other side of the road.

The prevalence zoning lasted until June 2013. They were disbanded in favour of a ‘buyer beware’ system, whereby authorities and governance have relinquished control of the OJD zones and farmers buy and move stock at their own risk (Sheepmeat Council of Australia & Wool Producers Australia, 2013). OJD has now become incorporated as a set of six questions onto the sheep health statements (SHS) (See Appendix G). Given the disruptions to farming businesses during OJD and the inability to move and sell stock in quarantine cases, farmers have lost trust in the local biosecurity authority LHPA (now the LLS).
The LHPA were placed in a position of authority during the initial OJD outbreak and relations between some farmers and this organisation have since soured. However, the LHPA was farmer-funded through rates, which raises the question of why the state agriculture department would place the LHPA in an authoritative position. As Farmer 5 states, the authorities managed the control of OJD.

Farmer 5: Somehow those people became the front men and the policemen for the programmes, the OJD programme. So they became the enemy and I guess I’ve probably, because it really did with some of our civil disobedient actions we did, interventions and what not, we became quite, um, aggressive, not aggressive, quite hostile between the parties. So what all that used to be in place is what you thought were your friends and helping you with biosecurity actually became a bit our nemesis, or the people we were trying to wake up to it and things like that. So I’ve lost a lot of, I’ve probably lost, I probably need to get over it, been a bit sceptical about the health services if I was to rely on the department of ag or Rural Land Protection Board or bureaucrats and whatever put policies and things in place that keep me safe I’d be not sleeping that well.

Farmers were outraged by this move; as they pay for the LLS to help them be productive, not inhibit their ability to do so by quarantining properties. Farmer 11 illustrates this outrage:

They’re directed by the states as they were in the OJD to go in and impose state-based-programmes. The state didn’t pay anything for the Rural Lands Protection Board to pay that it was all producer funded, there you go. So it’s unbelievable!

Best practice recommendations are preferred to be sought from localised sources (Sligo & Massey, 2007, p. 177), and the LLS provided such a role in this community. However, similar to FMD, changes to best practice during the outbreak caused farmers to lose trust (Nerlich & Wright, 2006, p. 443) in the
LLS and their messages. These farmers reveal an incident during the height of OJD, which suggests why they are distrusting of the LLS.

Farmer 18: We had a big fallout [disagreement with the LLS] one day, [and I] reckon they were gonna close us down and we just refused and yeah
Farmer 19: And we’d only done what
Farmer 18: they’d told us to do. I wanted to move stock from here down to my other farm and they said ‘oh yeah you’re pretty right’ ‘I understand there’s some neighbours down there with OJD’ ‘Yes there is’, and they said ‘should be right because you’re on top of the watershed’. Which means the water runs off our farm onto their farm, anyway that’s alright. So two weeks after, three weeks whatever, I can’t remember how long it was they wanted to come and check us all over for OJD. They led us into a trap. [pause] Look there was a big fight over it for two years.

Therefore, the usefulness of LLS services is challenged and derives from the experiences farmers had with them during OJD. This has changed over time as Farmer 18 remembers: ‘[the] Rural Lands Protection Board or Pasture Protection board, you know that’s what it was there for to protect you’. From their incident with the LLS the stress lies on ‘was’. This suggests from experience of dealing with the LLS first-hand during an ‘outbreak’ these farmers will not be trusting of the LLS, or their services and messages for the next outbreak.

Farmers’ experience informs their sociocultural knowledge and perspectives of how to interpret the risk situation. These farmers learned by how they were treated that governments overlooked their lifetime of localised livestock management expertise. In crisis situations authorities step in and assume disease management roles. However, in practice, this involves the management of farmers. These farmers were able to recall their impressions
of the outbreak, which may also consist of observation, and their collective memory serves to continuously link this community of farmers together (Irwin et al., 1999, p. 1315). From farmers’ perspectives during OJD there was a greater focus on pointing fingers and placing blame than controlling the spread of the disease. This treatment manifested itself in farmers not trusting government decisions. How farmers are able to make sense of future expert advice (Palmer, 2006) will be impacted by their perception of actions by government agencies during OJD. Many of the farmers interviewed feel that the LLS will not be useful in the role of governing organisation on the ground during the next outbreak event, because they cannot be trusted. Farmers’ perceptions of trust are closely linked to risk management and future biosecurity practices promoted by authorities, such as the LLS, may not be well received. The following section considers surveillance as a biosecurity management tool.

**Surveillance**

Surveillance is one example of shared responsibility that, in practice, has increased the risk of incursion to the sheep industry, as some post-border spaces have limited monitoring. Surveillance is an important activity because if an unknown is reported and contained early the social and economic impacts
will be less devastating. On-farm surveillance is the farmers’ responsibility, and monitoring practices beyond the farm gate belong to the state government (Beale et al., 30 September 2008, p. 8). A level of trust is required for each party to adequately fulfil their surveillance roles and responsibilities. The demise of state extension resulting in limited DPI representatives on-the-ground, combined with the LLS restructuring means that the sharing of surveillance responsibilities appear heavily weighted on the farmers’ side.

Surveillance is carried out by farmers as a preventative biosecurity practice. This can contribute to tensions between farmers and governments. This section explores some of those tensions and farmers’ roles and responsibilities in regards to surveillance and shows the risky spaces beyond the farm gate, which have been exacerbated by the withdrawal of government extension.

For the parameters of this study, surveillance is an important pre-emptive set of practices to help ensure that unwanted pests, weeds and diseases remain on the other side of the fence; it is a useful on-farm management tool (Morley, 2002, p. 136) that ideally acts as a warning system of change (Salman, Stark, & Zepeda, 2003, p. 689). ‘A key component of biosecurity is surveillance’ (Vanclay, 2004, p. 217), which requires the monitoring of human and non-human actors (Donaldson & Wood, 2004, p. 375). Biosecurity surveillance activities for these farmers include:

- monitoring any on-farm vulnerabilities
- monitoring the fence line for new holes from pests
- constant watching, chipping and spraying of weeds to minimise the spread
- monitoring stock for signs of ill-thrift

On average, the farmers reported to be monitoring sheep every two days, depending on the season and other farm activities. This level of monitoring is motivated by previous experience of managing diseases. These farmers have the experience and knowledge to use a range of surveillance practices to monitor endemic risks without government reminders.

Governments require farmers’ responsibilities to include on-farm biosecurity surveillance activities. However, they have limited control of farmers’ surveillance reporting behaviours, if they locate an anomaly. Governments decide the division between risks that require surveillance and that which is free from monitoring (Bigo, 2002, p. 82). Australian governments have shifted funding priorities to reflect shared responsibility, which requires farmers to have a greater role in biosecurity. This suggests that governments have a level of trust that farmers will manage post-border biosecurity with less government involvement.

If notifiable diseases are detected, a classificatory system advised by the OIE and WTO is enacted, and this becomes problematic for a country’s ability to trade in the global market place (Law, 2006, p. 230). For example, there are three classifications for FMD\textsuperscript{24} that may impact trade, and as with any

\textsuperscript{24}‘a) disease free without (routine) vaccination; b) disease free with vaccination; and c) endemic disease’ (Law, 2006, p. 230).
animal disease reporting to authorities minimises the impacts. The use of surveillance practices contributed to the early detection of FMD in the UK, which reduced the severity and length of infection on a property (Waage & Mumford, 2008; Ward, Donaldson, & Lowe, 2004). This shows the importance of farmers’ surveillance activities as a preventative disease detection strategy.

In the UK, despite government involvement in post-border biosecurity, increasingly it falls to farmers to cover the costs associated with livestock diseases (Enticott & Franklin, 2009, p. 384). The surveillance expectations are that farmers monitor stock and land, and if there is an unknown sighting it is to be reported (Department of Agriculture, n.d-b).

Farmer 26: I think that’s all the government can do and relying on the farmers to report, which is basically when it comes the farmer reports a problem to a DPI guy and they’ve gotta come round and check it out and hopefully it goes from there.

It is the farmers’ responsibility to comply with government recommendations and report unusual situations. Hernandez-Jover et al suggest that farmer compliance with regard to disease reporting is an important component to minimising risks (2012, p. 261). Farmers continue to monitor for overall animal health, as was found among Australian beef producers, rather than for signs of an emergency disease, as governments and vets would prefer (Windsor et al., 2015). This will continue to present challenges for governments until the method of delivery for these types of services changes (Heffernan et al., 2008; Palmer, Fozdar, et al., 2009, p. 371).
Governments appear to have failed to adequately communicate their shift to shared responsibility and the increased capacity farmers’ biosecurity role entails, as these farmers maintain the same biosecurity risk behaviours as prior to the Beale review’s recommendations (Department of Agriculture Fisheries and Forestry, March 2012). The frequency with which participants monitor boundaries, weeds and stock is self-regulated and changes with seasonal needs, rather than based on government changes. This current limitation of articulation of the farmers’ role in surveillance activities is demonstrated subtly in the extension literature. For example, the majority of the recommended practices concern farm hygiene, such as cleaning, disinfecting and record-keeping (Department of Agriculture, n.d-a), but details of the requirements are left to the responsibility of the farmers. This seems to be resoundingly true especially in the sheep industry, where there still remains no specialised biosecurity manual available (unlike the pork, cattle and poultry industries) (Animal Health Australia, August 2012).

So how are these farmers supposed to know what a good biosecurity system looks like? The Farm Biosecurity website offers general recommendations for grazing animals, which are designed to bring awareness and offer limited guidance of concrete practices. Biosecurity guidelines originate from human health (Atlas & Reppy, 2005, p. 56), which is why there is a seemingly large focus on cleaning and disinfecting recommendations that are the standardised biosecurity messages across the industries.
Sheep farmers have no biosecurity role model. In Australia there are annual biosecurity awards whereby farm businesses are nominated to win various biosecurity categories (Farm Biosecurity, 2012). Over the years, the animal category has had several sheep farmer finalists; although to date no individual sheep farm has won a biosecurity award. Nominees’ good practices are not well detailed in media, should a farmer wish to imitate finalists. However, collective biosecurity efforts for the sheep industry have been recognised by national awards. In 2009, 99 per cent of the sheep producers in the old Broken Hill RLPB area won the livestock farm biosecurity award. Under Greg Curran’s guidance (the LHPA vet), Broken Hill farmers implemented an OJD exclusion plan to keep their region clear from the disease (Agriculture Today, 2009). In 2014, the Federation of Australian Wool Organisations (FAWO) was recognised by DAFF in the Australian biosecurity awards. Over the years FAWO’s planning activities for FMD, EAD and the AUSTVET plan contributed to their win (Australian Government Department of Agriculture, 2014). Recognising collective biosecurity efforts still continues to overlook the majority of sheep producers who do biosecurity every day. This combined with AHA’s withdrawal of sponsorship of the biosecurity awards in 2014 (pers comms. April 24th 2014) means that it will be increasingly difficult to see a model sheep farmer who conducts biosecurity well enough to be recognised and celebrated across the country.
Based on interviews with farmers and understanding their everyday practices, the following list is indicative of the requirements for a good sheep farm biosecurity system:

- Good fences
- Best practice dipping, drenching and vaccinating
- Fox baiting participation
- Shooting and poisoning other feral animals
- Weed spraying

(Further explanation of each practice is found in Chapter 4). These practices contribute to participants being able to produce productive and profitable sheep. However, even with all of these in place, a good biosecurity system still needs room for breaches (Permin & Detmer, 2007, p. 32), as acceptable levels of biosecurity risk exist (Beale et al., 30 September 2008). In other industries there is a gap between biosecurity knowledge and implementation (Negro-Calduch et al.; Toma et al., 2013). While there is always room for improvement, many of the participants run their businesses according to the recommendations laid out in the graziers’ manual, although they are not aware of it.

One challenge for post-border biosecurity surveillance is the few people who can actively contribute to these activities. The current system assumes that farmers have the time to perform thorough surveillance activities, which proves challenging over the increasing sizes of properties. In this study, the average farm size was 8,970 acres. This is best illustrated by Farmer 29 who notes in the past how many more people were available to monitor the piece of land that two people now monitor.
Farmer 29: And that’s one of the problems in this country because there’s so few of us. There’s less people to keep an eye on these things. We farm now what 50 years ago nine families would have farmed. I do it with one worker and myself. Well those nine families would have all had a permanent employee and they would have had lots more casual employees at harvest and shearing. So a lot more people to watch these things. I mean you didn’t have, you weren’t travelling as far so there weren’t so many. But nine sets of eyes are better than one. Look do you ever hear that Australian farmers are very efficient? But I reckon its bullshit. We’re efficient at producing a lot per person, but we’re inefficient in managing the country. I reckon we’re spread too thinly. So the more of these problems that come in, biosecurity issues, because there’s not enough people around or enough concerned people to do something about it.

The time requirement needed to monitor such a sizeable area by one or two full-time workers appears to be demanding. Additionally, there is an expectation that farmers know the free call exotic hotline number that should be contacted to report unknowns. However, a West Australian study found there is very little reporting to vets, which means there is no evidence to suggest that disease exists (Palmer, Sully, et al., 2009, p. 33). These farmers already monitor for the known biosecurity problems because they have the lived experience in what to look for. A known biosecurity problem, for example, is during the season where flies are more prevalent and farmers are continually monitoring ‘at risk’ flocks, especially after rain, which encourages flies to lay eggs in the wet wool.

Other forms of surveillance are the use of National Vendor Declarations (NVD) and recording stock movements via the National Livestock Identification System (NLIS) database, which is perceived by these farmers as useful surveillance for governments only. Using the NVD is a national legal
requirement with any movement of sheep between properties, which is either
completed in hard copy in triplicate or on the website. There is a slow shift
towards an entirely web-based system and during the transition it means there
is still room for error while filling in the forms. For example, on the NVD form,
there is a box to tick that means the product is eligible for sale in Saudi Arabia
and Russia. When questioned, farmers knew of this box, but many could not
articulate why they tick that box beyond giving their product further potential
markets in which to be sold. Interestingly, even the stock agent who was
interviewed at his workplace had to inquire with another staff member what
ticking that box meant.

Interviewer: Oh the markets, ok well someone said on their Vendor Dec they put Saudi and Russia ok, what is that?

Farmer 20: Oh [pause] it’s um [pause] basically processors [pause] they need, they’re the only ones that want that. Basically the people that are selling the meat. They um [pause] and that’s what the Saudis and the Russians want, that’s just what they want to see on the Vendor Dec. Obviously, it’s ticking a box, um [pause] I write it on the Vendor Dec haven’t got a clue what it means
[ Goes to find out from other staff members ]
Farmer 20: Russian and Saudi eligible is basically about one chemical and it’s basically penicillin and to say they haven’t been treated with that in the last 50-100 days. Just trying to track down

Interviewer: Well if you don’t know then lots of people don’t know

Farmer 20: Yeah, but then again um. You know people are aware that if you give penicillin to a sick animal that you don’t sell it anyway till it’s outside the withholding period. So I guess those processors just need to see it on the Vendor Dec and then I guess they trust that everyone is doing the right thing. But that piece of paper unlike the animal health statement that is, that’s a legal document. So if you did write that and you got traced back you would be in the shit.
This agent is in a position within the farming community where one would expect that he would know these complexities, by being a farmer, and through his job. Industry knowledge inconsistencies, such as this particular tick box when filling in a legal document, are potentially more commonplace than acknowledged. One farmer mentioned that he had been audited and had learned through this process how to fill in paperwork with greater vigilance and knowledge of the system.

Farmer 7: because I got audited here three or four years ago by...I guess it was by the LPA livestock, the people that operate the Vendor Dec book. Somebody came and audited me for that and...I’d been...he went right back through it and he said ‘you’ve got down here that these stock weren’t raised on your farm’ and they were obviously you know some rams I’d sold. And he said ‘when you fill that in say were all these animals in this consignment raised on your property and you say no, you must up in the top section there where you put in the number and the description of the sheep you must put in the PIC number as well next to that box’. Now I’d never been told that...It seems a little bit curious to me that the number of times we go into these merchandise nights or Co-op night or they’ve got their sheep specialists there that they don’t bring someone in and re-enforce that with growers, producers, to how to properly fill in that book.

His suggestion to use a time when farmers are gathered together could be helpful in distributing biosecurity messages.

Despite the legality of the practice, some farmers do not comply with the system correctly and record all movements. For example, this farmer owns multiple properties in the district and moves sheep frequently between them. He believes that recording their movements benefits the system rather than assisting him and his business.

Farmer 5: Every time I shifted sheep got on that internet like you’re meant to and tell big brother in Canberra, the bureaucracy, about these
sheep moved here to here, I might just bring them back from one farm from here to here to shear them for the day and take them back again, well that should be two, get on the internet telling them where they have been and everything else about that animal [indistinct] I just can’t be bothered telling them.

Interviewer: What, even between the properties?
Farmer 5: [nods]
Interviewer: Really?
Farmer 5: Yeah it’s just bureaucracy, it’s not disease fixing or solving, if there was a foot and mouth outbreak then it’s not going to solve a thing.

Farmer 28: Australia is too big to have a system like the English system now where pretty much every animal has a travel passport effectively. And I think cattle, electronic tag trace back probably would make trace back pretty quick. I know there’s faults in the system, you seem to have the odd animal transfer error issue but I think in general it would probably make a reasonably fast traceback. On the sheep, I think the

Farmers are required to enter details pertaining to the property by using their individual Property Identification Code (PIC), which presumes that in the event of an exotic outbreak the NLIS database will be used by authorities for traceability purposes.

The tagging system for sheep is also a mandatory requirement that is used for surveillance across properties. Upon arrival to each property, sheep are to be tagged with a new tag that identifies the individual property through the unique number present on each tag. In NSW there is a colour system, for example, the 2015 ear tags are sky blue (NSW Industry and Investment). This means that an individual sheep may arrive at slaughter with a number of tags in its ear from each property they have resided at during their useful lives. This system imposes surveillance across multiple farms and can track a sheep’s life. Farmers participate in this because they are legally required to. Farmers recognise the flaws in the tagging system.
system has some major flaws, especially at the sale yard level and the NLIS system.

One limitation of the current practice is the possibility of a sheep losing a tag either in the confines of a truck, during mustering and yard activities, or simply during paddock living. The tag is designed to maintain robustness over the course of a sheep’s useful life, and for surveillance purposes, it is assumed that each tag will remain intact. Tags are sometimes lost. For example, one farmer reported finding sheep on his property and using the PIC number to identify the owner: ‘So out of the eight or 10 [sheep] that I got there was only one with a PIC number on the ear tag so I was able to work out that they were his’ (Farmer 7). A solution is to adopt the technology of electronic tagging, as is common in the cattle industry.

Some farmers mentioned that they are against the introduction of electronic tagging because of the increased expense and knowledge of software needed to warrant the use of the electronic system. Farmers are not interested in expensive tagging alternatives that appear to offer no on-farm management benefits (Hernandez-Jover et al., 2008, p. 1696). However, two of the interviewees have introduced electronic sheep tagging into their business and use it as a management tool.

Farmer 5: We’ve done electronic ID tags and individual animal ID all before other people and the hardware and stuff was there but not the software. It was supposed to make your life simpler, with scanning the electronic IDs and data capture and things like that, it’s been four years of hell for [wife] and I because we were ahead of where the software and stuff. Sometimes it’s not good to be an early adopter, it’s better off to be a medium or something where someone else, like if you could get your
electronic IDs and data capture in your studs now it would be so easy. Three years ago it was just a nightmare and I still shudder!

Farmer 19: Yeah, much easier...and that’s where our sheep consultant has been instrumental in helping us to do that. And look for the average sheep farmer you know that doesn’t want to do it, most of them think it probably is expensive, but for us when you use it as a management tool. I mean we’ve had to buy electronic guns and computers and software and all that to support, and we’re still learning [laughs]. If you can view anything positively...we’re not just dopey old Dave and Mabel you know [laughs], even our kids are impressed [laughing].
Figure 19 Using the electronic scanner in the yards
This farmer demonstrated the information they are able to quickly capture by scanning the electronic chip embedded in each sheep when they are in the yards (see Figure 17). For their business electronic tagging has given them more control, and they can make more informed decisions while working with their sheep. They mentioned some software issues and the capital expenditure required to enter into the electronic tagging system, but overall it has improved their ability to make decisions. These farmers now have experience with a different and new form of flock surveillance that is currently uncommon within the Australian sheep industry.

Surveillance is useful for government monitoring, as blame can be placed more easily once an outbreak occurs. Although it is recognised that governments are interested in managing outbreaks until resolution (Enticott, 2009, p. 328), some activities during the crisis are related to finding and placing blame. For authorities, traceability is a part of surveillance activities (Hernandez-Jover et al., 2008, p. 1692) to the extent that it is a legal requirement for farmers to input sheep movements into a national database. Blame is an important agenda item once an outbreak occurs and is evidenced in the language used in the communication channels such as the media (Measham & Lockie, 2012, p. 6). Often the media magnifies the risk beyond scientific assessment (Renn, 2008, p. 94). For example, during the British 2005 avian flu outbreak, as time passed and it became clearer that migratory birds had a small impact on the main reason for infection. The importing/exporting market from European countries were scrutinized to find a
source of blame (Nerlich et al., 2009, p. 353). This presents a challenge and with the current system it is possible that the same could happen here. The MLA website states that using the vendor declarations is for ‘Australia’s meat and livestock food safety reputation’ (Meat and Livestock Australia, 2014e). However, farmers have no use for the information stored within the NLIS system and it only adds to their administrative workload. Therefore, it is foreseeable that in an outbreak event a resource such as the NVD surveillance system could be used as a source of blame.

A limitation for governments is that presently Australian biosecurity surveillance literature extends only to include livestock disease reporting to vets (Hernandez-Jover et al., 2013; Palmer, 2009). The report findings inform governments’ that farmers are conducting few surveillance activities. For example, sheep farmers are less likely to report unless multiple animals die within a week or two, upwards to 20 (Palmer, 2009, p. 345). Some farmers joke about the cost of vets and a cheaper option for shooting problematic sheep, for example Farmer 20: ‘That’s our policy for control – rifle! [laughing]’. It was more common to hear farmers calling for vet advice.

Farmer 5: I’m not going to shoot any if they are just dead in the paddock for no reason. If I use my skills and limited things for diagnosis and can’t come up with a logical reason...If it’s one unexplained death in the paddock, well that’s running sheep. It could have been a heart attack, sheep are no different than humans, faulty hearts, hole in the heart or to do with something and they just die and things. One or two sheep ‘round every now and again don’t worry too much, but if there’s a group of sheep and I can’t put a reason to it, which has never happened, but if it did I’d be ringing the vet very quickly.
These farmers demonstrate an underlying serious regard for the welfare of their livestock under their custodianship and recognise their own knowledge limitations, which shows no reluctance to report the unknown. This finding differs from the current Australian biosecurity literature that currently considers only livestock. Farmer 5’s quote states that when there are a multitude of livestock deaths for reasons beyond his knowledge base he will contact a vet and report said occurrence. Vet reporting is one method that governments can use to monitor farmers’ surveillance activities in regards to livestock disease control. However, when referring to biosecurity holistically and monitoring for potential risks, weeds and pests must also be considered.

Space exists for improvements to the current reporting system and most useful would be consideration of farmers’ needs and acknowledgement of their localised knowledge. There already exists surveillance system failures of disease reporting, even with human parasite health issues (Fearnley, 2008, p. 1622). Similar failures can occur with animal disease because the system relies on people to be self-governing and report suspicious activity to authorities, void of any pre-existing personal connections. But it is already known that farmers prefer face-to-face interactions with people known to them (Yang, 2006, p. 578), often a vet (Brennan & Christley, 2013, p. 5). Therefore, the current system of calling 1800 675 888 and speaking to a random on-call vet somewhere in the state, most likely unknown to the caller, is not conducive to farmers’ preferred interactions. As demonstrated above, farmers already engage with local vets and believe that the vets will take the
necessary steps to notify further authorities if they discover a notifiable
disease. Some farmers were of similar opinion to farmer 18 in identifying this
point.

Farmer 18: But a lot of people are wary of getting the vet out in case
there’s a major problem. Look if you had a vet come out here um...like
a private vet and there was a problem he’s not gonna shut up about it,
he’s gonna have to do something. He’s gotta, he’s bound to do
something, so
Farmer 19: If you had a notifiable disease, if you had a bad disease
Interviewer: Like footrot or something?
Farmer 18: Yeah, if we had footrot he’d have to notify the RLPB yeah

Therefore, farmers see no direct need for them to use the emergency animal
disease watch hotline. This is one issue that needs to be considered and
overcome if reporting behaviour among farmers is to change.

For thorough surveillance to have a real chance of occurring more on-
ground personnel are needed, both on and off the farm. This will be an
ongoing challenge for Australia, as the trend towards urbanisation is having
dramatic effects on rural populations. This means that it will be difficult to use
another country’s surveillance models here. The government’s role in
surveillance activities has changed due to the reduced spending on extension
personnel. As the findings above demonstrate, sheep farmers do not
necessarily treat surveillance as a shared responsibility. Industries and the
private sector were supposed to fill this gap. However, farmers did not
mention any involvement with either actor in regards to surveillance. This
suggests that, in practice, farmers’ surveillance roles have not changed beyond
the legal requirements of completing the NVD and the NLIS. Farmers continue
to monitor for endemic pest, weed and disease problems that they have prior experience in managing. As surveillance is an important area in biosecurity for containing the spread of pests, weeds and diseases (Department of Agriculture, n.d-b), then it appears it may require an outbreak to occur for any of these systematic issues to be reconsidered beyond current activities.

**Conclusion**

This chapter has examined how sheep farmers prioritise biosecurity risks in relation to other priorities and pressures, and the implications for following biosecurity practices recommended by governments, which addresses the second research question. The question has been addressed by identifying that these farmers’ priorities focus on managing endemic biosecurity problems, whereas governments are attuned to exotic risks. Farmers’ roles and responsibilities have changed as a result of shared responsibility, and the subsequent withdrawal of government funding from RD&E, and farmers are required to be more self-governing. This chapter has contributed to the literature on biosecurity risk management by showing farmers priority on managing endemic risk. The farmers have socially constructed the risks they deem important that will affect their business, which are climate, market uncertainty and diseases. This contrasts with the governments’ risk agenda,
which is more concerned with exotic diseases. This is evidenced with recent findings on the economic impact of FMD (Hafi et al., 2015).

Risks are minimised through the continuous surveillance that farmers are already conducting. This is a gap in the literature, as government has limited knowledge of farmers’ current biosecurity activities. Farmers manage risk by monitoring for new signs of pests, weeds and disease incursions and they have the knowledge of what to look for with endemic risks. However, space exists for exotic diseases to emerge, as knowledge of signs and symptoms are unknown and therefore may go undetected even with on-farm surveillance activities occurring. Both actors are participating in different surveillance activities, at the local and national levels, which is suggestive of a thoroughly monitored system. However, gaps will always exist because of the realisation that zero risk is unobtainable. Biosecurity risk management activities, such as surveillance and monitoring, contribute to farmers participating in government recommended biosecurity practices.

One finding that differs from the literature is farmers’ self-efficacy and how they use vet expertise. Palmer et al asserted that there is limited disease reporting in WA (2009). However, these farmers have shown they use their tacit knowledge to manage livestock diseases, but they do contact their local vets when they discover livestock anomalies in their farming system. There is a place for vets, and they will actively seek out their expertise when they come across issues they cannot self-diagnose. Tensions exist between government and farmers because of a lack of trust. Governments’ expertise has been
challenged when outbreaks have occurred. The farmers’ perception of
governments and their role in biosecurity has changed because of the lived
experience with OJD management. This parallels the low trust that exists
between farmers and agricultural departments in the UK in relation to how
FMD was handled (Enticott, 2008a, p. 442). Farmers are now in a place to
really trust only those that they know, which places increased importance on
those links to the personnel within the LLS. Despite the lack of trust in the
agency, they are the only on-ground personnel that these farmers have access
to. Distrust in the LLS to deliver useful services during the next outbreak is
debatable from the viewpoint of some of these farmers. Distrust extends to
other government funded biosecurity services on the border. The data suggests
, a lack of awareness of best practices is not a feature as farmers are sceptical
of border controls remaining a useful source of defence against the unwanted,
due to firsthand experience of staffing indifference to biosecurity procedures.

The management that is in place at both levels needs to recognise each
other’s contribution to the problems. Farmers and governments operate in
different everyday spaces and have differing goals and priorities that impact
Australia’s food security. Various opportunities for biosecurity messages to be
articulated to farmers have been presented throughout this chapter.

Nevertheless, these farmers’ appear to actively take up many of the
governments’ recommended biosecurity practices, as articulated in the
graziers’ manual and commented on in further detail in Chapter 7. The next
chapter discusses the implications for post-border biosecurity as a result of the disconnect between policy and practice.
Chapter 7 – Discussion

Introduction

The aim of this chapter is to discuss the findings from the preceding three analytical chapters, and align with the theoretical framework of good farming, to demonstrate how they address each of the research questions. In doing so, the chapter also considers the broader implications of the project’s findings for existing scholarly and policy approaches to on-farm biosecurity. Given the ‘few accounts of farmers’ understandings of biosecurity have been published’ (Enticott, 2008b, p. 1568), this thesis is significant because it provides detailed insights into biosecurity knowledge and practices from farmers’ perspectives.

Much of the literature to date assumes that farmers have a biosecurity knowledge deficit (Nampanya et al., 2012; Noremark et al., 2010), which should be addressed through farmer education (Laanen et al., 2014). From this perspective, the main role of governments and industry is to raise awareness and educate farmers on ‘good’ biosecurity practices, with the intention that it will improve on-farm implementation. However, current top-down extension approaches, which consist of governments educating farmers, tend to overlook farmers’ tacit knowledge.

This thesis provides an alternative viewpoint and argues that farmers are already focused on endemic pest, weed and disease management, backed by
years of local knowledge and experience. The interviewees shared their knowledge of best practice and how they apply it on-farm, which demonstrates their understanding of good farming. These farmers’ definitions of good farming are socially constructed through their network and are performed through their biosecurity practices. Farmers’ practices are adaptable as risk priorities change over time. The findings contribute to, and build upon the current social science biosecurity literature, specifically the notion of good farming. This is achieved by showing that farmers are active and knowledgeable actors who practice biosecurity in ways that make sense to them, and that accord with their priorities, values, and understandings of good farming. This raises questions regarding the appropriateness and effectiveness of current on-farm biosecurity strategies. The chapter discusses the key findings from this study, which address the research questions. It then considers the limitations of current biosecurity messages.

**Key findings**

This section re-visits the research questions that were outlined at the end of the Chapter 2 – Literature review, and discusses how the project’s findings contribute to addressing those questions.

*Research Question 1 – What role does farmers’ local knowledge play in their understanding of biosecurity and how do they learn about it?*
Biosecurity knowledge is learned through experience and from, other farmers, other biosecurity professionals, written materials and extension. Based on the interviews conducted in this study, it appears that the information distributed by governments and industry has a limited impact on farmers’ practices, as no one mentioned the Farm Biosecurity website, AHA, PHA, and only DPI assistance from many years ago. These are the sources of knowledge that governments and industry have in place to raise awareness, with the intention of influencing on-farm implementation. However, a better strategy would be to consider the sources that these farmers use.

This study confirms what is already known about Australian farmers preference for learning, which is face-to-face from trusted others and local professionals (Bamberry et al., 1997; Kilpatrick & Johns, 1999). Chapter 4 is concerned with farmers’ biosecurity knowledge, and the categories of informal and formal sources of knowledge have not previously been applied to biosecurity studies. This is another way this study contributes to the social science biosecurity literature. The range of sources that participants use to develop their knowledge shows that they are actively engaged with learning about biosecurity.

Governments and industry desire to see improvements in on-farm biosecurity, but behaviour change is difficult. The findings in this study are centred on endemic biosecurity problems, because they are farmers’ key pest, weed and disease concerns. Currently biosecurity messages are disseminated with the underlying purpose of encouraging behaviour change. However, the
impact the biosecurity messages have on practice is unknown as evaluation and monitoring of projects is limited.

This study has identified how farmers learn about biosecurity, which could be used to better target biosecurity messages. It is similar to Garforth et al’s findings that show instances where the transfer of knowledge needs to be adapted to the specific ‘technology and audience’ (2004, p. 27). Biosecurity knowledge dissemination in Australia currently mirrors some of the stages of Roger’s diffusion model (2003), making biosecurity not such a different story than the adoption of other farming ideas and technologies. With new practices, farmers prefer to go through a trial period in addition to seeing and experiencing it elsewhere. Therefore, it seems possible to glean success stories of adoption from the various projects involving other Australian sheep farmers and apply it to biosecurity practices (such as in Hunt and Coutts, 2009).

The withdrawal of government-funded extension services means that government agencies are less involved in the promotion and implementation of biosecurity at the local level. The amalgamation of local agricultural services into the LLS at the beginning of 2014 also contributed to solidifying the limited provision of government services to Riverina farmers, as on-ground staff were lost during the process. Regional biosecurity is left to those living in regions to initiate, grow and maintain. Even though ‘participatory bottom-up models’, which are founded on the deficit model, fail frequently (Palmer, 2009, p. 49),
they have the potential to positively influence farmers’ practices because they are farmer-driven and include local knowledge.

Given the abundance of information available today for farmers increases the need for it to be contextualised to local conditions and to come from trusted sources. This will help farmers to be open to receiving information that is available through localised and trusted sources such as stock agents, some vets, agronomists and shire weed officers. This study’s findings show that farmers are successfully engaging in biosecurity in many forms of their enterprise and access the information they need from local sources. Consequently, there is limited scope for the success of the current graziers’ manual, as it contains generic information that goes across industries. One positive element to the one-size-fits-all approach is that recommendations can be adapted to any grazing livestock business, as there are a multitude of possible interpretations of the wording.

Currently in extension, biosecurity messages are present, but they are not articulated explicitly as biosecurity, such as in the contents of BredWell FedWell and the Graham Centre sheep forum. Since incidental biosecurity already exists it may be better to ‘piggy back’ onto current providers of education, where biosecurity is already implicitly part of the programme. Therefore, obvious times to address these would be in farmer group forums where like-minded farmers come together. The forums mentioned in the interviews were field days, Lifetime Ewe Management, BredWell FedWell, the Graham Centre sheep forum, informal groups, on-farm trials, on property ram
sales and nights sponsored by stock agents/merchandisers. These are identified spaces already occurring in the Riverina region that could be used to further spread biosecurity messages.

Potentially any place where farmers come together, a small reminder of good biosecurity practices can be interwoven into the event programme. This approach is similar to Hernandez-Jover et al’s suggestion of tapping into existing networks to communicate biosecurity messages (2013). One problem with their suggestion is that existing networks are named where biosecurity information should be disseminated (Hernandez-Jover et al., 2013, p. 508). However, this approach relies on the limited personnel who work in the region following the recent LLS restructuring. The current system with few dedicated staff left on the ground regionally means that there is a heavy reliance on farmers’ own motivation, management goals and self-governance to implement further biosecurity practices to better secure their farms.

Research Question 2 – Which practices do farmers engage in to prevent threats and manage biosecurity on-farm?

Farmers’ knowledge deficit is viewed as a contributing factor in not following recommended biosecurity practices (Laanen et al., 2014). Through co-funding arrangements, governments and industry work together to produce

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34 These events are not advertised as containing biosecurity information, but my findings show they do. It should not be assumed all those in attendance always practice good biosecurity as short cuts are sometimes taken.
and disseminate recommended biosecurity practices to farmers. Governments and industry are particularly interested to see recommendations followed a) for the benefit of the Australian economy having continued access to international markets and b) to see improvements in practice with the introduction of shared responsibility (Beale et al., 30 September 2008). Both of these factors mean that farmers are under increasing pressure to improve their international competitiveness while bearing the costs of production, including biosecurity management, themselves.

The interviewees tacit knowledge feed into localised notions of good farming. The findings from Chapters 5 and 6 demonstrate that farmers have tacit knowledge of on-farm biosecurity that informs their farming practice. Participants know about on-farm biosecurity through their lived experience, and they continually build upon their tacit knowledge by attending regional events where scientific knowledge is disseminated and where they can engage with other farmers and biosecurity professionals. They are motivated to attend, and they exhibit a desire to increase their knowledge about the specifics of the industry within a local group environment. By learning and reinforcing best practice and then applying it on-farm shows their attitude towards wanting to be good farmers as they define it. This aligns with other social science literature that shows that farmers’ biosecurity knowledge is well

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35 Traditionally publicly funded extension was used to disseminate good biosecurity messages. However, nowadays in Australia private sector has failed to follow the example set by government of providing extension support to farmers (Hunt & Coutts, 2009).
developed (Palmer, 2009, p. 343) and the understanding of their land comes from monitoring over time (Riley, 2008, p. 1290).

In contrast, others claim that farmers have ‘inconsistent awareness and/or adoption of available knowledge’ (Kung et al., 2013 pg1), and epidemiological vet studies argue that farmers have a biosecurity knowledge deficit (Heffernan et al., 2008; Noremark & Sternberg-Lewerin, 2014; Racicot et al., 2012). One reason for this contrast is the interpretivist approach taken in this thesis, which focused on gaining an in-depth understanding of farming knowledge and practices. Epidemiological studies tend to focus on what farmers think and do. However, in this study, the rich descriptions captured through semi-structured interviews provided insights into the why and how of farming practices. Following this approach highlights farmers’ extensive tacit knowledge of biosecurity and desire to be good farmers. It suggests that the claimed knowledge deficit is not necessarily an accurate depiction of why these farmers are seen to not be participating in on-farm biosecurity practices. Low rates of implementation of on-farm biosecurity practices are explained by farmers’ lack of knowledge across livestock industries (Alarcon, Weiland, Mateus, & Dewberry, 2014; Hernandez-Jover et al., 2013; Laanen et al., 2014; Rosanowski, Rogers, Cogger, Benschop, & Stevenson, 2012).

I gained an understanding of Riverina sheep farmers’ current biosecurity practices by asking how they manage the various pests, weeds and diseases. A selection of these answers is presented in Chapter 5 (see Figure 5 Farmers incidental biosecurity management practices) and demonstrates the breadth of
biosecurity practices in which farmers are currently engaged. The findings are best captured by the term ‘incidental biosecurity’, which refers to the biosecurity practices farmers are ‘doing’ that incidentally align with government recommendations, one of the key findings of this thesis. Farmers’ incidental biosecurity practices are part of their overall farm management and contributes to notions of being a good farmers as their practices show that these farmers are actively securing farm boundaries.

Farmers are seeking to secure their farm boundaries by managing pests, weeds and diseases for two reasons - to be good farmers and to remain financially viable. These two themes emerged from the interview data and it became clear that these were motivating reasons for farmers to practice incidental biosecurity. Currently, in the epidemiological literature, farmers are usually portrayed as actors who should be contributing more to post-border biosecurity. In contrast, this study found that farmers are not only engaged in biosecurity, but that biosecurity concerns are integrated, often incidentally, into everyday farming practices. Incidental biosecurity adds to the academic literature by introducing a new way to view farmers’ active participation in biosecurity management. This contribution broadens the knowledge of post-border practices that farmers are engaged in and signals the importance of considering their tacit knowledge and notions of good farming.

Research Question 3 – How do farmers manage risks and in what ways does this impact their ability to implement the recommended biosecurity practices?
Farmers manage risks in the context of other farming risks and priorities. They prioritise market access, endemic disease and the management of climatic risk. Farmers’ ranking of risk priorities change depending on the season, and the challenges they are facing at any given time. Despite increased interest by governments in on-farm biosecurity, farmers manage in a holistic sense. Farmers view biosecurity as one part of good farm management. Biosecurity is not independent from managing their whole farm, everyday they are securing their properties by engaging in the on-farm biosecurity practices (discussed in Chapter 5), which aligns with the notion of good farming. For these farmers, biosecurity is part of their business and, as such, they have been managing risks throughout their entire farming careers. The significance of this finding highlights the need to consider farmers’ perceptions and risk knowledge when developing frameworks for managing biosecurity risks.

Governments have introduced the notion of shared responsibility. For shared responsibility to be workable farmers must have the capacity to adopt additional tasks that were previously fulfilled by departmental personnel. Risk perceptions differ; the interviewees were concerned with endemic risks, compared to governments concern of exotic threats. This is evidenced by the governments’ injection of funding into the impacts of FMD, from economic to emergency preparedness (Animal Health Australia, 2014c; Hafi et al., 2015; Harris, 2014). Therefore, until risk priorities better align, tensions between governments and farmers are likely to remain.
Tensions exist between farmers and government, in part because trust has been broken between the two parties. Over time participants have lost trust with governments’ ability to perform their biosecurity roles and responsibilities. For example, farmers’ first-hand experience of inconsistencies in OJD management and lax airport surveillance make them question the effectiveness and necessity of recommended biosecurity practices. Through these avenues it can be appreciated how farmers have lost trust with governments. Similar to other studies that report farmers’ loss of trust in governments (Enticott, Maye, Fisher, Ilbery, & Kirwan, 2014; Palmer, Sully, et al., 2009; Wynne, 1992a), the findings of this thesis demonstrate the impact this may have on the reception of biosecurity messages.

The findings in this thesis contrast with those of Palmer (2009) because WA farmers utilise the state Department of Agriculture whereas NSW farmers access information and biosecurity expertise from the LLS at the regional level. State department workers have more territory to cover as positions continue to be retrenched, meaning farmers have less face-to-face interaction, and this could negatively impact their willingness to participate in recommended practices. This means that farmers in NSW receive regionalised assistance with some biosecurity practices, as the LLS operate as a link between farmers and the DPI. The unique structure of the LLS in NSW that houses biosecurity professionals such as vets, compared to every other Australian state or territory, suggests that NSW farmers have greater access to regional expertise. However, the 2014 amalgamation has decreased the number of
regional staff that are available to assist farmers, which further strains the relations that are necessary for successful biosecurity risk management. Risks are managed by following best practice and given farmers’ lack of trust in the governments’ ability to manage biosecurity this may jeopardise the uptake of recommended practices in an exotic outbreak.

Farmers meet many of the recommendations as set out by government and industry. It is possible to ascertain government and industry recommendations from the graziers’ manual, where all graziers (specifically managers of cattle, sheep, goats and camelids (Animal Health Australia, August 2012, p. 4) are categorised together and therefore presumably have the same biosecurity issues. The manual tends to present biosecurity issues as being similar in nature, a one-size-fits-all approach, but it is also important to consider other knowledge. The Farm Biosecurity website houses the digital copy of the graziers’ manual, where farmers can locate government recommendations. Farmers interviewed in this study were carrying out the majority of practices as recommended by government and industry to manage pest, weed and disease issues (see Chapter 5).

To address the part of the research question that refers to farmers’ uptake of government recommendations the seven principles as outlined in the graziers’ manual follow. The findings show that these farmers meet and follow many of the listed biosecurity recommendations:

Principle 1: Livestock – Manage the introduction and movement of livestock in a way that minimises the risk of introducing or spreading infectious disease (Animal Health Australia, August 2012, p. 8).
These farmers purchase livestock using the NVD, and enter data into the NLIS. They observe new stock for signs of ill-thrift before integration with other mobs and they do not purchase livestock from sale yards. They also monitor boundary fences.

Principal 2: People, equipment and vehicles – People, equipment and vehicles entering the property are controlled to minimise the potential for property contamination (Animal Health Australia, August 2012, p. 9).

These farmers generally have one access road to the farm.

Principal 3: Feed and water – Quality of stockfeed and water is fit for purpose (Animal Health Australia, August 2012, p. 10).

Most farmers have enough feed for their animals (the exception being through the back-to-back drought periods in the 2000s). Some farmers buy in hay to feed their livestock during leaner periods and buy from farmers who they know to have good biosecurity and the same weeds. When feeding out bought in feed these farmers limit the area in each paddock to spread out the feed in case other weeds are present. Farmers also monitor the water troughs in the paddocks.

Principal 4: Feral animals/wildlife/weed control – Minimise the potential for wildlife and domestic or feral animals to introduce diseases to livestock (Animal Health Australia, August 2012, p. 11).

These farmers recognised foxes as the biggest feral animal problem for their sheep enterprise, and as such they all participate in the fox baiting programme. In addition, they shoot feral animals and monitor fence lines, which will also minimise the chances of other feral animals from entering the property, e.g. kangaroos and wombats (who may carry weed seeds). To control the weeds farmers have a spray programme in place.

Farmers know the signs of ill-thrift to look for in livestock because they have a lifetime of experience managing endemic diseases. Farmers know to monitor their stock with greater frequency during seasons where the risk of contracting a disease is higher, for example, when flies may cause body strike. They will contact a vet when many sheep die and when they cannot self-diagnose.

Principle 6: Staff instruction – All staff and contractors understand the importance of the biosecurity requirements for the operation in which they work and can implement the agreed practices for which they are responsible (Animal Health Australia, August 2012, p. 13).

Most farmers work with family members. On these particular sheep properties in this study, only three farmers employ other full time staff, in addition to family labour units, and they have been working alongside them for many years. In these cases they are familiar with the necessary biosecurity requirements, how to contact the local vet if necessary and how to identify sheep of ill-thrift. Other contractors such as mulesers and shearers are brought onto the property and most often have been working with the particular farmer for a number of years, and therefore know their biosecurity requirements.

Principle 7: Carcass, effluent and waste management – Disposal of dead animals and waste is managed to minimise the spread of disease (Animal Health Australia, August 2012, p. 13).

Farmers have a particular place on the property where they dispose of carcasses.

The generic wording of the recommendations means that not all are applicable to sheep farmers. Therefore, I conclude that farmers are meeting
the government recommendations as defined in the graziers’ manual. This study has shown farmers’ management of endemic problems in ways that are not reported in government and industry documents. It has been useful to include farmers’ perspectives as they are at the forefront of managing biosecurity problems. The generic nature of biosecurity recommendations is encouraged by Enticott, Franklin and Van Winden (2012) because it means that practitioners (vets and farmers) can adapt the practice to various situations. They argue that ‘flexibility is an important element of biosecurity behavioural change initiatives’ (Enticott et al., 2012, p. 336). Considering that Australian governments are seeking farmers to change their biosecurity behaviours, greater awareness is needed that flexible guidelines allow local interpretations.

These sheep farmers’ biosecurity practices have changed very little over the course of their farming careers. It could therefore be argued that farmers’ practices are overlooked in studies that present them as not participating adequately in biosecurity. Sheep are often run as part of a mixed enterprise and therefore studies in the UK present cattle and sheep practices together (Heffernan et al., 2008; Hovi, McLeod, & Gunn, 2005; Sahlstrom et al., 2014), and Palmer’s (2009) work in Western Australia also combines the two species. This study differs in that mixed enterprises in the Riverina region are usually crop and sheep, and I was only interested in the sheep side of the business. However, mixed crop farming meant that these farmers were particularly weed vigilant because they have a wider understanding and knowledge of the impact
of weeds on their business. This shows that farmers’ biosecurity knowledge and practices are intertwined, and that their skill set has developed over their farming career. I have challenged existing epidemiological studies across the various livestock industries that assert farmers have poor and inconsistent on-farm biosecurity practices (Casal et al., 2007; Heffernan et al., 2008; Toma et al., 2013). It has been shown that farmers are ‘doing’ biosecurity on-farm in various ways that are not always recognised as such, and that these contribute to government recommendations as encapsulated in the graziers’ manual.

Local biosecurity knowledge is often overlooked and part of the reason for this problem surrounds the definition of biosecurity; it means different things to different people. Findings from this study show that farmers’ definitions of biosecurity are different to scientific and government definitions. A consequence is that farmers may not recognise particular everyday practices as biosecurity. Currently, government definitions of biosecurity are narrow, whereas if they were broadened it would help in appreciating farmers’ knowledge and the breadth of practices in which they engage.

Governments want to see improvements in on-farm biosecurity. However, participants did not perceive the need to improve their current practices. The findings in this study indicate that farmers are already engaged in many on-farm biosecurity practices. Therefore, governments’ perceptions of their practices are inaccurate. Governments are focused predominantly on exotic threats, whereas farmers manage endemic problems. From a government point of view, these practices need to be performed as a
safeguard against biosecurity risks and to assist with food security. The practices these farmers are required to do for food security and compliance purposes when trading sheep are to complete the NVD and input information into the NLIS database. This means that farmers must have a PIC number\textsuperscript{36} for their property and enter that number on the NVD form. The farmer then has seven days with which to upload the NVD onto the NLIS\textsuperscript{37} (Department of Industry and Investment & Livestock Health and Pest Authorities, May 5th 2011, p. 24). These are the only two required practices for compliance purposes. Current compliance requirements in the sheep industry appear minimal, and only occur when sheep are traded. The other practices (including using the SHS when trading sheep) are recommended.

Other incidental biosecurity practices are completed for reasons of being a good farmer, which farmers have been doing for their entire farming careers, and happen to match many of the recommended practices. Given that recommendations have only been written since 2012, and these farmers have a lifetime of biosecurity knowledge and experience. This shows that they choose to engage in practices that contribute to notions of good farming and simultaneously achieve government recommended biosecurity practices. Good farmers not only adhere to best practice they are known in the district/region through social networks for their production successes and management.

\textsuperscript{36} PIC numbers have been a legal requirement since September 1\textsuperscript{st} 2012 (Department of Primary Industries, 2012).

\textsuperscript{37} The NLIS has been compulsory since July 2010 and ‘non-compliance means no sale’ (Meat and Livestock Australia, 2010).
practices. Many of these farmers exhibited these behaviours and it became evident when interviewees spoke of other interviewees. This further demonstrates that ‘doing’ biosecurity is just part of business. However, there is always space for improvement.

One of the gaps between recommendations and practice identified in this study is farm hygiene, or principle 2. For farm hygiene to improve, behaviour change of a variety of players needs to occur. Specifically, in the Riverina sheep industry, this would include behaviour change from farmers, agronomists, LLS rangers, vets, stock agents, telecommunication workers, truck drivers, shearers and other contractors. The findings showed that good biosecurity behaviours are the responsibility of individual agri-food chain actors, not just the farmer. Other actors who enter farms most often do not participate in practices such as hand washing, disinfecting and boot and tyre cleaning. Since the NSW biosecurity vision includes ‘government, industry and the people of NSW working together’ (NSW Government, May 2013, p. 1) it requires everyone to be responsible for their decision to participate, or not, in on-farm biosecurity practices.

It is difficult to know what the economic benefit is for doing some practices (Gunn et al., 2008, p. 310), as the cost and time involved in changing behaviours in these players in the post-border agri-food chain, not just sheep farmers, may mean other practices are sacrificed. For example, if truck drivers took the time to wash down their vehicles before/after entering each property, they may not have the time to complete all of the transport
jobs needed in one day. The findings in Chapter 5 showed that farm hygiene practices tend to be overlooked by farmers in the current non-outbreak time. This is not uncommon, as Swedish livestock farmers assert that biosecurity practices will be heightened in the event of an outbreak (Noremark et al., 2010, p. 233). The farmers interviewed in this study receive relatively few visitors on-farm, unlike examples from abroad where people movements are a frequent occurrence. This appears positive for mitigating transmission risks and is perhaps one reason why farm hygiene practices are for the most part, absent.

One way to overcome this deficit of biosecurity is to make farm hygiene practices more explicit. An example of this could be in a trialling format at on-property ram sales. Usually utes and trailers come onto the property and farmers walk among the area with penned rams to make their visual selections. Both of these activities open up possibilities for potentially infected organic matter to spread across properties. Best practice recommends the provision of foot baths with truck wash and hand sanitiser (pers comms. April 2nd 2014). To manage the risks associated with vehicles it is best to either provide cleaning equipment or park in designated areas where farmers can later inspect for new weeds. It is an opportunity where other farmers can see what farm hygiene looks like, and because there is a level of trust towards the stud owner for being a good farmer, this is one possible pathway for biosecurity practices to be adopted at the local level.
In addition, ram sales have the traceability aspect with the use of Vendor Declaration records of the sale and movement of sheep, which appeals to authorities in outbreak situations. Stud owners are a useful starting point to assist in the dissemination of farm hygiene practices; they have a captive audience, already implement biosecurity practices and are considered trusted sources among the local sheep farming community. Much of the stud owner’s business is reliant on biosecurity practices being followed, and commercial farmers acknowledge this. This way it also gives the stud owner the opportunity to trial on-farm and let others see and experience first-hand what the farm hygiene aspect of biosecurity looks like.

This study shows that adoption of biosecurity practices is more extensive than previously reported, although some challenges exist for further adoption. The study has shown that lack of knowledge is not the issue affecting farmers’ implementation rates. Instead, it draws attention to some of the barriers farmers face, including costs, time, labour and retirement. These barriers result in some biosecurity practices that are not followed through. For example, if farmers follow best practice for vaccination with 6 in 1, then a booster shot will be given at weaning (Lloyd & Playford, June 2013, p. 46). However, some farmers do not have time and/or labour to re-muster lambs and give the booster shot. The farmer, who chooses to participate in these short cuts, assumes a level of risk. Reasons for non-adoption or barriers to adoption are borne from critiques of Rogers classic adoption model. Farmers prefer to adopt new practices within the parameters of their similarly
interested social peer group (Vanclay & Lawrence, 1995 p105). Although animal health or disease farming scripts are embedded in the rural culture and contribute to farmers’ identity and behaviour (Enticott & Vanclay, 2011, p. 293), there are some examples where ‘normal’ farming scripts exclude biosecurity. An example of a normal farming script that excludes biosecurity is when visitors or farm workers (such as contractors, transport operators or LLS rangers) enter a property and are not required to participate in farm hygiene such as hand washing, boot and tyre washing. Farming scripts can be identified as dialogue that farmers know and use, and has been used in biosecurity studies around animal disease, specifically in regards to farmers’ identity, accountability and behaviour (Enticott and Vanclay, 2011, p293). Social interest in such practices needs to exist in order to increase their biosecurity practices.

**The problems with current biosecurity messages**

The identified problems drawn from this study are (a) the lack of sheep industry specific guidelines, (b) the delivery method of national biosecurity messages and (c) farmers as the target group of message recipients, rather than including the broader rural and regional populations. Biosecurity is a shared responsibility between ‘government, industry and the community’ (NSW Government, May 2013, p. 3), and farmers seem to be the only community
participants being targeted. This is an issue because spaces beyond the farm gate also require surveillance and monitoring for biosecurity problems. Rural populations could be helpful in this quest and therefore should also be exposed to biosecurity messages. These problems create barriers for farmers and rural communities to adopt further biosecurity practices such as farm hygiene.

The lack of sheep industry specific guidelines

One key limitation in farmer adoption of recommended biosecurity practices is the absence of a sheep industry specific biosecurity manual. It is identified as a limitation because defining what good biosecurity is in the Australian sheep industry is difficult. It requires piecing together extension material and using epidemiological literature, which essentially provides a checklist of practices to build an idea of what good biosecurity involves. To date ‘correct biosecurity behaviour’ in Australia involves preparing health statements and Vendor Declarations when trading sheep (Denney, 2007) and again this advice applies to all livestock industries. This barrier means that farmers must continue to use their knowledge to guide their biosecurity behaviour.

Presently this system appears to work, even with government and industry focus on increasing awareness. Good biosecurity on a sheep property is not explicit and more industry specific guidance could be useful. A sheep industry biosecurity manual is needed as a resource that gives guidelines of
what a good biosecurity system entails, as per other Australian livestock industries. This would provide information to sheep farmers that is more closely related to their practices than the generic biosecurity information found in the graziers’ manual.

Governments and industry are trying to appeal to graziers’ by encouraging groups on a regional level to discuss and implement their own strategies. A new ‘buyer beware’ system for OJD is being encouraged by industry (Sheepmeat Council of Australia & Wool Producers Australia, 2013), which places greater decision-making power on individual farmers for the risks of buying in sheep, rather than the old system where stock movements were restricted by lines drawn on maps. This form of self-regulation represents a shift in how this risk is framed by authorities. Governments once considered animal health their responsibility, however, now in line with the neoliberalist agenda, it has shifted to be the responsibility of farmers (Enticott, 2008a, p. 434). This removes the responsibility from government and places it upon farmers, who seem to be only conscious of this since the removal of extension and now the combining of LLS; this is an example of biosecurity and neoliberalism being intertwined (Maye, Dibden, et al., 2012, p. 157).

The problem with the delivery method of national biosecurity messages

The current problems with the delivery of biosecurity messages can have implications for extension and education programmes. Biosecurity messages
and the mistakes made in their delivery can be mirrored to that of environmental issues in the Australian context. The Australian model for NRM delivery is through regional groups, and it is aimed at farmers rather than at the community level (Palmer, 2009, p. 42). Similar trends can be seen when addressing biosecurity problems.

The traditions of the top-down approach to extension are visible in the current transfer of biosecurity recommendations, which means that similar problems with non-adoption will be faced. However, this time there are additional difficulties in the transfer of knowledge that are exacerbated by the lack of on-ground staff to assist in the delivery of messages. The findings of this study show that one barrier is the lack of on-ground personnel available to disseminate biosecurity information. The recent amalgamation of the LHPA and CMAs, and the creation of the LLS, adds pressure to the handful of regional biosecurity professionals whose jobs survived the cuts. With government providing awareness and crisis management, the top-down approach relies on biosecurity professionals to pass on the information. This demonstrates that government’s preparation and rapid response protocols are in place. Farmers are busy managing endemic diseases, which leave rural communities to take on a larger biosecurity role.

Currently many messages are delivered via the Farm Biosecurity website (Farm Biosecurity, n.d), and even the name of the site is suggestive that it aims to only serve those on-farm. It is unclear where the equivalent information, in website form, is for the rest of rural and regional populations.
The current NSW biosecurity strategy labels ‘landowners, occupiers and the community’ as being responsible for surveillance and monitoring practices to detect risks early (NSW Government, May 2013, p. 26). People are part of the shared responsibility approach and should assist in carrying out surveillance in post-border spaces. However, the literature and biosecurity messages are not aimed at rural and regional people, and therefore it leaves spaces beyond the farm gate as risky.

Problems with targeting farmers to do more biosecurity

Currently, targeted information is not presented in a farmer friendly way. Some of the problem with government recommendations is that knowledge transfer activities are currently not focused on improving on-farm biosecurity, as a gap exists in evaluating the impact of biosecurity information on farming practices (Kruger et al., 2009). Although increasing on-farm biosecurity practices is the goal, government and industry dissemination of knowledge is more interested in awareness-raising than having measurable outcomes. For example, the current goal of AHA’s Farm Biosecurity Programme is to improve awareness among producers (Animal Health Australia, 2014b, p. 22). Measures of success of the programme are via a survey where farmers are asked to provide details such as defining the term biosecurity, identifying biosecurity benefits to the farm and identifying sources of biosecurity
information. For example, the AHA survey found that most farmers monitor their livestock for disease and pests (Animal Health Australia, April 2014).

This thesis argues that such practices have been carried out farmers’ entire career, rather than as a result of awareness of the Farm Biosecurity programme. This demonstrates how farmers are in fact meeting government recommendations as part of their routine farming practices, rather than as a consequence of following biosecurity guidelines. Further, there is currently no concrete way to measure the link between information dissemination and visible improvements to on-farm biosecurity. Therefore, the challenge is to better integrate government and industry understandings of farmers’ tacit knowledge and current contributions to post-border management practices. Although the goal may be behaviour change, the activities governments and industry are currently invested in focus on awareness-raising. The next step is to move beyond awareness and evaluate the impact it has on practice. The focus on raising farmers’ awareness may be undermining the multitude of biosecurity practices farmers are engaged in and their tacit knowledge of how to manage them. Further consideration of how farmers view risks and the other priorities is needed.

Conclusion

39 Monitoring and evaluation projects may assist in highlighting areas of practice that have improved as a result of awareness-raising programmes.
This chapter set out to address the key research questions and draw conclusions from the findings of Riverina sheep farmers’ biosecurity knowledge and practices in line with the theoretical framework of good farming. The key finding was that farmers’ biosecurity practices are not accurately represented in the current literature. Epidemiological studies often conclude that farmers have a biosecurity knowledge deficit and this explains their low engagement in on-farm biosecurity and surveillance practices. In contrast, this study has shown that farmers are knowledgeable biosecurity practitioners, who are adept at managing their properties and are backed by a lifetime of knowledge and experience. These farmers participate in on-farm biosecurity and their continued engagement with such practices, beyond the few required for compliance, demonstrates their desire to be good farmers who secure their properties. They are, in practice, following many government biosecurity recommendations, referred to as incidental biosecurity. These farmers’ incidental biosecurity practices are in place to manage endemic problems, not exotic threats.

This project helps to improve the understanding of the various barriers influencing implementation of biosecurity practices. The current barriers to adoption are the lack of a sheep industry biosecurity manual, the continued top-down delivery of biosecurity messages, cutbacks to government extension staff, and the lack of inclusion of rural and regional populations in monitoring and surveillance practices. One way to overcome these issues is to use existing on-farm extension to further promote biosecurity best practice.
Governments and industry should consider farmers’ perspectives when developing extension material and delivering it in ways that adhere to farmers’ preferences.

The contribution to the social science biosecurity literature is addressed by understanding biosecurity from the farmers’ perspective. This is achieved by showing that farmers play an active role in post-border biosecurity management, and the ways in which their practices align more closely with government biosecurity recommendations than is currently recognised. Additionally, applying the notion of good farming as the theoretical framework to biosecurity has not previously been done before. Good farmers are known in the community, who seek out localized best practice management, do on-farm biosecurity and produce robust livestock. Understanding farmers’ risk perceptions has shown the on-farm priorities, such as time and labour, which limit the uptake of particular biosecurity practices. This also has implications for the uptake of further biosecurity practices. Farm priorities shift when a threat becomes evident. It suggests that practice will not change until an event occurs that will cause biosecurity to feature higher on the list of priorities. The final chapter summarises the key contributions to scholarly knowledge found in this thesis and considers further research directions.
Chapter 8 – Conclusion

The aim of this research was to understand biosecurity from the farmers’ perspective. Farmers’ perspectives, specifically their knowledge and practices, have received little attention in the social science biosecurity literature. As farmers are the vanguards of post-border biosecurity, it is important to consider their point of view in a world where biosecurity outbreaks are becoming more frequent and have the potential to cause significant economic and social devastation.

This project sought to contribute to knowledge in this area by way of three research questions. To address the research questions the project adopted an interpretivist approach. This approach was chosen because it enabled an emic understanding from the farmers’ perspective, thereby providing in-depth insights into their biosecurity knowledge and practices. Such an approach differs from much of the existing epidemiological research, which tends to adopt a positivist approach, with an emphasis on capturing farmers’ biosecurity attitudes and behaviours. The study captures perspectives of on-farm biosecurity knowledge and practices that are not explored in the existing literature, specifically in relation to the notion of good farming. This chapter summarises the key research findings and demonstrates the contribution to scholarly knowledge from the three themes identified in the literature review and the over-arching theoretical perspective. Finally, this
chapter discusses the implications of the research and possible directions for future research.

**Key findings and contributions to literature**

Farmers’ perspectives are often absent from the biosecurity literature (Enticott, 2008b, p. 1568), and this study set out to address this issue. This study shows that farmers have a lifelong knowledge of managing biosecurity on-farm, and they draw upon a breadth of sources to extend their knowledge. They have a local understanding of their environment and livestock, and are best placed to notice anomalies. They are the first to notice any changes to the environment and livestock, which signifies the importance of the role of farmer knowledge in biosecurity. The following sub-sections demonstrate how this study has built upon each of the areas present in the scholarly literature – boundaries, risk and trust, and scientific and local knowledge, and the overarching theoretical framework of good farming.

*Farms as spaces of biosecurity*

The literature categorises boundaries into territorial and conceptual, which are politically defined, maintained and enacted. The categories using
distinguished with terminology such as ‘inclusive’ and ‘exclusive’ (Migdal, 2004), ‘us’ and ‘them’ (Lamont & Molnar, 2002), ‘clean’ and ‘dirty’ (Bashford, 1998), and ‘othering’ (Heap et al., 2012). Boundaries are socially constructed by governing agencies from the international level down to the local level.

Since 2001, government interest in biosecurity has amplified (Donaldson, 2008) and as a result, governments view farms as risky spaces that must be managed to maintain the integrity of borders for trading purposes. Traditionally, in countries such as Australia, borders were managed through the enforcement of quarantine restrictions at national border crossings (Bashford, 2006). However, a shift occurred and nowadays governments attempt to control biosecurity threats by defining and managing boundaries at different spatial scales (Maier, 2000). The increase in the regulation of farming space means farmers’ practices are under increased scrutiny to practice biosecurity in order to ensure that ‘clean’ spaces exist. Farmers’ role in the construction, negotiation and surveillance of boundaries is recognised as important in the social science literature (Enticott, 2008b; Wynne, 1996), however, it has only been explored to a limited extent. Despite governments attempting to control post-border spaces, pests, weeds and diseases ignore human-negotiated boundaries’, it is farmers’ every day role to manage these risky spaces. Farms are one example of a space of biosecurity negotiated by governing agencies (Enticott, 2008b, p. 1575), and although farmers manage farm spaces, they are often excluded from the negotiation of spatial boundaries.
The findings from this study contribute to the literature by illustrating how farmers define boundaries as part of their everyday efforts to manage pests, weeds and diseases. Additionally, the findings show how farmers manage farming spaces in a way that meets their existing priorities and goals, while simultaneously contributing to broader biosecurity recommendations. Farmers manage farm boundaries in ways that make sense to them. For example, the farmers in this study construct territorial boundaries around and within their property through the use of fences. Within farm borders, land is managed in accordance with existing priorities of addressing seasonal endemic pest, weed and disease risks. Farmers survey boundaries frequently to ensure they are maintained. This research has considered how farmers maintain and enact boundaries on-farm, and it has shown their active participation in keeping out the unwanted through good biosecurity management.

The increased emphasis by governments in shared responsibility, along with less funding for extension, means that farmers are expected to take greater individual responsibility for biosecurity within their property boundaries. In effect, farming practices are becoming crucial in the construction and governing of farms as spaces of biosecurity. Shared responsibility is a cost-sharing measure that in the NSW context envisions ‘the people of NSW working together’ (NSW Government, May 2013). This means sharing in the management of farming spaces. However, as public funding for extension is increasingly being withdrawn, farmers are required to take greater responsibility for the self-governance of their farms. Farmers are responsible
for managing their properties, and alerting biosecurity personnel when they see anomalies. As farmers receive less support from state government agencies than they once did, it could be argued that post-border biosecurity looks like a shift in responsibility rather than greater sharing of responsibility. This study has enhanced understanding of what shared responsibility looks like in practice by showing the implications of the withdrawal in extension funding for farmers’ biosecurity practices.

Farmers’ responsibility for risk management and surveillance and the role of trust

The concept of risk is relevant to biosecurity studies because governments, industry, scientists and farmers assign value to it. Each level of governance, from international to local, assigns roles and responsibilities to manage risks. Biosecurity governance at the international level is regulated by the WTO, and its risk framework includes the SPS agreement (Miljkovic, 2005). The subsequent levels of governance vary from country to country and adapt WTO guidelines to suit. The Australian national government has constructed shared responsibility as a way to coordinate relevant actors’ roles and responsibilities to achieve good biosecurity outcomes. A degree of trust is necessary to ensure that roles and responsibilities are fulfilled. The government constructs perceived risk around biosecurity, and these are in line
with neoliberalist ideas, where the government encourages individuals to exercise surveillance, monitoring and self-regulation (Lupton, 1999, p. 25).

Farms have always been managed privately. However, with increasing government interest in biosecurity risk management farm space is no longer a private matter. Studies show that farmers currently manage biosecurity risks poorly and inconsistently (Casal et al., 2007; Gunn et al., 2008; Heffernan et al., 2008; Noremark et al., 2010). This means a level of trust is needed to ensure that farmers fulfil the risk management recommended by governments. However, it is argued that the absence of trust between farmers and governments is based on past experience (Palmer, 2006), and is a result of decreased agricultural funding over time (Palmer, Sully, et al., 2009). ‘Trust is an essential component of modern socio cultural knowledge’ (Fischer, 2005, p. 58), and low levels of trust between farmers and governments may be problematic during an outbreak situation because farmers may not adhere to recommended practices.

This study found that farmers participate in biosecurity incidentally as part of the broad management of farming risks. Part of this risk management strategy is surveillance of their land and livestock. The findings differ from the existing epidemiological literature because these farmers are active biosecurity participants who ‘do’ some form of biosecurity every day. Until now, scientific studies of biosecurity have viewed farmers as passive participants who mostly do not follow recommended practices (Racicot et al., 2012; Sarrazin et al., 2014). These farmers have a lifetime of knowledge and experience of
biosecurity management, which aligns incidentally with most government recommendations. The term, *incidental biosecurity*, was developed to capture farmers’ biosecurity behaviours that align with risk management strategies endorsed by governments and industry.

Farmers perceive endemic risks to have the greatest impact to their business and as such focus on managing those pest, weed and disease problems that present risks. The main limitation of farmers addressing endemic biosecurity concerns is that they are less concerned with exotic pest, weed and disease risks that may have more significant implications for international trade. Previously, Australian studies have identified that the main risks to farmers are neighbours, feral pests (Barclay, n.d), peri-urban landholders (Maller, Kancans, & Carr, 2007) and low rates of reporting livestock deaths to vets (Palmer, 2009). Instead of concluding that farmers’ uptake of biosecurity is poor (Heffernan et al., 2008; Sarrazin et al., 2014) and suggesting education as a way to improve implementation rates (Laanen et al., 2014), this study shows the specific areas of risk management where farmers focus their practices. This study has identified the risks that these sheep farmers consider to be important and given the agenda of shared responsibility it means that governments must place more trust in farmers to follow the recommended practices. The levels of trust governments assume is a result of fewer extension personnel on the ground, as they are now largely reliant on relationships between vets and farmers to ensure the reporting of livestock deaths or illness. These farmers focus on endemic risks to their business,
which differs from the national government priority of exotic threats. Endemic risk management is shaped by farmers’ experience, goals and priorities.

*The significance of farmer knowledge for biosecurity*

Veterinary epidemiology studies of biosecurity often fail to appreciate local farmer knowledge and farmers’ perspectives. The implications of this are that biosecurity messages are sometimes rejected by farmers, because of their limited input (Enticott, 2008b, p. 1576). Scientific knowledge is not the only form of expertise. In other social science studies, expertise at the local level is demonstrated by farmers’ understanding and knowledge of their particular environment, which scientists fail to appreciate (Enticott, 2008b; Wynne, 1996). Livestock health decisions are in the hands of farmers (Palmer, Sully, et al., 2009, p. 33).

Farmers’ tacit knowledge of their local environment and their expertise in stock management means that they are best placed to notice changes, which is significant for biosecurity purposes. A lack of knowledge of biosecurity practices is considered a barrier to adoption facing farmers (Roche, Jones-Bitton, Meehan, Von Massow, & Kelton, 2015), therefore, extension and education is suggested by scientists as a way to improve on-farm implementation rates. However, extension as the tool to improve farmer knowledge has proved limiting as a way to transfer knowledge because ‘extension needs to be relevant to the needs of the farmer’ (Vanclay, 2004, p.
Presently for the sheep industry there are only endemic biosecurity problems that farmers already know how to manage, and government extension is focusing on exotic threats. This suggests that farmers may not currently be responsive to biosecurity extension because of a lack of relevance to their farming business. The adoption of new technologies and ideas occurs when they align with farmers’ personal goals (Vanclay, 2004, p. 215).

Farmers’ tacit knowledge of their environment and livestock plays a vital role in disease reporting behaviour. Palmer’s work shows that farmers’ disease reporting is reliant on trust built with local vets and government bodies (Palmer, Fozdar, et al., 2009). This research has built on Palmer’s work by exploring in more depth how farmers’ tacit knowledge of endemic diseases influences their reporting behaviour. These farmers have a strong capacity based on their previous farming experience to diagnose the problems they detect during farm surveillance. This impacts their reporting behaviour because their experience and belief in their own skill set means that they have a limited need to confer with a vet. Additional constraints of time, cost and the trusting relationship they have with the local vet may also play a factor in reporting behaviour.

Farmers’ lived experience and knowledge also calls into question the notion that further education is necessary to increase the implementation of biosecurity practices. Scientific studies often find that farmers are unwilling to invest in biosecurity to secure their farm, and a common barrier is that they have no belief that biosecurity practices actually prevent diseases (Lanyon,
Anderson, & Reichel, 2015); alternatively they are not participating in biosecurity practices and farmer education is recommended to counter this deficit (Laanen et al., 2014). However, Chapter 5 outlined the variety of pest, weed and disease practices farmers’ are engaged in, demonstrating the breadth of their knowledge of how to manage these risks. These practices demonstrate farmers’ knowledge through their everyday engagement with biosecurity management. Palmer’s study also found ‘many farmers were well-informed about biosecurity’ (2009, p. iii), however, there was little evidence of this knowledge being implemented on-farm.

This study has identified that the particular practices associated with farm hygiene are currently being overlooked, which are encouraged in outbreak situations. In Australia, government recommendations encourage farm hygiene as part of good biosecurity, but currently there is no specific education initiative that addresses farm hygiene. A time to make good farm hygiene practices more explicit would be at on-farm field days, where farmers can see and experience processes such as tyre and boot cleaning, and from there they can consider how to adapt such practices to their own farms. Improving implementation rates of farm hygiene offers additional protection against both endemic and exotic threats. As per overseas, once an outbreak occurs, such as FMD, it affects attitudes towards biosecurity because farmers are more aware of the need to implement practices such as disinfecting, using footbaths and running closed herds (Lanyon et al., 2015, p. 162). Therefore, contrary to scientists concluding that education programmes are the solution
(Rosanowski et al., 2012), education alone seems unlikely to improve implementation rates.

Barriers to the adoption of more biosecurity practices on-farm are regularly framed by farmers’ lack of knowledge; other barriers include finances, time and droughts (Barclay, n.d). However, this study has shown that farmers’ tacit knowledge plays a significant role in the management of endemic pests, weeds and diseases. This study confirms the importance of local farmer knowledge (Enticott, 2008b; Maye, Ilbery, et al., 2012). One of the notable differences between this study and the available academic literature is the identification of sources of farmers’ knowledge. In Chapter 4 the sources of farmers’ biosecurity knowledge were categorised into informal and formal. This labelling of sources of information has not previously been applied to biosecurity, and it demonstrates the complex networks through which farmers obtain and receive biosecurity information. This study also confirms that Australian farmers still favour face-to-face engagement as a way to transfer information (Bamberry et al., 1997; Kilpatrick & Rosenblatt, 1998; Kruger et al., 2009).

Notions of good farming and biosecurity

Each of the three themes boundaries, risk and trust, and science and local knowledge feed into the theoretical framework of the notion of good farming by showing the connection between how farmers frame biosecurity
management and how their knowledge and practices contribute to their definitions of good farming. These farmers’ knowledge and practices are built over a lifetime of managing their properties and securing them from endemic pests, weeds and diseases. They may not refer to their everyday on-farm tasks as biosecurity, however, the various practices fit into the broader biosecurity categories of pest, weed and disease management. Farmers’ tacit knowledge of how to manage their farms and incursions has been demonstrated by interviewees by their enthusiasm to discuss what they do everyday and stories of managing outbreaks. Farmers’ biosecurity knowledge and practices are part of being a good farmer, as biosecurity is part of their overall farm management.

This theoretical perspective has not previously been applied to biosecurity, and by doing so is a contribution to the broader farming literature. Other Australian studies (Bamberry et al., 1997; Gray & Phillips, 2001) and some from abroad (Burton, 2004; Haggerty et al., 2009; Silvasti, 2003) have not focused on biosecurity practices and farmers’ knowledge. Good farming is relevant to this study as these farmers motivation to participate in biosecurity and continually update their knowledge of practices is evidence of their aspiration to be good farmers. These farmers definitions of good farmers, whilst a dynamic concept, is evidenced by the production of robust livestock, few visible weeds in paddocks and participation in the fox baiting program, all of which require active biosecurity management.
The application of good farming to biosecurity is a useful way in which to view the breadth of farmers’ knowledge and practices. It has been argued that farmers do biosecurity for reasons of wanting to be seen as good farmers. Good farmers have knowledge of seasonal risks and manage their farms accordingly. They are known in the local community and regional networks as being good farmers. Their reputation is a result of both production and visual clues from their farm landscape. I now summarise the implications of this thesis and provide direction for future research into post-border biosecurity practices.

**Implications of the research**

This study shows first and foremost that a one-size-fits-all approach to biosecurity is limited in improving on-farm uptake of biosecurity practices. The generic wording of the recommendations in the graziers’ manual may be considered useful to some extent in providing farmers with flexibility in the interpretation and application of biosecurity (Enticott et al., 2012). However, farmers also need industry-specific guidance on which recommendations are the most important so they have the capacity to make informed choices about how they implement on-farm biosecurity in practice (Windsor et al., 2015). This represents a dilemma for governments in how best to promote improved biosecurity practices.
Given that governments desire to see an improvement in biosecurity practices, a greater understanding of farmers’ priorities is needed, beyond this region and industry. The findings from this study, specifically incidental biosecurity, may be found in other regions and other Australian livestock industries as a result of the generic guidelines provided by governments. This means that farmers’ biosecurity practices are not as well understood, as epidemiological studies assert, and how farmers interpret the guidelines to suit their situation must be considered. Therefore a major implication of this study is the need to pay greater attention to farmers’ tacit biosecurity knowledge and the various ways in which practices differ across different geographical, political and industry contexts.

The interpretive approach adopted in this study meant that I focused on farmers’ biosecurity perspectives, which are centred on managing endemic problems. Farmers know and practice management of endemic problems during non-outbreak times. Beyond the scope of this study is how farmers will manage during an exotic outbreak. This could be an area for future research.

Increasing awareness more broadly among the people of NSW, and moving beyond the targeting of farmers to improve their uptake of biosecurity could be useful. The usefulness of educating a wider array of people about the signs of incursion could increase the speed of anomalies being reported. Some issues brought to the attention of border security are made by the general public (Department of Agriculture, 2013). Queenslanders will have to take a more proactive role in 2016 when new laws oblige individuals and
organisations, beyond farmers, to know about biosecurity risks that pertain to their work and hobbies (Farm Biosecurity, 2015). Perhaps this is a model that other states can adopt. Therefore, it may be more useful to focus efforts on the broader public, specifically rural and regional populations, on problematic pests and weeds to increase the number of eyes able to monitor Australian land.

One of the findings from my research is that farmers’ practices align with many of the recommendations outlined by governments and industry. As a result, a direction for future research could be to investigate how to overcome the identified deficit area of farm hygiene present in farmers’ current practice. In Chapter 4 the literature shows that farmers have a biosecurity knowledge gap (Heffernan et al., 2008; Hernandez-Jover et al., 2008), and further research could challenge the view that there is currently a knowledge deficit. Future investigations of farmers’ biosecurity practices need to go beyond understanding the extent of the knowledge deficit and identify how existing knowledge influences their biosecurity practices. Farmers’ knowledge and focus is on endemic biosecurity problems, which may leave open spaces for exotic threats to spread quickly. However, until diseases such as FMD enter Australia and priorities are adapted as a result, it is likely that farmers will continue to rely predominantly on their existing knowledge, experience and goals to inform their biosecurity practices.
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Appendix A – Ethics Approval

29 July 2013

Ms Lileko Lishomwa
lileko@gmail.com
Protocol Number 103/2013/05

Dear Ms Lishomwa,

Your research proposal entitled “Post-border biosecurity – Farmers’ perspectives: on-farm biosecurity knowledge, practices and attitudes” has been reviewed by the School of Humanities and Social Sciences Ethics Committee.

The School Ethics Committee operates in accordance with the National Health and Medical Research Council’s National Statement on Ethical Conduct in Research Involving Humans.

I am pleased to advise that the project meets the requirements of the National Statement, and ethical approval for this research is granted for a twelve month period from 29 July 2013.

Final documents approved:
- Form 1 June 28th.pdf
- Form 2 June 28th.pdf
- Information sheet June 27th.doc
- Consent form June 27th.doc
- Interview topics for ethics.doc

The protocol number issued with respect to this project is 103/2013/05. Please be sure to quote this number when responding to any request made by the Committee.

Please note the following conditions of approval:

- all Consent Forms and Information Sheets are to be printed on Charles Sturt University letterhead. Students should liaise with their Supervisor to arrange to have these documents printed;
- you must notify the Committee immediately in writing should your research differ in any way from that proposed. Forms are available at http://www.csu.edu.au/__data/assets/word_doc/0010/176833/ehre_annrep.doc
- you must notify the Committee immediately if any serious and unexpected adverse events or outcomes occur associated with your research, that might affect the participants and therefore ethical acceptability of the project. An Adverse Incident form is available from the website as above;

www.csu.edu.au
CRICOS Provider Numbers for Charles Sturt University are 00005F (NSW), 01947G (VIC) and 02900B (ACT). ABN: 83 878 708 561
• amendments to the research design must be reviewed and approved by the School Ethics Committee before commencement. Forms are available at the website above;
• if an extension of the approval period is required, a request must be submitted to the School Ethics Committee. Forms are available at the website above;
• you are required to complete a Progress Report form, which can be downloaded as above, by 29 July 2013 if your research has not been completed by that date;
• you are required to submit a final report, the form is available from the website above.

The Committee wishes you well in your research and please do not hesitate to contact the Chair on telephone (02) 6933 2249 or email humgen@csu.edu.au if you have any enquiries.

Yours sincerely

[Signature]

Dr Emma Rush
Chair, Ethics Committee
Post-border biosecurity – farmers’ perspectives: on-farm biosecurity knowledges, practices and attitudes

Researcher: Lileko Lishomwa
Email: lileko@gmail.com
Telephone: 0409 799 197

Supervisor: Dr Vaughan Higgins,
Associate Professor in Sociology
Email: vhiggins@csu.edu.au
Telephone: 02 6933 4514

You are invited to participate in the research project 'Post-border biosecurity – farmers’ perspectives'. The aim of this project is to explore farmers’ knowledge and practices of pest, weeds and diseases on their properties and how they learn about biosecurity.

You will be asked to talk about your experiences in an interview in your own home or another suitable location. The focus of this discussion will be what you do on your farm to manage pests, weeds and diseases, and risk, in regards to animal health. It is hoped you will raise issues which are important to you to help the researcher understand the decisions you make from your point of view.

The interview will take about 1 hour. If there are topics not covered in this time frame, you will have the opportunity to complete a follow-up interview. As a participant, you will be asked if you are willing to have the interviews taped, and only with your permission will they be recorded.

If you decide to participate in the project you are free to withdraw at any stage prior to publication. You can also ask that some things we may discuss during the interview not be published in any form.

To ensure complete anonymity and confidentiality names will be changed and any distinguishing characteristics that are likely to make you recognisable by others will be omitted from publication or disguised. Records from the interviews will be stored separately from your name and address. Results from this study will be published in a PhD thesis and subsequent journal articles and conference presentations.

NOTE: The School of Humanities and Social Sciences Research Ethics Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through:

The Chair,
Research Ethics Committee,
School of Humanities and Social Sciences,
Locked Bag 678
Wagga Wagga NSW 2678
Ph/Fax: (02) 69332249
Email: humgen@csu.edu.au

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

If you would like to participate in this research, please contact me:
Lileko Lishomwa, School of Humanities and Social Sciences, Charles Sturt University,
Wagga Wagga, lileko@gmail.com 0409 799 197
Appendix C – Consent Form

Post-border biosecurity - farmers’ perspectives: on-farm biosecurity knowledges, practices and attitudes

Researcher: Lileko Lishomwa  
Email: lileko@gmail.com  
Telephone: 0409 799 197

Supervisor: Dr Vaughan Higgins,  
Associate Professor in Sociology  
Email: vhiggins@csu.edu.au  
Telephone: 02 6933 4514

I have read and understood the description of the project. On this basis I agree to participate as an informant in the project. I consent to the inclusion of material from my interview in this research on the understanding that my anonymity will be preserved. I also understand that I may withdraw from the project at any time. I understand that, with my permission, the interview will be audio taped. At the end of the project the tapes and transcripts will be destroyed.

Name (please print) ........................................

Signed..........................................................

Date..................................................

In my opinion consent was given freely and with understanding

Signed..........................................................

(Lileko Lishomwa – researcher)

Date..................................................

NOTE: The School of Humanities and Social Sciences Research Ethics Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through:

The Chair,  
Research Ethics Committee,  
School of Humanities and Social Sciences,  
Locked Bag 678  
Wagga Wagga NSW 2678  
Ph/Fax: (02) 69332249  
Email: humgen@csu.edu.au

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.
Appendix D – Interview Guide

How did you become sheep farmer?
What prior farming experience do you have? How do you learn from others? Upskilling yourself and family. What do you do on a typical day? What farm associations do you belong to/hope to get out the association?

What does the term biosecurity mean to you?
How do you keep informed about biosecurity risks and practise in Australia/NSW/Riverina? What is the most significant risk that concerns you as a farmer (+ something you don’t have)? How did you transform your farm to keep out diseases? How much time would you spend in a day/week doing biosecurity/securing your farm against disease? Do contractors/visitors have to clean machinery/equipment and boots before coming onto or leaving your property? How do you find information about biosecurity? How trusting are you of biosecurity information? How useful is it? What role does the internet play in finding biosecurity information? What sort of information are you looking for? What are your biosecurity goals/standards? Do you think doing biosecurity is more cost and time efficient than treating disease on-farm? If there was a biosecurity risk how would you find out about it? Who do you think has the responsibility of doing biosecurity and how much responsibility do you think they have?

How can pests, weeds and diseases arrive on your farm?
Can livestock get through your boundary fences? When sheep are not in the boundary what do you do about it and how frequently does this happen? Are you aware of the health status of your neighbours flock? Do you co-ordinate with your neighbours about feral animals? Do you clean equipment before sharing it? Do you buy in feed? How do you make sure it is not contaminated? What preventative things are you doing for possible disease outbreak? Is animal health something you are often thinking about when you buy in new stock? How do you make sure you source animals from disease free properties? Do you use the SHS forms? How reliable do you think they are? How long do you isolate new stock for? Do you drench, dip and vaccinate them/from what and when? How often do you do worm tests (FEC)?

Science and biosecurity expertise
How useful do you think an industry biosecurity plan is? Can you tell me a bit about what governments in Australia do to prevent on-farm biosecurity risk? How do you make sense of the biosecurity and animal health information presented at field days? What do you do if you don’t understand some scientific things? Can you tell me a bit about the role
that vets play in terms of providing advice on animal health? Who would you talk to about a disease or weed you didn’t recognise? Where do you prefer to get animal health information from?

**Risk**
How likely do you think you are to have a disease, pest or weed outbreak? Biosecurity wise are there any areas we have talked about that you would like to improve on your farm? How do you justify the risk? What are some of possible risks/actual risks? What are your other priorities for not engaging in more biosecurity practices?

**What are the main pest, weeds and disease problems you face?**
Why do you consider these as important? How do you manage these?

**Questionnaire:**
- What is the size of your farm?
- How many employees?
- How many acres are used for sheep, what breeds and how many do you have?
- What else do you farm?
- What year did you buy your farm?
- How often do you monitor your sheep?
- How often do you read farming magazines, do you have any subscriptions?
- What do you hope to achieve, future aspirations?
- How often do other sheep farmers contact you for advice, gossip?
- What is your highest qualification?
- How old are you?
- What other activities paid/unpaid you do aside from farming sheep?
- Do you think you are innovative compared to your neighbours?
- Do you know anybody else who would want to participate in this research?
Appendix E – Recommended use of Sheep Health Statement

DON'T RISK THE HEALTH OF YOUR FLOCK. ASK FOR A SHEEP HEALTH STATEMENT.

The National Sheep Health Statement (SHS) is the most important disease risk management tool that buyers can use. For more information ask your agent or visit www.ojd.com.au

START USING THE NEW SHS FROM JULY 1, 2013
Appendix F – DAFF Biosecurity Recommendations

Don’t put this farm at risk!

You can protect our animals from pests and disease. A major animal disease outbreak in Australia could put your industry at risk and have a devastating impact on our economy. While on this property it is important that you apply the simple biosecurity measures below.

Soil, organic material, saliva, mucus, manure and hair can all carry disease which can be easily spread on your clothing, vehicles and equipment. Be sure to:

- **Wash your hands with soapy water** between handling different animals.
- **Clean and disinfect clothing, equipment and vehicles.** Change into clean clothes before coming into contact with other people’s animals. Wash out floats or trucks before loading new animals. Don’t share equipment and saddlery with other people/animals. If your gear has been used by others, clean and disinfect it before using it on your animals.
- **Keep your feed shed clean, dry and tidy, and use secure lids on storage bins.** **Clean out water troughs** regularly and don’t place them under trees or where birds or bats perch.
- **Don’t allow visitors unnecessary contact** with your animals. People working with your animals (such as vets, farriers etc) should **wash their hands**, and wear clothes that have not been soiled by other animals.
- **Keep a detailed log** of animals that are coming onto, and going off your property—including transport dates and details of any identification markings or tags.
- **Isolate new animals** to your property for at least seven days and check them regularly for signs of disease before introducing them to your existing herd or flock.
- **Know what diseases your animals are susceptible to and what symptoms to look for.** If you suspect a serious disease incursion or there are a number of unexplained animal deaths, immediately phone the **Emergency Animal Disease Watch Hotline** on 1800 675 888.

Report animal disease and deaths to the national Emergency Animal Disease Watch Hotline on 1800 675 888.


Biosecurity measures help protect our economy, environment and people’s health from pests and disease.
Appendix G – Sheep Health Statement

### NATIONAL SHEEP HEALTH STATEMENT (SHS)

Completing this Sheep Health Statement (SHS) will assist prospective buyers to determine the suitability of these sheep for their enterprise. Although the SHS is voluntary in most states, it is mandatory in SA. (Version 3, July 2013)

<table>
<thead>
<tr>
<th>Attached to accompanying NVD/Waybill No</th>
<th>PIC of the consignment property</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### A: BIOSECURITY INFORMATION

A1. All consigned sheep were born on the consignment property.  
Yes [ ] No [ ]

A2. The number of different sources of sheep that have been introduced onto the consignment property in the last 5 years is:
- 0 (closed flock) [ ] 1-5 [ ] 6+ [ ] Rams Only [ ]

A3. All consigned sheep are from a property with a livestock biosecurity plan. (see note 1)  
If Yes, Property Plan [ ] Regional Biosecurity Plan [ ] (name)
Yes [ ] No [ ]

#### B: FOOTROT / LICE / OVINE BRUCELLOSIS

B1. To the best of my knowledge, all consigned sheep are from a flock free of virulent footrot.  
Yes [ ] No [ ]

B2. To the best of my knowledge, all consigned sheep are from a flock free of lice.  
Yes [ ] No [ ]

B3. All consigned sheep are from a flock in an ovine brucellosis scheme.  
If Yes, flock accreditation no. (except QLD) Expriy Date:
Yes [ ] No [ ]

#### C: OVINE JOHNE’S DISEASE (OJD)

C1. All consigned sheep are from a Sheepmap flock. (see note 2)  
If yes, Status: Year commenced in Sheepmap:
Yes [ ] No [ ]

C2. All consigned sheep are from a flock with a negative test for OJD. (see note 3)  
If Yes, which test?
- Faecal 350 within the past 24 months [ ]
- Abattoir 500 within the past 24 months [ ]
- Abattoir 150 within the past 12 months [ ]
- Other (see note 4) [ ]

C3. To the best of my knowledge, all consigned sheep are from a flock not infected or suspected of being infected with OJD. (see note 5)  
Yes [ ] No [ ]

C4. All consigned lambs are “T” tag lambs. (see note 6)  
Yes [ ] No [ ]

C5. (a) All consigned sheep are approved vaccinates. (see note 7)  
(b) If Yes, I have been continuously vaccinating all retained lambs in the consignment flock for OJD for years.
Yes [ ] No [ ]

C6. Sheep introduced onto the consignment property in the last 5 years were from a flock with: (see notes 2, 3 and 7 - multiple answers may be applicable)
- Sheepmap accreditation [ ]
- Negative Faecal 350 [ ]
- Negative Abattoir 500 [ ]
- Negative Abattoir 150 [ ]
- All approved vaccinates [ ]
- Unknown status [ ]
- Other (see note 8) [ ]

#### D: TREATMENT INFORMATION OF CONSIGNED SHEEP

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Product</th>
<th>Date of Last Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Parasite Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Parasite Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccination (other than OJD)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### E: ADDITIONAL INFORMATION (optional - see note 9)

#### F: DECLARATION (see note 10)

I (full name):  
Address:  

I declare that, I am the owner and/or person responsible for the husbandry of the sheep in this consignment and all the information on this Sheep Health Statement is true and correct:  
Signed: Date:  
Phone Number: Fax number/email:  

Producers are advised to retain appropriate records to support this declaration. Persons making false statements may be liable under fair trading and other relevant state legislation.
NATIONAL SHEEP HEALTH STATEMENT
Explanatory Notes

NOTE 1: Biosecurity Plan: Agreed actions and activities of farms and/or producers to prevent the incursion of animal disease(s) into a flock or onto a property. It may outline measures including (but not limited to) conditions on sheep movements into the area, vaccine policy and response to disease detection. These plans can be at a property or regional level and can cover a range of diseases. The National Farm Biosecurity Reference Manual for Grazing Livestock Production and regional biosecurity plan guidelines can be used to develop plans.

NOTE 2: SheepMAP: An audited quality assurance program incorporating a property biosecurity plan, animal health risk assessment, testing, and movement controls that provide a source of low risk animals. (Note: level of testing varies depending on status.)

NOTE 3: Faecal 350: A test of 350 representative sheep over 2 years of age (or all sheep over 2 years of age in smaller flocks) by Pooled Faecal Culture (PFC) or equivalent test in pools of up to 50 sheep. The sheep must have been on the property for at least 2 years.

Abattoir 500: At least 500 sheep, over 2 years of age, have been submitted to an abattoir in the past 24 months, in 1 or more lots, have been examined and all found negative for OJD. The sheep must have been on the property for at least 2 years.

Abattoir 150: At least 150 sheep, over 2 years of age, have been submitted to an abattoir in the past 12 months, in 1 or more lots, have been examined and all found negative for OJD. The sheep must have been on the property for at least 2 years.

NOTE 4: Other: Post mortem examination by a SheepMAP vet with no indication of OJD, or other negative test.

NOTE 5: Infected Flocks: A flock which is infected with OJD, and there is evidence of or likely potential for transmission of infection within the flock, and the flock has not met the requirements for resolution of infection in accordance with the current National OJD Standard Definitions, Rules and Guidelines (SDR&Gs).

Suspected of being infected: A flock is suspected of being infected with OJD if the owner has reasonable grounds to believe that the flock has been exposed to OJD infection or that OJD may exist in the flock, based on:
- trace back or trace forward contact with an infected flock
- contact with OJD contaminated land or facilities
- a positive Johne’s disease screening test, e.g. abattoir monitoring or blood (ELISA) test
- is a neighbour of an infected flock unless there is an effective biosecurity barrier
- clinical signs of OJD, or
- advice from the relevant state agricultural department.

AND the flock has not met the requirements for resolution of suspicion in accordance with the SDR&Gs.

NOTE 6: ‘T’ tag (terminal) lamb: A lamb which is to be slaughtered before it cuts its first permanent teeth and is identified by an NLIS (sheep) ‘T’ tag. The ‘T’ tag may be a requirement for trading into some areas.

NOTE 7: Approved Vaccinate: A sheep that is identified by an NLIS (sheep) ‘V’ tag and is:
- vaccinated with an approved OJD vaccine by 16 weeks of age, or
- vaccinated with an approved OJD vaccine after 16 weeks of age, when the flock:
  o was in the SheepMAP, or
  o had undertaken a negative Faecal 350 test in the two (2) years preceding the vaccination, or
  o had a Negative Abattoir 500 status at the time of vaccination.

NOTE 8: Other: This could include sheep sourced from historical Low Prevalence Areas (LPA), or sheep that previously had an ABC score higher than 4, or were from an area with a regional biosecurity plan.

NOTE 9: Additional information: A producer may wish to add additional information pertaining to the consignment and/or consignment flock that is not covered by answering the listed questions. Examples may include historical tests or prevalence areas for OJD, history of OJD vaccination if not continuous, worm resistance test results, where introduced sheep were sourced from, blood lines, micron, breed society, etc.

NOTE 10: Declaration: Signing this declaration has legal significance. Regulatory authorities may take legal action, and purchasers may seek damages for any information that is incorrect. Before signing you must be satisfied you understand all elements of the document, and these explanatory notes.

For more information on biosecurity or diseases go to www.farmbiosecurity.com.au
Appendix H – Which of these sheep have OJD?

Which of these sheep have OJD?

They all do: most sheep shedding OJD show no clinical signs.
<Ileo-caecal area of an OJD affected sheep.

Note:
thickened lower small intestine (ileum) and enlarged lymph nodes.

<Intestinal tract of an OJD affected sheep.

Note:
thickened lower small intestine, enlarged lymph nodes, prominent lymphatic vessels in the membrane and the raised ridges on the lining of the small intestine.

All photos courtesy of NSW Agriculture