Antibiotics and Dry Cow Therapy: What’s the Problem?

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Executive Summary

There is global concern about food safety and the effect antibiotic use in animal production has on our ability to treat human infections in high profile “superbugs” such as MRSA. Antibiotic use in animals has come under significant scrutiny, with a call to reduce their use. Global consumer brands have increased the profile of this issue by announcing their desire to reduce antibiotic use in their supply chains. This has further fuelled public perception of the potential implications of antibiotic resistance.

New Zealand is a recognised leader in food production, particularly in dairy products, and it is the aim of this project to review how the use of antibiotics in this economically important sector may create both risks and opportunities.

Antibiotics are an important tool for treating disease and have a critical role in food production systems. By volume and importance, the greatest use of antibiotics in the dairy industry is for dairy cow mastitis (mammary gland infection) and in particular the treatment of cows finishing their milking season, known as dry cow therapy (DCT). In many cases whole herds are treated prophylactically with these antibiotics. In a competitive marketplace where many trade partners are seeking barriers to prevent imports and protect local business, this prophylactic, or blanket use, creates a potential market access risk.

After reviewing the literature and interviewing a cross section of stakeholders in the use of DCT, several conclusions were drawn.

Put simply, there are two ways to reduce the use of antibiotics and mitigate risk. The first is to reduce the number of animals needing treatment with antibiotics through improved integrated herd management, disease prevention and alternative treatment approaches. The second is the more judicious use of antibiotics, targeting known disease only and not treating the herd prophylactically. Both strategies reduce the volume of antibiotics used.

The management of disease in a production environment is complicated, creating a range of barriers to reduced and more judicious use of antibiotics. Broadly these are related to people, economics, technology and information.
To overcome these barriers and set the standard to which others aspire will require strong leadership. Education, science & innovation, and importantly, a focus on the principles of stewardship and a prioritisation of "food safety", will be enabling. It will require support for our farmers and veterinarians and courage by industry leaders to question the status quo and be willing to continually set new standards for improvement.

This paper recommends that a national strategy is developed by industry leaders. This strategy should be inclusive, aspirational and bind stakeholders throughout the value chain, from producers to consumers. Regulation should be seen as a tool to be used sparingly to influence change. It is a change in culture that will create the sustainable leadership position desired. Most importantly the strategy and its leadership should aspire to position New Zealand product as the gold standard for food safety.
## Contents

Executive Summary ............................................................................................................................................. 1  
Foreword .............................................................................................................................................................. 5  
Acknowledgements ............................................................................................................................................. 5  
1. Introduction .................................................................................................................................................. 6  
2. Purpose of the Research .............................................................................................................................. 7  
3. Background and Literature Review ............................................................................................................ 8  
3.1 Antimicrobial Resistance .......................................................................................................................... 8  
3.2 Bovine Mastitis and Current Management Approaches ........................................................................... 14  
3.3 Regulators ................................................................................................................................................ 23  
3.4 Stewardship .............................................................................................................................................. 24  
4. Method ......................................................................................................................................................... 27  
5. Findings and Discussion ............................................................................................................................... 28  
5.1 Antimicrobial Resistance ........................................................................................................................ 28  
5.2 Dry Cow Therapy (DCT) .......................................................................................................................... 29  
5.3 Barriers to the Reduction of Antibiotic DCT ......................................................................................... 30  
5.4 The Role of the Regulator ....................................................................................................................... 31  
5.5 Looking to the Future ............................................................................................................................... 32  
6. Recommendations ....................................................................................................................................... 34  
6.1 Leadership & Collaboration ..................................................................................................................... 34  
6.2 A Culture of Stewardship ....................................................................................................................... 35  
6.3 Education ................................................................................................................................................ 35  
6.4 Science ...................................................................................................................................................... 36  
6.5 Regulation ............................................................................................................................................... 36  
6.6 Access to Data ......................................................................................................................................... 36
Foreword

As a veterinarian in the 2001 Foot and Mouth Disease outbreak in the United Kingdom, I experienced first-hand the impact of the outbreak from start to finish. Since then I have been involved in the development of new hi-tech businesses based on intellectual property from New Zealand’s research institutions. This has included a new animal health pharmaceutical and diagnostic company, a rural internet provider, and companies developing solutions for primary industry.

I selected this research area for my Kellogg Rural Leadership project for a number of reasons. First, to increase my own understanding of the intricacies of this particular issue, secondly, to identify barriers to change and thirdly, to identify possible areas where technology solutions might assist.

Overall I believe that New Zealand is well-placed to lead the world in food animal production standards, particularly in dairy, by setting the standards for others to achieve. With the importance of agriculture to our economy we need to embrace the concept of “Onehealth”, where animal, human and environmental health intersect and create opportunity from the challenges we will face.

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1. Introduction

Public perception about the use of antibiotics in the food chain can significantly impact on market regulations, and therefore animal management decisions on farm. In the case of the dairy industry, the use of antibiotics in management of mastitis provides a useful case study for gaining an understanding of how animal and antibiotic management practices could impact on future economic returns to the sector. Farmers in the New Zealand dairy industry are under significant pressure to improve product quality while at the same time increase on-farm productivity.

We know from history that public perception, informed or otherwise, has the potential to create pressure on rule makers including government and regulators, and influence perceptions of brand value and buying behaviours of customers. Animal health products such as antibiotics play an important role on farm, and there is growing global recognition of bacterial resistance to antibiotics.

In reaction to public perception, industry is likely to face growing restrictions though regulation. In particular we are likely to see tighter controls on products used on farm to ensure that residues are not detected in export products. The implications from examples where this has occurred for other chemicals is considered in this report.

The aim of this project is to investigate and review the opportunity for the New Zealand dairy industry to take the number one leadership position internationally on antibiotic use for mastitis in dairy cattle. In addition to a literature review, this project collates views from key players from the dairy industry, including farmers, regulators, the public, industry leaders and veterinarians, to gain a balanced view of behaviours and attitudes to the use of antibiotics in dairy cattle and in particular for dry cow therapy. The overall aim of this study is to present a clear case for how New Zealand’s dairy industry can achieve better management and stewardship of antibiotic use in dairy cattle, and whether this can create a significantly better market position for our products and/or reduce the risk of losing market access in the future.
2. Purpose of the Research

The primary aim of this project was to investigate and review the opportunity for the New Zealand dairy industry to take a leadership position internationally on antibiotic use for mastitis in dairy cattle. The secondary and related aim was to stimulate balanced debate amongst stakeholders on this subject. In addition to a literature review, this project collated views from key players from the dairy industry including farmers, regulators, the public, industry leaders and veterinarians to gain a balanced view of behaviours and attitudes to the use of antibiotics in dairy cattle. The overall aim of this study was to present a clear case for how New Zealand’s dairy industry could achieve better stewardship of antibiotics used in dairy cattle, and mitigate market access risk.
3. Background and Literature Review

3.1 Antimicrobial Resistance

3.1.1 What is Antimicrobial Resistance?

Antimicrobial resistance is a term used to identify a population of microbes upon which drugs used to kill the microbe have stopped working, or to which the microbes have become resistant. The terms antimicrobial and antibiotic are often used interchangeably but are not synonymous. In technical terms, “antibiotics” refer only to substances of microbial origin (such as penicillin) that are almost exclusively only active against bacteria, while “antimicrobial” substances (including synthetic compounds) destroy microbes in general (Guardabasse and Courvalin, 2006).

DEFINITIONS

**Antibiotic or antimicrobial resistance (AMR):** Resistance of a micro-organism to an antibiotic or antimicrobial medicine to which it was previously sensitive. Infections caused by resistant micro-organisms often fail to respond to conventional treatment, resulting in prolonged illness and an increased risk of death (WHO 2012)

**Antibiotic or antimicrobial stewardship (AMS):** Co-ordinated interventions designed to improve and measure the appropriate use of antimicrobials by promoting the selection of the optimal antimicrobial drug regimen, dose, duration of therapy, and route of administration (IDSA 2012)

Bacterial resistance to treatment can be intrinsic or acquired. An example of intrinsic resistance is a gram-negative bacterium that has an outer membrane that is impermeable to the antibiotic. Acquired resistance occurs when a previously susceptible bacterium becomes resistant through mutation (vertical evolution) or acquisition of new DNA (horizontal evolution). Mutation is the result of a random event that occurs spontaneously. Each time an antibiotic is used, the susceptible bacterial population will be removed enabling the proportion of resistant bacteria to increase (Prescott, 2000b). An example of how repeated exposure of bacteria to an antibiotic has favoured the development of a resistant population of drug-resistant strains is found in the Chinese dairy industry. *Staphylococcus aureus*, a key pathogen causing bovine mastitis in China, was routinely
treated with a cefoxitin, a cephalosporin antibiotic, leading to the development of a significant population of cefoxitin-resistant *Staphylococcus aureus* bacteria (Wang et al., 2015), effectively rendering this antibiotic an ineffective treatment choice. In order to reduce the likelihood that use of an antibiotic will promote further development of the resistant bacterial population, it is imperative that the appropriate antibiotic is used (e.g. that the bacteria is sensitive to the drug of choice), and that the dose concentration and duration of treatment is sufficient to exceed the minimum inhibitory concentration (MIC) (Laxminarayan et al., 2013).

### 3.1.2 What is the Impact of Antimicrobial Resistance?

Antibiotics/antimicrobials are an important tool in the treatment and prevention of disease in both humans and animals. Without them, the ability to fight infectious disease is significantly reduced, resulting in suffering, loss of life, and in the agricultural sector, reduced productivity.

The incidence and impact of antimicrobial resistance in humans and animals is significant and increasing as witnessed by the large number of impact statements;

In Canada alone the government’s report “Antimicrobial resistance and Use in Canada; A Federal Framework for Action 2014” stated that:

- More than 18,000 hospitalized patients acquire infections that are resistant to antimicrobials per annum.
- There has been a seven-fold increase in the incidence of Vancomycin-resistant Enterococci infections between 2007 - 2012.
- There has been an 8-fold increase in the rate of methicillin resistant *Staphylococcus aureus* (MRSA) infections among hospitalized patients in Canada from 1995 - 2012.

“The U.K.’s Review on Antimicrobial Resistance, established at the start of July 2014, released its first report in December, projecting that a continued rise in resistance would, by 2050, lead to 10 million deaths every year and a reduction of 2 to 3.5 percent in Gross Domestic Product (GDP).” (Zuraw, 2014)
A 2004 report from the Infectious Diseases Society of America (IDSA) noted that “About two million people acquire bacterial infections in U.S. hospitals each year, and 90,000 die as a result.

“This might be one of the world’s biggest problems, but it does not need to be its hardest” (O’Neill, 2014).

The World Economic Forum, in its 2013 annual report on global risks, concluded “arguably the greatest risk to human health comes in the form of antibiotic-resistant bacteria”.

In May 2014, World Health Assembly Member States endorsed a resolution which identified; “the urgent need of a Global Action Plan for antimicrobial resistance”, “A post-antibiotic era, in which common infections and minor injuries can kill, far from being an apocalyptic fantasy, is instead a very real possibility for the 21st century” (WHO, 2014).

“Every individual’s use of antibiotics contributes to loss of their efficacy over time for everyone else...when [use of antibiotics] occurs hundreds of millions of times per year, as for antibiotic prescriptions for outpatients...the aggregate harm to society is catastrophic” (Spellberg, 2014).

“Without urgent, coordinated action by many stakeholders, the world is headed for a post-antibiotic era, in which common infections and minor injuries which have been treatable for decades can once again kill.” Dr Keiji Fukuda, Assistant Director-General, World Health Organisation (PharmaSea, 2014).

3.1.3 Antimicrobial Resistance and Animal Health

Zoonoses are infections transmissible between animals and humans. Infection can be acquired directly from animals, or through the ingestion of contaminated foodstuffs. The severity of these diseases in humans can vary from mild symptoms (e.g. Trichophyton and Microsporum spp. also known as Ringworm) to life-threatening conditions (e.g. Bovine Spongiform encephalopathy also known as Mad Cow Disease). The zoonotic
bacteria that are resistant to antimicrobials are of particular concern, as they might compromise the effective treatment of infections in humans (European Food Safety Authority, 2013).

The development of antibiotic resistance in S. aureus populations is a key example of a global situation that constitutes a potentially significant risk to the health of both humans and animals. Of relevance to mastitis, S. aureus bacteria may be transferred between humans and cows via a number of mechanisms including during the milking process. In particular, methicillin-resistant S. aureus (MRSA) bacteria are resistant to antibiotic treatment and contain virulence factors which increase their ability to drive infection in the host (Pu et al., 2014).

There is public concern over the use of antibiotics in food animals. Concern relates to the development of antibiotic resistant bacteria which can be transferred to humans via food products and present a threat to human health. There are specific concerns that the routine exposure of food animals to low doses of antimicrobials used in human medicine will limit the ability of these classes of drugs to treat human infections effectively (Barlow 2011). A further key concern raised in the popular press is the emergence of resistant genes in crops that have been exposed to manure derived from antibiotic-treated animals (Cimitile, 2009).

With national and international government agencies and non-government organisations repeatedly describing the catastrophic dimensions of the growing crisis of antimicrobial resistance (AMR), it is critical that clear thinking and urgent action are applied to find a solution. The threats of greatest concern to public health have been identified by the World Health Organisation and the Centers for Disease Control and Prevention (CDC, 2013). Of the 19 microbial threats identified, seven have potential links to animals, including MRSA (Appendix 2).

The sheer volume of use of antimicrobials, both as a function of the size of the population exposed and the frequency of exposure events, is a risk factor in creating resistance both in animals, humans and the environment (Public Health Agency of Canada. 2014).
The greatest volume of use of antibiotics in the New Zealand dairy industry is for the treatment of mastitis, predicted to account for over 85% of total antibiotics used, and is used prophylactically in “dry cow therapy” (McDougall, 2014). However, it is clear from a review of the scientific literature that the development of antibiotic resistance in dairy cattle is multifactorial, and in addition to the volume of antibiotics used in the industry (Ruegg, 2013), poor management of dose is another key factor (Call et al, 2008). It needs to be noted, however, that there is minimal conclusive scientific evidence to date showing a significant increase in the antibiotic resistance of mastitis-causing pathogens (Laven, 2013; Oliver et al., 2011).

Dry cow therapy (DCT) antibiotics have two functions; to cure existing infections, and to prevent new infections during the dry period and around calving time. They may be either generally short acting (e.g. Bovaclox™) or long acting (e.g. Cepravin®). A teat sealant may also be used in the dry period to form a plug and prevent pathogens entering the mammary gland. There is concern about the potential to seal pathogens into the gland when the teat sealants are used in unsanitary conditions, resulting in severe, rapid and often life threatening mastitis.

3.1.4 Public Perception

It can reasonably be assumed the media has a significant influence on shaping public perception, and there continues to be significant high profile coverage and media attention to the use of antimicrobials in food chain animals. The sheer volume of publicly articulated articles in the popular press around the growing incidence of AMR is testimony to community concerns around risk, and in particular with regard to the impacts of antibiotic overuse in animals on humans (e.g. Couric, 2010).

The articles present a mixture of views, some balanced, some not, and are often driven by author bias. Whatever the stance, these popular press articles succeed in driving vigorous debate in the media. (Barlow 2011; Price, 2014).

Engagement of some well-known high profile consumer brands in this debate serves to further raise awareness about the issue of antimicrobial stewardship in food animals, as demonstrated by the McDonalds Corporation (McDonalds Corporation, 2015). In May
2015, Walmart announced its intent to see suppliers reduce their use of antibiotics including a move to greater transparency and reporting (Huffstutter & Layne, 2015).
3.2 Bovine Mastitis and Current Management Approaches

Mastitis in dairy cattle is the persistent, inflammatory reaction of the udder tissue (Mastitis in dairy cattle, 2015). There are a range of causes of inflammation of the udder tissue, with the most common being due to bacterial infection.

Taking into account the results of the literature review conducted in the current study, it is clear that the pathogenesis of bovine mastitis is complicated, with a number of factors contributing to disease status. The complex interplay between host immune factors and pathogenic agents complicates progression of the disease and at the individual cow level, life history (e.g. biological age, previous exposure to pathogen load, housing conditions, nutrition, genetics, body condition score, calving history, milking frequency) plays an important role (Awale et al., 2012).

Clinical mastitis is readily recognised by the farmer and visible symptoms may include a cow having an inflamed udder (e.g. classic hallmarks of inflammation including being red, hot and swollen), and milk stripped from the infected quarter containing clots, blood and pus.

Recognition of the subclinical state creates an additional challenge to managing mastitis and the transmission of pathogens between animals. In the subclinical state there are no visible symptoms. The measure of somatic cell count (SCC) is used as a proxy marker for inflammation, because when there is inflammation in the mammary tissue there is a corresponding increase in the number of immune cells (e.g. macrophages, neutrophils and lymphocytes) present in the milk. SCC scores above a threshold level indicate immune system activation. There is a direct correlation between SCC and milk quality, and low SCC cows yield higher volumes of milk (Wiseman, 2011). Furthermore, cows with subclinical mastitis in their first lactation produce about 8% less milk and this affects the second lactation even if the infection is cured (DairyNZ, 2008).

In New Zealand it is common practice (but not a regulation) for farmers to undertake herd testing, and milk samples from individual cows are analysed by accredited laboratories (e.g. LIC diagnostic services, CRV Ambreed) for a number of quality indicators (e.g. total...
milk volume, milk fat and protein content) including SCC. Subclinical mastitis can be detected at this time, and the presence of a pathogen may also be confirmed from further analysis of the milk sample.

It follows then that successful management of bovine mastitis requires a number of key factors to be considered, and there are a variety of approaches to management.

3.2.1 Management

Existing best practice guidelines for the dairy industry pertain separately to standards for milk quality (food safety), and animal health and welfare management. While regulators and milk processors set the standards for milk quality, herd improvement agencies and industry advisory councils set the recommendations for intervention for the prevention of mastitis. The Ministry of Primary Industries (MPI) registers veterinary medicines for appropriate therapeutic use in animals in accordance with the Agricultural Compounds and Veterinary Medicines (ACVM) Act and these are mainly distributed to farmers through veterinary channels.

The best practice guidelines are communicated to farmers via a number of channels, including DairyNZ, LIC and CRV Ambreed, advisors, and through the conditions of supply set by the individual milk processors (e.g. Fonterra). Veterinarians in particular play an integral role. These guidelines are discussed briefly here:-

3.2.2 Guidelines and Industry Good Advice (DairyNZ)

DairyNZ is the single industry good body for the New Zealand dairy industry. The organisation was formed in 2007 and is funded by levies from milk solids sales to dairy companies. DairyNZ states that its role is to "support on-farm change, create on-farm opportunities, build capability and mitigate risk to achieve the industry’s strategic objectives. This is being done through research, development, engagement and leadership" (DairyNZ, 2014). DairyNZ recognised that mastitis management was a
significant challenge for dairy farmers and in 2010 developed a new programme (SmartSAMM) in conjunction with the National Mastitis Advisory Committee (NMAC). The SmartSAMM approach was designed to educate farmers about changes to behaviour and their impact on udder health, through engaging with farmers and vets in a targeted education programme (Blackwell & Lacy-Hulbert, 2013). DairyNZ identified that in order to modify farmer behaviour it was critical to target multiple channels of the dairy sector, including marketing and communication, vets, advisor networks and milk processors.

SmartSAMM was first introduced on the back of new regulations set by the European Union which put in place non-tariff barriers requiring bulk milk containing SCC of over 400,000 cells/ml to be excluded, and at the same time imposing financial penalties on suppliers for bulk milk containing SCC exceeding 500,000 cells/ml (and the penalty threshold was lowered to 400,000 cells/ml in the next season). This penalty approach led to a significant reduction in SCC as it forced farmers to focus on monitoring SCC carefully, through regular testing and recording of SCC (Blackwell & Lacy-Hulbert, 2013). In order to comply with the requirement for SCC to be under threshold levels, cows with a history of high SCC may be selectively culled (Blackwell & Lacy-Hulbert, 2013). Therefore it is not possible to ascertain whether there was a reduction in incidence of infection or whether the observed changes in bulk SCC were obtained due to a significant proportion of animals being removed from the population.

After an initial improvement in SCC there was a slow-down in changes to SCC (Blackwell & Lacy-Hulbert, 2013), suggesting that a lack of focus on milk quality could be a contributing factor to SCC levels, and therefore the incidence of mastitis. Milk price is also implicated in farmer management of SCC, with high prices leading to lower penalties for poor quality (high SCC), and low prices leading to a reduction in the use of dry cow therapy. Monitoring SCC is clearly a critical component in managing the incidence of mastitis, and economic drivers for SCC monitoring are likely to have an impact. However, there is still significant room for improvement with regard to SCC management across the industry, and Blackwell & Lacy-Hulbert (2013) have noted that complacency is an issue where cell counts are below penalty levels, along with a lack of awareness of the on-farm benefits of low SCC milk.
Milk processors, including Fonterra Co-operative Group Limited (Fonterra) and Synlait Milk Limited, work in conjunction with industry bodies such as DairyNZ to educate farmers and run continuous improvement programmes. It has been reported that DairyNZ consulting officers are having a significant impact on educating farmers to change farm management processes, with 30% of dairy farmers confirmed as having changed management practices in the three years to May 2013 (Bell et al., 2014).

Fonterra runs a Mastitis Support Programme to help its farmer suppliers keep SCC below threshold levels, and avoid demerits. The provision of an incentive scheme by the milk processors (e.g. Tatua Co-operative Dairy Company Limited) for suppliers to keep SCC low also aligns with the DairyNZ best practice guidelines about animal health management.

Fonterra milk suppliers have experienced a decline in SCC, on average, by around 35,000 cells/ml (from 210,000 to 175,000) since 2010 when SmartSAMM began (Bell et al., 2014).

Key components of the Smart SAMM programme include:
- Healthy udder delivered through vets trained specifically in mastitis management
- Online resources for education
- Benchmarking against national targets
- Cost benefit calculators for different interventions and management options
- Training

SmartSAMM advocates an integrated approach to mastitis management:
- Vigilance; know the cows, and conduct regular rapid mastitis testing / California mastitis testing (RMT) of known high SCC cows
- Separation of infected cows
- A clean, stress-free environment
- High quality teat spraying (also ensuring teats are in good condition)
- Stripping of high SCC quarters
- Appropriate supportive therapy
- Appropriate culling
- Developing systems, processes and team skills around farm-specific policies and procedures, *e.g.* optimal teat spraying systems

In the future SmartSAMM seeks to develop new tools and technologies to foster a cooperative spirit in the management of mastitis in New Zealand, and to improve milk quality by reducing the incidence of mastitis in New Zealand. SmartSAMM recognises that farms each have their own individualised complexities regarding management of mastitis, and that farmers should work with their vets to develop the best strategy for reducing bulk milk SCC and mastitis, utilising teat sealants and antibiotics as appropriate.

Available data suggests that the collaborative effort of DairyNZ with farmers, milk processing companies, vets and other rural professionals should be expected to deliver close to the target result of a 10,000 reduction in SCC each year by 2016 (Bell *et al.*, 2014).

### 3.2.3 Herd Improvement Agencies

Livestock Improvement Corporation (LIC) is a farmer co-operative head quartered in Hamilton New Zealand. LIC originally set up and ran the Mastitis Advisory Council before assigning the intellectual property to DairyNZ, along with the management of the forum. As outlined previously, SmartSAMM was developed as a collaborative approach by NMAC with LIC and DairyNZ (National Mastitis Advisory Committee, 2008). It follows then that both DairyNZ and LIC advocate the same message to farmers regarding best practice mastitis management. LIC emphasises the economic impact of managing SCC to farmers, stating that 5% of cows contribute to 50% of the bulk milk SCC (National Mastitis Advisory Committee, 2006), and advocate the important role genetic selection plays in determining reduced susceptibility to mastitis (Jury *et al.*, 2010).

LIC has long played a key role in providing herd testing services to farmers. As noted previously, farmers are not obligated to undertake herd testing, but when it is performed it must be done by an accredited agency (*e.g.* LIC or CRV Ambreed). Best practice guidelines suggest that herd testing should be performed four times a year and that the milk samples collected for testing should include both a morning and evening milking
(Bryant, 2015). The data is only useful if it is stored so that patterns can be identified and used to inform future decisions about animal management. Data collected through herd testing is recorded alongside other herd records, including information relating to mating, calving, animal health and other information on a farmer’s dairy herd. The completeness of herd records and the form of those records (e.g. paper or electronic) vary amongst farmers.

3.2.4 Best Practice Management of Mastitis According to a Review of the Scientific Literature

Owing to its global status as an economically important disease in dairy herds, there has been significant investment in mastitis research. In New Zealand there are a number of science providers who work with the dairy industry, and many of the trials undertaken by DairyNZ and LIC have been in collaboration with AgResearch. The review of the peer-reviewed scientific literature undertaken in this project identified the key factors underlying mastitis which need to be managed in order to have an impact on the prevalence of the disease. These factors inform the strategies disseminated to farmers by industry bodies, including DairyNZ and LIC, and are discussed briefly here:

While mastitis is a prevalent and costly disease for the dairy industry, farmers need to choose their management strategy by weighing up expenditure on treatment and prevention against the likely reduction of mastitis-related losses. In order to understand the cost-benefit analysis, farmers need to be able to access the necessary tools and education resources. In addition to having a sound understanding of the economics surrounding mastitis management, farmers need to gain an understanding of the unique epidemiology and aetiology of mastitis on their farm.

There has been a shift in the prevalence and aetiology of mastitis in New Zealand dairy herds in the last half century and it has been suggested that this reflects a change in mastitis control strategies (McDougall, 2002; McDougall, 1998; Bradley et al., 2006). Due to the changing nature of herd management, with a move to housing stock on standing pads and herd homes, and adoption of more starch-based nutrition (e.g. maize), it is likely that there will be further changes to prevalence and aetiology (Lacy-Hulbert et al.,
It is critical that an appropriate antibiotic is selected according to the herd’s prevailing epidemiology in order to achieve optimal cure rates (Petrovski, 2011). Effective bio-surveillance should be undertaken utilising both data (e.g. full herd records including SCC, cull decisions, and milking frequency) and diagnostic identification of pathogens where appropriate, enabling changes in disease patterns to be mapped (Lacy-Hulbert et al., 2002). By measuring SCC several times during the season, the farmer can gauge whether transmission and therefore infection of the herd is occurring.

It is critical for veterinarians to be familiar with pathogen prevalence during different stages of lactation, and the diagnosis of the causative pathogen should be confirmed by lab culturing where possible. Testing by bacterial cultures are useful for identifying sensitivity to treatments, but due to the cost and time required for lab cultures, there remains a gap in the market for novel cowside diagnostics. Rapid, cowside diagnostics which enable rapid and reliable identification of bacteria would have a significant impact on management.

The ongoing susceptibility of mastitis pathogens to different treatments needs to be assessed by the dairy industry to ensure that the most efficacious treatments are available for farmers (Petrovski, 2011). Ongoing investment into R&D within the dairy industry will enable the development of novel treatments. It is noted that farmer behaviours with regard to animal handling (e.g. farm practices inside and outside the milking shed) are equally as important as effective use of antibiotic treatments in controlling the transmission of pathogens. The cycle of transmission can be better managed by having all of the cows dry at the same time, and by excellent hygiene in the milking plant with respect to contagious pathogens (e.g. S. aureus) (Williamson & Malcolm, 2012). Mastitis prevalence on dairy farms depends on the number of infected cows and the duration of each intra-mammary infection, and the greatest impact is made by reducing the number of infected animals. Cows that consistently exhibit clinical mastitis, and particularly those that are positive for S. aureus, will be high risks for pathogen transmission and should be culled from the herd (Green & Bradley, 2004).

Having all cows dry at the same time is optimal for removing existing intramammary infections and use of teat sealants has been demonstrated to have the greatest impact on cure rates when the seal contains a long lasting antibiotic (e.g. cephalonium) (Bradley et
al., 2010). There is abundant evidence that half of all new mammary gland infections occur during the dry period (Hillerton, 2012) and this has formed the justification for utilising blanket DCT (Bradley et al., 2010).

3.2.5 Managing Sub-Clinical Mastitis

Subclinical mastitis is deemed to be present when cows have high SCC in the absence of any visual symptoms of mastitis (e.g. no pus or mammary swelling). One of the critical actions to identify a cow with subclinical mastitis is to conduct regular SCC checks and compare the individual cow SCC (ICSCC) data to its corresponding herd records. Due to their age and relative exposure to pathogens over time, heifers generally have the lowest rate of subclinical mastitis in the herd (Green and Bradley, 2012). Having a relatively high SCC is generally caused by mastitis, but a range of other factors need to be identified and managed too (McDougall, 2012). Behaviour modification is an important factor in managing infection rates and milking subclinical cows last helps to manage transmission of pathogens between cows.

Thresholds of cell levels provide useful indicators or intervention points. For example older cows with a SCC exceeding 250,000 cells/ml are classified as having a high probability of developing clinical mastitis (Smolders et al., 2005), whereas the threshold for heifers would be lower (over 150,000 cells/ml).

DairyNZ continues to advocate blanket use of DCT as best practice in the dairy industry under SmartSAMM (Lacy-Hulbert et al., 2010). Hillerton (2012) argues that it is pointless trying to cure mastitis during the lactation cycle and that DCT is the only effective time to cure the cows of the pathogen load. Due to the observation that most cases of subclinical mastitis self-resolve, McDougall (2014) advocates that antibiotics should only be administered as a treatment when there is clear evidence of infection. As is the case with industry best practice guidelines for antibiotic use, it is preferable to identify the specific bacteria and ensure that it is sensitive to the chosen antibiotic. The likelihood that a cow with a high SCC at drying off time will develop mastitis is a key factor in deciding whether to use antibiotic DCT. The success with which antibiotic DCT might cure the cow depends on how effectively the chosen antibiotic and duration of treatment (e.g. long
acting or short acting) matches the specific pathogen, along with the age of the animal (e.g. heifer or older cow) (McDougall, 2010). McDougall (2014) recommends that the herd should be stratified into four groups: not feasible to treat, to be treated with antibiotics, to receive teat sealant, or to receive no treatment at all.

The other research finding which is important to note is that due to the complex nature of mastitis, its management needs to rely on modifying other aspects of the farming system, rather than just using antibiotics to cure existing infections or using antibiotics prophylactically to stop them developing during the dry period (Hillerton, 2013). In order to achieve more sustainable management of mastitis, a sound strategy would be populating herds with cows that have superior genetic resistance to mastitis. There remains an opportunity to develop better tools for management of the milking process itself (e.g. disinfectants and teat sealants) along with tools for animal management (e.g. data capture tools, health indicator measuring devices and diagnostics for pathogen identification).

3.2.6 Economics

Decision tree analysis has been used to evaluate treatment options for drying off, with economics being a key influence in the decision-making process (Berry et al., 2004). DairyNZ advocates the blanket use of DCT based on the cost of DCT ($25/cow) being outweighed by the economic benefits of the production gains from eliminating infections going into the dry period and preventing new infections (Poland, 2012). Also noted is the influence that the cure rate has on the economics and the effect of specific pathogens.

In a different area of dairy animal management, the induction of calving, a tool used to reduce the time spread of calving, has been phased out over recent years due to market pressures and following subsequent regulation. Economics has been at the heart of the debate through the process, and while it is an important consideration, and one that needs to be carefully understood to support change, Verkerk et al., (2011) have shown regulations reducing inductions didn’t create negative economic impacts. Verkerk’s view in the case of inductions was that the loss of that management tool should not have resulted in undue economic pressure as there are many other aspects that contribute to
profitability. Further strategies to develop best practice not only mitigate possible economic loss but actually increase profitability.

3.3 Regulators

In New Zealand, veterinarians can prescribe antibiotic DCTs which are classified as restricted veterinary medicines under the Agricultural Compounds and Veterinary Medicines (ACVM) Act 1997. Advice from the New Zealand Veterinary Association (NZVA) website states: “Prescriptions for dry cow therapy must be based on epidemiological knowledge of mastitis within the herd, bacteriological identification and management factors. Refer to the Veterinary Council Handbook for the standard relating to Sufficient Information for prescribing or authorisation of DCT.” This standard can be found in Appendix 3. In effect, veterinarians can prescribe DCT for prophylactic use in bulk from veterinary practices, and they can be used by the farmer at will, with no requirement for at-the-time veterinary inspection of the animals or veterinary application of the antibiotic.

This is in contrast to the situation in Sweden, a high-cost production system, where all antibiotics used in the production animal sector must be administered by the veterinarian to the affected animal after the presence of a pathogen has been confirmed and identified to the species level (SVA National Veterinary Institute, 2014).

In the United States of America, the Federal Drug Administration (FDA) is the regulator for antibiotic use in animals. It has chosen to implement a voluntary approach to reducing the use of medically important antibiotics, on the basis that regulating straight away would require significantly more resource and in fact take longer than the collaborative approach (FDA 2012).

There are a number of case studies where a common practice on farm, or the use of a particular product on farm is, has become restricted or regulated. These include:

- The use of induction to tighten calving patterns (Verkerk et al., 2011)
- The regulation of milk handling (temperature) from cow to the vat
- The use of sanitisers e.g. teat spray compounds (Wilson, 2014)
Each of these case studies is characterised by having associated negative public perception with the issue, and it has been considered there might be associated risk from overseas trading partners if the issue is not managed. This has led to implementation of change via a phased approach. In all cases alternative products or practices were required (Antimicrobial Resistance and Use in Canada a Federal Framework for Action 2014).

There is a clear link between market pressure and industry regulatory change. Due to global market partners perceiving there to be a risk to consumers from the presence of quaternary ammonium compounds (QACs) in milk, milk processors including Fonterra recognised the need to change farmer behaviours and remove this potential trade barrier (Christie, (2014). Fonterra responded to the potential trade risk by developing and implementing a programme to identify QAC residues in milk and educate farmers about the threat these posed to future trade (Fonterra, 2013). The “Rinsing Programme” involved collaboration between farmers, Milk TestNZ, detergent companies, Farm Dairy Assessors and Fonterra working together to test and find solutions for any farm with residues above the 30ppb QAC limit (Fonterra, 2013). Demerits for residues were then implemented as of June 1 2014, after the industry had a chance to respond to the new regulations. These changes required reformulation of detergents to remove QACs, and modification to the steps involved in the cleaning process itself (e.g. addition of rinsing cycles).

### 3.4 Stewardship

Guardabassi and Prescott (2015) noted that ‘antimicrobial stewardship’ is used to describe the multifaceted and dynamic approaches required to sustain the clinical efficacy of antimicrobials by optimizing drug use, choice, dosing, duration, and route of administration, while minimizing the emergence of resistance and other adverse effects. McDougall (2014) states that “stewardship is a broad concept which aims to ensure efficacy of antimicrobial use, but also recognising that effective outcomes involve not only the choice of the right drug, but many other aspects, including disease prevention, reducing the risk of infection, training of prescribers and the consumers, appropriate
diagnostics, collection and use of surveillance data. The term stewardship is combined with an increasing emphasis on appropriate prescribing of antibiotics (McDougall 2014). Stewardship is also the focus of a number of strategies at a country level, (Anon, 2013), and industry level (Weese et al., 2015).

McDougall (2014) notes that stewardship is distinct from judicious use (which covers a wide range of species), and that while the New Zealand Veterinary Association and others have provided guidelines, these provide only general advice. McDougall (2014) states that a key difference for the dairy industry in applying judicious use of antibiotics, is that it involves a herd, and that the primary diagnosis and treatment may be undertaken by the stock owner and manager as opposed to a licensed health professional.

The following quotes provide further context;

“The veterinary profession must work to educate all veterinarians about issues related to conservative antimicrobial drug use and antimicrobial resistance so that each individual is better able to balance ethical obligations regarding the perceived benefit to their patients versus the perceived risk to public health.” (Morley et al., 2005)

“Conserving the effectiveness of existing treatments through infection prevention and control guidelines, education and awareness, regulations, and oversight” (Antimicrobial Resistance and Use in Canada a Federal Framework for Action 2014).

“Preserving antimicrobial effectiveness in the future through ethical practices today” (McDonald’s Corporation and their “Vision for Antimicrobial Stewardship in Food Animals March 2015”).

“Strengthen the promotion of the appropriate use of antimicrobials in human and veterinary medicine” (Public Health Agency of Canada 2014).

In 2010, the United States FDA released their recommendations for the judicious use of medically important antimicrobial drugs in food producing animals (FDA, 2012).

According to the FDA the key principles of judicious use include:
The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that are considered necessary for assuring animal health, and,

The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that include veterinary oversight or consultation (FDA, 2012).
4. Method

Following the literature review, interview questions were developed in order to determine how different members of society view the role and management of antimicrobial use, with a focus on mastitis and DCT, and the macro and micro impacts of that use. Further questions were focused on their understanding of antimicrobial resistance and their views on the roles farmers, veterinarians, government, export partners and the public might play.

Finally, questions sought solutions to problems or risks that were identified during the interviews including barriers to implementation of those solutions.

A total of ten people were interviewed including the following;

- Dairy processors
- Veterinarians
- A policy maker
- Dairy farmers
- Members of the public

Semi-structured interviews were carried out mainly by phone, with interviews ranging from 30-70 minutes. Interviews were recorded either through written notes or digital recording, as required.

All interviewees were given an overview of the project and why it was being conducted, and were encouraged to provide genuine answers, practices and motivations.

Base questions are provided in Appendix 1. In addition and based on answers from interviews, a number of industry experts from the author’s own networks were also contacted with specific questions.
5. Findings and Discussion

5.1 Antimicrobial Resistance

The concept of antimicrobial resistance and the health issue it posed to people was recognised by all those interviewed, however the depth of technical understanding was highly variable. What was not so clear amongst the interviewees was their understanding of the possible link between treatment of animals with antibiotics and human health. Two debates surfaced. The first was a view that it was not proven that there was a link, and the second was the view that it was highly likely there was a link, mentioning that all of the risk factors were present, and that the dairy industry couldn’t ignore the issue even though the definitive data may be light.

All people interviewed agreed that regardless of having definitive proof or otherwise, the general public were likely to perceive antimicrobial use in animals to be an issue. The interviewees felt that public perception of a risk was heightened by high profile company marketing (e.g. McDonalds Corporation), and that the views of the consumer could significantly affect buying behaviour.

All of those involved in the industry felt that the risk of antimicrobial resistance posed a potential risk for the dairy industry. One of the interviewees drew parallels with existing knowledge about parasite resistance and the risks that this has posed to effective parasite treatment. While being quite separate from a food quality issue, this statement demonstrates that there is some awareness amongst the farming community of the potential consequences of poor drug stewardship, and the possibility of losing the ability to treat sick animals. When asked what the effect of public perception might be on the issue there was a mixed response. All interviewees felt that perception of food quality could influence decision making and consumers’ buying behaviour, and result in potential restriction to market access for New Zealand products. One respondent, however, didn’t believe that this particular issue was likely to be an issue for them.

Another noted:
“If it’s not managed carefully this issue has the potential to have the biggest impact on the dairy industry, well surpassing the phasing out of induction.”

He subsequently cited “knee jerk” regulatory reactions in Australia as a risk to be avoided. A second stated that while he recognised the importance of the issues under discussion, it was not currently an issue of high enough profile that it was currently being tabled amongst his networks.

It would seem from the interviews that the profile of the risk and issues was variable.

5.2  
Dry Cow Therapy (DCT)

The use of blanket, or whole herd antibiotic DCT, was described to interviewees where required. When asked how they felt about the prophylactic use of antibiotic, all recognised that they were treating animals that may not need it, and all those in the industry cited the benefits of its use in their initial response (being reduced mastitis, animal welfare, reduced SCC, herd management etc), and that it was an industry-wide acceptable practice. On further discussion, and when asked to consider this in the light of antimicrobial resistance, all interviewees recognised that blanket use of antibiotics in DCT was a potential risk. A number of interviewees continued, commenting that compared to other dairy industry territories, including the US barn-based systems, New Zealand’s use of antibiotics was small in terms of actual volumes used. However it was also noted by one that while this could be positive, unless there was a more detailed comparison of actual antibiotic type and how antibiotic is applied, drawing definitive conclusions was difficult. It was also noted that we don’t currently have adequate surveillance of antibiotic use at the level that is required. This was contrasted with some European countries. There is a report on New Zealand antibiotic usage due out, however this has been delayed and is unlikely to have the resolution required.

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1 From 1 June 2015, routine use of induction drugs to shorten gestation will not be permitted. Farmers will need to focus on other management areas, such as heifer rearing, body condition score, heat detection, genetics, AB practices, bull management and cow health to manage calving pattern.
One farmer noted;

“*I have been feeling uneasy about this blanket approach for a while.*”

He went on to say that this year he had rationalised his use of DCT antibiotics for the current dry period, and that this had created an economic benefit in reducing his spend on antibiotics. However, he was also concerned that it might backfire and he would end up with clinical mastitis problems later at calving and lactation.

One interviewee described Tatua’s approach which positively incentivised low SCC milk and that this produced a premium for the higher quality product, though in turn was likely to incentivise blanket DCT antibiotic use.

### 5.3 Barriers to the Reduction of Antibiotic DCT

All interviewees recognised that in order to reduce the volume of antibiotics used for DCT, there was an opportunity to move from blanket dry cow treatment to cow specific treatment, however that to do so it required the ability to accurately differentiate between cow treatment groups. A number of barriers were identified including; farmer access to electronic data, the quality or accuracy of that data, that herd test data (SCC) may not be recent (or in periods of low pay out done at all), that history of previous mastitis and antibiotic interventions may not have been updated in the system as it was often kept on paper in notebooks, and a lack of appropriate diagnostic tools to more accurately identify causative agents. Two respondents also identified management issues related to the size of farms, the degree of technology on farm, and the quality of farm labour. Variability in the farmer's ability to use data systems was also raised.

One noted that where some farmers were not using antibiotic DCT as a blanket therapy, and were instead replacing it with alternatives e.g. teat sealant, that this was economics driven, and that cow deaths were highly likely to be due to issues with staff not following good practice/cleanliness. In contrast, he noted there were some, typically smaller owner-
operator herds, that were able to reduce use of antibiotic DCT through use of teat sealant through adherence to good practice in applying the teat sealant. In summary, this respondent felt it was possible to reduce usage (e.g. 10-20% reduction dry cow), but under current practices not all farmers were well equipped to do this without causing potential welfare issues (i.e. cow deaths). Another noted that by using teat sealant as a dry cow therapy, the potential to supply colostrum was limited. This respondent also noted the importance of managing heifers appropriately to reduce the likelihood of mastitis in later years and reinforced the importance of general herd management approaches, nutrition, environment, rather than relying on an antibiotics approach.

Education was also noted as a challenge. The decision-making process for which cows to select for treatment with long or short antibiotics, or alternatives such as teat sealant, was recognised as complicated. Where there was understanding of on-farm practice by the interviewee it was noted there was a need for better tools and that it was important there be more balanced science to prove the economic benefits, a key driver for farmer decision making. While it was recognised that better dry cow management might be beneficial for reducing antibiotics, even if it could be shown to have longer term benefits through improved control, and therefore have pay back over multiple seasons, a key barrier was the general focus on the financial year, and current milk prices. Economic drivers were not only cited as an issue on farm but also for veterinary practices, given challenges with ongoing profitability, the revenue antibiotic DCT provides, and which in some cases subsidises other separate veterinary interventions. General inertia and resistance to change was also cited as a barrier, along with a reluctance by many farmers to make operational data available to veterinarians.

5.4 The Role of the Regulator

There was general recognition that some sort of new or modified regulation on the use of DCT was likely. At the same time there was also widespread concern at change driven solely or in isolation by the regulator, in particular concern over a “knee-jerk” reaction, with some respondents concerned that if a market access issue occurred the regulator might respond in this way. There was mixed support for the “threat” of regulation as a tool
to raise the profile of the issue and stimulate change. One respondent noted that if this was the approach, clear time lines were required to ensure the various industry groups that were needed to drive change were well engaged. Careful management of the “increased profile” was needed to ensure it demonstrated New Zealand’s leadership position and couldn’t be used by off shore markets to highlight a problem.

The use of drugs to induce calving was again raised and used to highlight the influence the ACVM can have as regulator. In this case, the altering of label claims for specific drugs used for induction has meant that veterinarians can now only use these drugs as a therapeutic rather than a management tool.

5.5 Looking to the Future

All interviewees noted the need for leadership by key industry representatives, with most recognising that regulation was likely to increase and that the public perception and market access risk was a factor and driver.

One noted that the veterinarian had an ongoing role to play as the “gate keeper” or steward of antibiotics, particularly medically important antibiotics, though there needed to be greater support of the veterinary industry and compliance by veterinarians themselves to ensure they retained this privilege. Improved “custodianship” of drugs on farms was also suggested in order to better demonstrate responsible management on farm, from prescription, through storage and application. Better transparency and auditability was a likely outcome.

The need for enforcement of any new regulation was highlighted and while it is clearly important for veterinarians to ensure adherence to standards, this was also raised as an issue by farmers. One cited inductions as an example, stating that if some farmers could access the drugs they would still be using inductions as a tool for poor herd management practice. He emphasised that control and enforcement will be needed for change.
All were clear that change was required or inevitable and needed to be supported by scientific evidence and balanced debate, and that no one organisation can do it alone. All agreed that there was likely to be significant inertia and uptake and change at farm level would be reliant on a range of factors which differed on every farm. All cited sources of information, such as industry bodies, as key to accelerate widespread adoption of new standards. There was recognition by some that the timeframe for change, and particularly regulations, needed to be clearly laid out. One respondent noted that there was a need for and value in a national strategy, ideally led by MPI, but with all stakeholders involved and most importantly committed. A second reinforced the strategy approach and called for early action rather than months spent developing the perfect strategy.
6. **Recommendations**

From the review conducted in this project, and recognising the small cross section of stakeholders interviewed (n=10), this report highlights a disconnect between the advice given to farmers by industry, science community opinions, marketplace trends and regulatory policies. It seems likely that the regulation of antibiotic use in some manner will increase in the future and on-farm practice will change. The project presents a compelling case for the need to develop a clear national strategy to set the gold standard for antibiotic use using dry cow mastitis management as a focus.

Key components of a national strategy are addressed below. Importantly a strategy should provide a roadmap, and work should quickly move to implementation.

6.1 **Leadership & Collaboration**

Before change can occur there needs to be recognition of a need and a catalyst to begin the process. To be effective, change in any situation requires strong leadership trust, integrity and an understanding of the issues that may prevent change. With antibiotics at the centre of the debate, leadership by the New Zealand Veterinary Association, through the promotion of good practice stewardship of antibiotic usage by veterinarians will be key to raising the profile. A national strategy will be required to provide the roadmap for the future and aspirational goals will need to be agreed to by all stakeholders across the value chain. MPI is well-placed to lead the development and coordination of that strategy.

Promoting change that may impact on the economics of individual businesses (farm and veterinary practice) in order to strengthen the industry as a whole will be challenging. Change will require co-ordinated leadership by all groups across the value chain. Genuine collaboration will provide a greater likelihood of success while a fragmented and uncoordinated approach by individual organisations is likely to create risk and delay.
6.2 A Culture of Stewardship

It is recognised that veterinarians play a key role in providing advisory services to farmers to support reduction of mastitis, as well as the diagnosis and treatment of clinical and sub-clinical mastitis and the on-farm custodianship of antibiotics.

In order to lead, New Zealand needs to implement more effective stewardship practices and ensure more judicious use of antibiotics. Fundamental to stewardship is ensuring connectivity and collaboration between all the stakeholders. A simple first step is for stakeholders to reach agreement on the principles of stewardship. A number of programmes have been developed internationally, providing an opportunity to review, adopt and adapt existing programmes for the New Zealand environment.

6.3 Education

The New Zealand dairy industry is well placed for support through education. DairyNZ’s SmartSAMM provides an excellent and well-respected framework. With likely minor modification (if any) this is likely to be a highly effective tool for educating farmers. To some degree it can be argued that it will be as much about creating positive profile and recognition of the issue as it will be for the educational tools themselves. This is where industry good organisations such as Federated Farmers can assist with a collaborative stance. All industry players will all also need to play their part. Consideration in this process should also be given to a “prophet” from afar. Bringing in experts who are internationally recognised on the issue, independent of politics and ensuring they understand the New Zealand context, can be powerful.
6.4 Science

New Zealand is well-placed to deliver the science required, but again this will require collaboration and co-ordination to be effective. Science underpinning disease management, and most importantly the impact of decision making on economics will be critical. Science and industry investment will be required to seek alternatives to antibiotics, decision-making tools and diagnostics. New products would not only provide solutions for New Zealand, but export opportunities in their own right.

6.5 Regulation

The introduction of regulation is perhaps more a matter of timing than whether it is introduced or not. The FDA’s stance in the US is interesting in that it is seeking a collaborative voluntary approach first, stating this is faster and more cost effective than imposing regulations. This approach still signals a clear intent to regulate in the future and, like the New Zealand experience with inductions, it provides a framework and timeline for change. The faster the adoption of change, the more likely New Zealand will be able to reduce risk of trade barriers and ideally set the standards for others to follow. Regulation should be developed as one tool to create, support and enforce change, but most importantly this should be undertaken as part of an integrated national strategy. Critically, any regulation should be made proactively based on sound data and reasoning, rather than in reaction to market activity.

6.6 Access to Data

Without national surveillance of the incidence of the disease and detailed use of antibiotics, it is not only difficult to gauge the extent of the problem, but more importantly
to measure and document the impact of any change or intervention or to set regulatory frameworks.

With widespread recognition of the importance of data to timely and accurate decision making, surveillance, traceability, and auditable, the opportunity to support or fast track integration of the various data sources should be considered. While this area is beyond the scope of this project, the challenge in implementing this seems likely to be high considering the individual information, and “silod” ownership of much of the data. A national strategy should consider the costs and benefits of this approach and seek an appropriate mechanism for stewardship and application of the data that ensures proprietary rights are preserved. It is the author’s view that a neutral and independent organisation tasked with connecting and consolidating the complete data-set is required for New Zealand’s ongoing market leadership. This organisation will need to protect confidential or proprietary rights where required, and balance this with access for appropriate and improved decision making, and national surveillance and response.

### 6.7 Tools and Diagnostics

The epidemiology of mastitis is understood to be due to a complicated combination of nutritional, and environmental factors. This is demonstrated by the prevalence of different pathogens in the New Zealand pasture system compared with the US barn system. In New Zealand, where the pasture system has been dominant, farmers are familiar with the prevalence of *Streptococcus. uberis* dominant mastitis in the early milking season and *Staphyloccocus. aureus* in the late milking season. As farming becomes more intensive and nutrition changes to a more starch-based source (*e.g.* maize), along with changes in management practices, such as more time spent on standing pads or in herd homes, there is likely to be a shift in relative pathogen prevalence. The epidemiology around this is not as well understood.

A key barrier to change is access to the appropriate information to inform decision making. No one tool or diagnostic is likely to be the silver bullet. With the combination of bio-surveillance data and other information available, plus the addition of specific
diagnostic tools to improve accuracy and timeliness of detection (causative pathogens) as part of the regular workflow, better decisions can be made.

6.8 New Antimicrobials and Alternative Treatments

One partial solution to resistance is the development of new antimicrobial options. Primarily this is driven by pharmaceutical companies and the development of new chemical entities to kill bacteria. While on the surface this may seem attractive, without improved disease management this approach does nothing but delay or slow resistance development. There are a range of reasons – from return on investment to regulatory barriers – as to why the development of new antimicrobials solutions by pharmaceutical companies is slow.

Other treatment approaches which improve the immune system response (e.g. vaccines, immune modulators providing the body with its own mechanism for fighting the disease or resisting infection) provide more attractive alternatives, particularly when combined with good practice and judicious use of antibiotics. Ensuring excellent overall cow health will continue to be fundamental to disease prevention and management.
7. Further Work

It is clear from the work completed to date and the limited scope of this project that further work is still required. There would be benefits to increasing the cross section and number of interviewees with a particular focus on New Zealand processors. These processors have significant ability to influence the standards of product they receive. It is also important to understand how data is both captured and used, and how the different “owners” of the data interact. From a leadership and change perspective, more can also be learned by dissecting the inductions case study, and identifying the factors that catalysed the early conversations. Given the focus on market access risk, detailed understanding of overseas markets and their perception of this as an issue would be valuable, particularly in developing the case for strengthening our market position. More work is also required to understand and quantify the specific market access risk, in order to attempt to create a model for return on investment from any change.

Ideally further work would be done on the impact of any changes in process or regulation. Finally, further work is required on new product opportunities that might exist or be developed to remove barriers to change.
8. Conclusion

The public will continue to be concerned about the use of antibiotics in relation to the products they consume. In turn, this affects consumers’ buying behaviour and creates a risk for New Zealand’s exports. Veterinarians, farmers and exporters can be reactive to consumer concerns and the concerns of markets or they can lead by setting the global standard. To create new standards of product quality through judicious use of antibiotics in dairy products, leadership through education will be key. Change will rely on a collaborative “all of industry” approach to ensure rapid culture change to one of custodianship of antibiotics. Further science and understanding the economic impacts both at micro and macro levels will be valuable. Expecting behaviours to change without the specific tools to do so and without knowledge of the benefits of change, and without strong leadership and clear aspiration supported by the implementation of a national strategy, is naïve, however without these, the risk of loss of market access seems a very real risk.
9. References


Appendix 1: Interview Questions

Many interviewees were expected to already have an understanding of the issue, so questions were designed to stimulate discussion, resulting in a relatively free form interview. The following questions provided the foundations:

1. Have you heard of anti-microbial or antibiotic resistance and if so what does it mean to you?
2. Does antimicrobial resistance affect you and your business in any way? If so how?
3. There is debate as to the cause of AMR, what are views?
4. How much of a role does public perception play in this debate?
5. What do you see as the risks of AMR, to you, to your industry, to NZ, globally
6. How do you think we compare to other countries?
7. Dry cow therapy is in many cases prophylactic, does that create any issues?
8. Dry-cow is the biggest use by volume, can we use less?
9. What are the barriers to reducing dry cow use and mastitis?
10. What role does or should the government or regulators use?
Appendix 2: Antimicrobial Threats in Animals


<table>
<thead>
<tr>
<th>MICROBES WITH ANTIMICROBIAL RESISTANCE THREATENING PUBLIC HEALTH</th>
<th>CDC 2013</th>
<th>WHO 2014</th>
<th>Animal Link</th>
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<tr>
<td>18 threats</td>
<td>9 threats</td>
<td>7/19 links</td>
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**URGENT THREATS (3)**

- *Clostridium difficile*
- Carbapenem-resistant Enterobacteriaceae (CRE) *Klebsiella pneumoniae*, resistance to carbapenems
- Drug-resistant *Neisseria gonorrhoeae* *Neisseria gonorrhoea*, resistant to 3GC

**SERIOUS THREATS (12)**

- Multidrug-resistant *Acinetobacter*
- Drug-resistant *Campylobacter* Possible
- Fluconazole-resistant *Candida* (fungus)
- Extended spectrum B-lactamase producing Enterobacteriaceae (ESBLs) *Escherichia coli & Klebsiella pneumoniae*, resistant to 3GC
- Vancomycin-resistant *Enterococcus* (VRE) Possible
- Multidrug-resistant *Pseudomonas aeruginosa*
- Drug-resistant non-typhoidal Salmonella Non-typhoidal Salmonella, resistant to FQs Possible
- Drug-resistant *Salmonella Typhi*
- Drug-resistant *Shigella* *Shigella species*, resistant to FQs
- Methicillin-resistant *Staphylococcus aureus* (MRSA) Methicillin-resistant *Staphylococcus aureus* (MRSA) Possible
- Drug-resistant *Streptococcus pneumoniae* Drug-resistant *Streptococcus pneumoniae*
- Drug-resistant tuberculosis

**CONCERNING THREATS (3)**
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<tr>
<td>Vancomycin-resistant</td>
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<td>(VRSA)</td>
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<td>Erythromycin-resistant</td>
<td><em>Group A Streptococcus</em></td>
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<tr>
<td>Clindamycin-resistant</td>
<td><em>Group B Streptococcus</em></td>
<td><em>Escherichia coli, resistance to FQs</em></td>
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Appendix 3: Veterinary Council Statement

The following statement has been copied from Veterinary Council of New Zealand

“Statement on the Authorisation of Dry Cow Therapy Purpose

The use of Dry Cow Therapy products is an area that continues to generate queries and concerns to the Veterinary Council of New Zealand (VCNZ). The purpose of this statement is to provide further detail and clarification for veterinarians on the VCNZ Code of Professional Conduct requirements when authorising, dispensing, recommending, selling and using these restricted veterinary medicines. Requirements Dry Cow Therapy (DCT) products are classified under the Agricultural Compounds and Veterinary Medicines (ACVM) Act 1997 as restricted veterinary medicines. When authorising the purchase and use of DCT products veterinarians must comply with the Ministry for Primary Industries (MPI) ACVM Performance and Technical Standard No 1 on Veterinarians recognised to issue a valid authorisation on purchase and use of Restricted Veterinary Medicines. When authorising the purchase or use of DCT veterinarians must also comply with the relevant requirements of the Veterinary Medicines section of the VCNZ Code of Professional Conduct (‘the Code’). These are set out in Appendix 1 and include meeting the requirements for veterinary consultation which is defined as follows in the Code: A veterinary consultation must include the veterinarian:

- interviewing the client (or a legitimate and authorised representative of the client);
- collecting and recording sufficient information relevant to the individual circumstances to ensure the proposed course of action (including treatment) is appropriate and meets the needs and best interests of the animal(s) and the client;
- obtaining appropriate consent to the proposed course of action;
- being given and accepting responsibility for the ongoing health and welfare of the animal(s) concerned in relation to the consultation. This includes arranging emergency care taking into consideration the circumstances and the potential for adverse effects from, or failure of, the agreed course of action;
- determining and providing the appropriate level of advice and training in order to be satisfied that the agreed course of action can occur as planned.
Consultation will usually involve the animal(s) having been seen by the veterinarian at the time of the consultation. If not, they will have been seen recently or often enough for the veterinarian to have sufficient personal knowledge of the condition/health status of the animal(s). This consultation is required in order for the veterinarian to be able to propose the particular course of action/treatment. Where DCT is to be authorised its use must be a planned and integral part of an ongoing mastitis control programme in which the veterinarian is involved. More than one veterinarian may be involved in a herd’s mastitis control programme (eg general practitioner and consultant). Either veterinarian may be in a position to authorise DCT providing they can comply with the requirements of the Code and this statement and take account of the particular circumstances including the preference of the farmer. If more than one veterinarian is involved in managing a mastitis control programme on a farm each should communicate with the other(s) to share appropriate information in order to optimise treatment and welfare outcomes. The authorising veterinarian must be aware of the current health status of the animals and their dairy environment by direct physical examination at the time of authorising the product - or by a sufficient number of prior examinations in the current season.

Interpretation of the epidemiology and bacteriology of sub-clinical and clinical mastitis must be demonstrable. The authorising veterinarian must have appropriately considered clinical findings, diagnostic test results, milking management, herd factors, residues and antimicrobial resistance issues and obtained and taken into account farm records where these are available including:

- Bacteriology from clinical and sub-clinical mastitis
- Clinical mastitis-incidence at calving (defined as calving to 1 week post calving)
- Incidence during lactation to dry off; incidence during dry period
- Bulk milk somatic cell count history for the previous year and the current year
- Individual Cow Somatic Cell Counts - this year and last year’s summary (as on herd test records) with particular emphasis on late season individual somatic cell count information from herd test data
- Data from in line diagnostic technologies
- Dry cow therapy records
- Culling history for mastitis over the last 3 years.

The authorising veterinarian must advise the farmer on the DCT product most suitable in the circumstances and how it should be applied in the herd, with appropriate advice on
how to avoid the risk of potential inhibitory substance grades. As a guide, an ongoing
mastitis control programme should include:

- Advice on culling, with attention to meat withholding times in treated animals sent
to the works
- Guidelines for the farmer on the economics of their course of action
- Advice on - correct administration of dry cow therapy - management of drying off
process - handling of clinical mastitis during the dry period - management of cows
prior to calving - management of cows post calving
- Advice on the selection of antibiotic for treatment of clinical mastitis
- Advice on the reason for current mastitis status eg. is the problem due to
environmental mastitis, poor dry cow management, a faulty milking machine
and/or milking management
- Action plans to help farmers manage their mastitis situation in the future.

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