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**Multiple perceptions of reality: a new lens
for examining on-farm milk quality in
New Zealand**

A thesis
submitted in partial fulfilment
of the requirements for the
Degree of Master of Applied Science
at
Lincoln University
by
Robyn C. Cox

Lincoln University
2016

"There are things known and there are things unknown, and in between are the doors of perception." — Aldous Huxley¹

¹ Huxley, A. (1954). *The doors of perception*. Pg. 62. New York: Harper & Brothers, Publishers

Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Master of Applied Science.

**Multiple perceptions of reality: a new lens
for examining on-farm milk quality in
New Zealand**

Robyn C. Cox

Although improvement of on-farm milk quality (OFMQ) is a goal of the New Zealand dairy industry, no New Zealand research has attempted to elicit the multiple perceptions of industry stakeholders about the pursuit of change. Accordingly, this thesis sets out to establish these perceptions. Events and ideas that contributed to OFMQ perceptions are investigated, and perceived barriers and constraints for further improvements as identified by stakeholder groups are presented.

Information was drawn from both in-depth interviews and secondary sources. Checkland's Soft Systems methodology (SSM) was used as an epistemology for eliciting the research questions that generated the data for this thesis, and Kurt Lewin's Force Field model was used to present the results. The data were analysed and presented as a combination of rich pictures and dialogue.

There have been changes over the 1992 -2012 period as to how milk quality is defined by the marketplace. Dimensions such as sustainability and ethics are now important as well as physical attributes encompassing chemical and biological qualities. Both regulatory and achieved standards for food safety and quality have increased.

It was evident that there are major differences both between and within stakeholder groups as to needs, drivers and constraints for further improvement. These differences ranged from the perceptions within the marketplace regarding milk quality measures, the motivation to reduce on-farm somatic cells, and the perceptions surrounding relationships both within and beyond the farm-gate.

The key conclusion is that the NZ dairy industry requires more engagement with the complex perceived realities of OFMQ amongst the various stakeholders. This requires a collaborative approach, and better recognition of target-audience diversity. Given the diversity of perceptions within the industry, SSM provides a suitable framework for system analysis and improvement of OFMQ.

Keywords: *New Zealand dairy industry, milk exports, milk quality, food safety, somatic cells, bacteria, contaminants, stakeholders, perceptions, SmartSAMM, soft systems, Peter Checkland, Kurt Lewin, George Kelly, Peter Senge, personal construct theory*

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This has been both a battle and a journey of self realisation. The journey was like a long OE with frequent stops, some of which were fruitful and others that simply resulted in “life getting in the way” of my writing. But I have many people to thank for finally getting here. The people include contributors, critiquers, guides and supporters. It would be very hard to single individuals out, because it was a combination of these peoples' contributions that got me there in the end.

In terms of contributors, most of them will remain anonymous as they are within this document, but they know who they are, and it was a privilege to get to know each and everyone of you, and it amazes me just how deep the talent and how genuine the passion is within the New Zealand dairy industry. Without your support, there would be no results. Two contributors in particular assisted me in my early phases of the research and I would like to name them: David Williams and Jane Lacy-Hulbert. Wow, you kept a straight face when I was asking the most naïve questions and always encouraged me, so thank you, (and sorry it took so long to finish this!).

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My supporters are many, and thank you all, again many of you will recognise yourself in this group. However, my unwavering and patient support from my family deserves the ultimate thank you. The thesis became the dreaded “t” word in our house and was responsible for many late nights and absences in both body and mind from you all. So thank you and I appreciated the love and support you have given me these past two years. I am especially proud of my daughter Taylor-Jane whom completed her own dissertation before mine.

Glossary

| | |
|----------|---|
| BMSCC | Bulk milk somatic cell count (also known as BTSCC) |
| BTSCC | Bulk tank somatic cell count (also known as BMSCC) |
| DCT | Dry-cow therapy |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| LIC | Livestock Improvement Corporation |
| MRL | Maximum residue limits (MRL) of pesticides in milk |
| MPI | Ministry of Primary Industries (NZ) |
| NMAC | National mastitis advisory committee |
| NZ | New Zealand |
| OFMQ | On-farm milk quality |
| PCT | Personal construct theory |
| SCC | Somatic cell count |
| SAMMPlan | Seasonal Approach for Managing Mastitis Plan |
| SSM | Soft systems methodology |
| TBC | Total bacteria count |
| WHO | World Health Organisation |
| WTO | World Trade Organisation |

Table of Contents

Abstract

..... 1

Acknowledgements..... v

Glossary vi

List of Tables and Figures..... xii

List of Tables xii

Foreword xiii

Chapter 1 Background to research problem 1

1.1 The problem statement 2

1.2 The connection between animal health and milk quality 3

1.3 The lens for eliciting research questions..... 6

1.4 Research Questions..... 7

1.5 Source of materials 7

1.6 SSM as a framework to examine problem statement..... 8

1.7 The thesis outline 10

Chapter 2 Milk Quality programmes: SAMMPlan and SmartSAMM..... 12

Chapter 3 Theoretical constructs for analysis..... 17

3.1 Introduction 18

3.2 Ontology and epistemology 19

3.3 Personal construct theory 20

| | | |
|-----|--|-----------|
| 3.4 | Soft-systems methodology (SSM) and Checkland..... | 21 |
| | The flux of everyday life” (events and ideas over time) yields: | 24 |
| 3.5 | Lewin’s force field model | 25 |
| 3.6 | Stakeholders..... | 27 |
| 3.7 | The analytical framework..... | 28 |
| 3.8 | Peter Senge | 30 |
| | Chapter 4 Methods | 31 |
| 4.1 | The Case Study | 32 |
| 4.2 | The Sample Frame..... | 34 |
| | 4.2.1 Identifying Stakeholders and assigning their codes | 35 |
| 4.3 | The interviews..... | 37 |
| | 4.3.1 Conducting the interviews | 38 |
| | 4.3.2 The interview questions are summarised as follows: | 39 |
| 4.4 | Analysis | 42 |
| 4.5 | Ethical considerations | 44 |
| | Chapter 5 | 45 |
| | Results Q1. What do stakeholders perceive to be the drivers or restraints for further improvement in on-farm milk quality in New Zealand? | 46 |
| 5.1 | Introduction | 46 |
| 5.2 | The questionnaire results..... | 47 |
| | Table 5-a: Stakeholders’ perceptions of the drivers for improvements in OFMQ based on questionnaire and subsequent personal interviews, | 48 |
| 5.3 | Farmers’ perceptions about the drivers and restraints for further improvements in OFMQ..... | 50 |
| | 5.3.1 Growing Herds | 50 |
| | 5.3.2 Money | 51 |

| | | |
|---|---|-----------|
| 5.3.3 | Relationships and skills | 53 |
| 5.3.4 | Education and training | 54 |
| 5.3.5 | Technology | 56 |
| 5.4 | Advisors (C1-3) and researchers (R1-4) perceptions about the drivers and restraints for further improvements in OFMQ..... | 57 |
| 5.4.1 | Money | 57 |
| 5.4.2 | Relationships | 60 |
| 5.4.3 | Research education and training | 63 |
| 5.5 | Supply managers from processing companies perceptions about the drivers and restraints for further improvements in OFMQ..... | 67 |
| 5.5.1 | Money | 67 |
| 5.6 | Government agencies and regulatory bodies' perceptions about the drivers and restraints for further improvements in OFMQ..... | 69 |
| 5.7 | Summary: How identifying drivers and restraints for improvements in OFMQ could be examined by the New Zealand Dairy industry..... | 70 |
| Chapter 6 Results: Question 2..... | | 72 |
| 6.1 | Introduction | 73 |
| 6.2 | Historic events in New Zealand that set standards..... | 74 |
| 6.3 | Idea: the economic implications of poor OFMQ are determined | 76 |
| 6.4 | Educational material is developed to reduce SCC..... | 77 |
| 6.5 | New science regarding milk quality and processing | 80 |
| 6.5.1 | Food Safety Standards for New Zealand OFMQ..... | 84 |
| 6.6 | Contaminants..... | 86 |
| 6.6.1 | Veterinary Medicines | 86 |
| 6.6.2 | Other contaminants | 88 |
| 6.6.3 | Regulations and recommendations are debated surrounding allowable levels of contaminants for tradeable milk..... | 89 |
| 6.7 | Environmental paradox creates emerging issues for milk quality | 94 |

| | | |
|---|--|------------|
| 6.8 | Summary Table | 97 |
| Chapter 7 Reflections and limitations | | 101 |
| 7.1 | Question 1 | 102 |
| What do stakeholders perceive to be the drivers and restraints for further improvement in milk quality in New Zealand? | | 102 |
| 7.1.1 | Information and assistance | 102 |
| 7.1.2 | Relationships and skills | 104 |
| 7.1.3 | The perceptions of costs versus benefits | 106 |
| 7.2 | Question 2 | 108 |
| 7.3 | Limitations of research..... | 113 |
| 7.4 | Summary | 115 |
| Chapter 8 Conclusions | | 119 |
| 8.1 | Conclusions | 120 |
| 8.2 | Key thoughts | 123 |
| Appendices and References..... | | 124 |
| A.1 | Milk quality – The laboratory perspective: a summary prepared by Dave Malcolm (2008) | 124 |
| A.2 | Summary of the management of antimicrobial inhibitory substances in New Zealand milk..... | 127 |
| A.3 | Summary table of Fonterra milk quality tests and standards, 2008 | 129 |
| A.4 | Summary Table: Bacterial families that can affect milk quality | 130 |
| A.5 | Summary table of the history of mastitis control schemes in United Kingdom(UK) and Australia. | 131 |
| A.6 | A screen shot of SmartSAMM information on the DairyNZ site:(Retrieved: June 8, 2013 from: http://www.smartsamm.co.nz/) | 132 |

| | | |
|-------------------|---|------------|
| A.7 | Copy of Letter sent to key informant interviewees | 133 |
| A.8 | On Farm interview | 134 |
| A.9 | Table summarising the conversion of milk, by a range of processes, into a variety of dairy products and food ingredients. | 143 |
| A.10 | Example of newspaper article depicting the reaction to antibiotics and dairying the United Kingdom (2012)..... | 144 |
| A.11 | Checkland’s SSM’s cycle of learning for action..... | 145 |
| A.12 | Personal Communication: Research Interview dates and locations summary. | 146 |
| | Researchers and Consultants | 146 |
| | Consultants..... | 147 |
| | Farmers..... | 147 |
| | Government Officials and Testing Agents | 147 |
| | Milk Supply Managers | 148 |
| A.13 | Summary table of Questionnaire to draw conclusions for Lewin’s force field models: | |
| Advisors. | 149 | |
| A.14 | Summary table of Questionnaire to draw conclusions for Lewin’s force field models: | |
| Farmers | 150 | |
| A.15 | Comparison between advisors and farmers’ drivers and restraints for OFMQ – part I | 151 |
| A.16 | Comparison between advisors and farmers’ drivers and restraints for OFMQ – part II ... | 153 |
| References | | 156 |

List of Tables and Figures

List of Tables

| | |
|--|----|
| Table 5-a: Stakeholders' perceptions of the drivers for improvements in OFMQ based on questionnaire and subsequent personal interviews, | 48 |
| Table 5-b: Stakeholders' perceptions of the for improvements in OFMQ based on questionnaire and subsequent personal interviews | 49 |
| Table 5-c: A comparison between advisors' and farmers' perceptions of the drivers and restraints for further improvements in OFMQ in New Zealand. | 65 |

List of Figures

| | |
|--|-----|
| Figure 1-a A rich picture as a lens for the Researcher to generate the research questions for this thesis..... | 6 |
| Figure 2-a Changes in bulk milk somatic cell count (SCC), averaged arithmetically for each season, for New Zealand since 1992, modified from: Lacy-Hulbert et.al, (2011) | 13 |
| Figure 3-a Researcher's lens for selecting constructs for analysis of the research questions | 17 |
| Figure 3-b: SSM's cycle of learning for action 1, Adapted from: Checkland and Poulter, (2006, pg. xix). | 23 |
| Figure 4-a: SSM cycle of learning model, adapted from Checkland (2000) and Researcher's lens for developing research method..... | 31 |
| Figure 4-b A structured–pragmatic–situational approach to conducting case studies, taken from Pan and Tan (2011, pg. 164) | 33 |
| Figure 5-a: The Researcher's lens for answering research Q1 | 45 |
| Figure 5-b: Stakeholders' perceptions of the restraints for further improvement in OFMQ ... | 49 |
| Figure 5-c: The closer we come to achieving our vision, the more the conflicting forces can pull us away from our vision | 70 |
| Figure 5-d: Examples of Force Field models for analysing the drivers and/or restraints for towards further improvements in OFMQ within the New Zealand dairy industry. | 71 |
| Figure 6-a: The Researcher's lens to view Research Q2 | 72 |
| Figure 6-b: A brief summary of the flux of ideas and events from key findings. | 73 |
| Figure 6-c Possible sources of contaminants for NZ milk identified from this research | 94 |
| Figure 6-d: A summary of the secondary and primary data collected to support Question 2. | 98 |
| Figure 8-a: Researcher's Lens to draw conclusions from research questions | 119 |

Foreword

“ Alone, I have seen many marvelous things, none of which were true” African proverb²

Frustration, disappointment, sudden epiphanies have all shaped both the document ahead and the author. The last two years have been a rich and rewarding journey where I have examined and re-examined my own view of reality. Now that I have ‘crossed over’, there is no going back. As a mother, a teacher, and as a researcher, my lens has not only changed, but I also accept this will not be the end.

Much of the latter interpretations and final conclusions were influenced by the material written by: Peter Senge, (Senge 2006) and Margaret Wheatley, (Wheatley 2005) characterized by the following quote:

“Chaos cannot be controlled; the unpredictable cannot be predicted. Instead we are being called to encounter life as it is: uncontrollable, unpredictable, messy, surprising and erratic”

(Wheatley, 2005 pg. 125)

And it is on this note that I begin.

Robyn Cox

² Source unknown

Chapter 1

Background to research problem

“The need is for government departments, educators and exporters, as well as farmers, to understand our customers. We need to understand their systems and ways of doing things a lot better than we currently do,” Bruce Wills, 2013.³

This initial chapter discusses the significance of the research to the New Zealand dairy industry and identifies the context of the study. It also discusses the appropriateness of the research design and attempts to justify the decision to use Soft Systems Methodology (SSM) to frame the research. The significance of this study will be to present a new lens to examine stakeholder perceptions around milk quality for a complex organisation such as the New Zealand dairy industry.

The quote from Bruce Wills above was in response to a botulism scare in the New Zealand milk industry in 2013. While the incident is not the context of the thesis itself, it does represent the landscape and the importance of the material within it. An investigation⁴ following the 2013 “botulism scare” highlighted that there were issues regarding collaboration, systems and the transparency (or lack of) of conversations within the New Zealand dairy industry during this period.

This chapter provides the background surrounding the importance of milk quality for the New Zealand dairy industry and defines milk quality. In addition, it explains how the diversity of stakeholders and their different perceptions might create issues in the pursuit of further

³ Bruce Wills the President of Federated Farmers New Zealand, in response to the Chinese reaction to a botulism scare in New Zealand Milk 2013, retrieved from: www.fedfarm.org.nz/publications/media-releases/article.asp?id=896 August 12th 2013.

⁴ Report reference: [https://www.dia.govt.nz/vwluResources/Government-Whey-Inquiry-Report-November-2014/\\$file/Government-Whey-Inquiry-Report-November-2014.PDF](https://www.dia.govt.nz/vwluResources/Government-Whey-Inquiry-Report-November-2014/$file/Government-Whey-Inquiry-Report-November-2014.PDF)

improvements in on farm milk quality (OFMQ). Finally, the chapter provides the rationale behind the two research questions.

1.1 The problem statement

The purpose of this initial sub-chapter is to provide background for the context of this study: on-farm milk quality (OFMQ), and its importance to the New Zealand dairy industry. The dairy industry is significant to New Zealand and contributes 25 per cent to New Zealand's merchandise export earnings. Exports exceeded \$13 billion in 2012, when the data from this research was collected, and New Zealand dairy exports accounted for over a third of the world's dairy trade, (Barnao 2012; Goodwin 2012; Saunders 2012). Any threat to this industry therefore, had substantial impacts on the New Zealand economy, and thus its security was a concern for a wide range of stakeholders both directly within the industry and externally to the industry including central government.

Although improvement of on-farm milk quality, (OFMQ) is the New Zealand dairy industry goal, no New Zealand research had previously attempted to elicit the perceptions of industry stakeholders about the pursuit of change. Accordingly, this thesis set out to establish these perceptions.

The New Zealand dairy industry has a reputation where its customers assume that the products that leave New Zealand are safe, high quality goods produced with integrity. However, often reputations are about perceptions rather than facts; therefore, building a strong brand image is a key for access to premium markets. A paradox is perceptions can also destroy an image, therefore traceability systems need to be robust. Affluent consumers purchase products based on image and they will pay premium prices for perceptions of safe food. Therefore, the New Zealand agricultural industry portrays their brand as wholesome, safe, and trustworthy. They must continuously uphold this, because the international market requirements for food quality and safety are constantly changing, and increasingly scrutinised, (Goodwin, 2012; Saunders, 2012).

“The dairy industry will either have to keep up with the changing definition of quality and ultimately get ahead of it, or get stomped by the stampeded of public opinion,”

Rick Bennett (quoted by Johnson, 2008, p.g.12)

For dairy products to be traded there are stringent controls for milk quality, accordingly, milk-processing companies penalise producers that do not meet the current standards⁵ (Livestock Improvement Corporation(LIC) 2001), particularly in terms of bacterial grades, inhibitory substances⁶, and somatic cell counts (SCC) (Franks,1994; Jamieson, 2012). Raw milk quality is very important to processors and customers because the quality of the raw product strongly influences the quality of the end-product for sale. While many factors both influence on-farm milk quality, this study will largely draw upon information pertaining to somatic cells and bacteria. Burgess (2010) summarised that milk quality standards that govern processors range from food quality, safety, and cost efficiency, of which, food quality and safety, provide the foci for this thesis.

1.2 The connection between animal health and milk quality

“Foodborne pathogens, mastitis, milk quality, and dairy food safety are indeed all interrelated.” (Oliver, Fish, Winter, Hodgson, Heathwaite, & Chadwick, 2012, pp.126)

A key concern is that milk is a source of human disease. In the past, these fears were associated with diseases such as tuberculosis and brucellosis, (Grant, 1991, LIC, 2001). While for less developed countries this might still be a an issue, for countries such as United Kingdom and New Zealand, *Salmonella* and *Campylobacter* are the key concerns for human health, (Adams & Moss 2008).

⁵ Appendix A.1 explains and summarises some of the quality control tests undertaken in the New Zealand dairy industry.

⁶ The inhibitory substance test is carried out to detect substances that inhibit or reduce the growth of bacteria in milk. For further details see Appendix A.2.

“To date, around 250 different food-borne diseases have been described, and bacteria are the causative agents of two thirds of food-borne disease outbreaks. Among the predominant bacteria involved in these diseases, Staphylococcus aureus is a leading cause of gastroenteritis resulting (Thorrold and McCall 2010) from the consumption of contaminated food, Staphylococcal food poisoning is due to the absorption of staphylococcal enterotoxins performed in the food,”

(Le Loir, Baron & Gautier, 2003, pg.63).

Cows with mastitis generally produce milk with higher total bacterial counts (TBC) and higher somatic cell counts (SCC) than milk from uninfected cows. Cows vary in their SCC levels due to factors including seasonal exposure, age, breed, and immune responsiveness. The New Zealand dairy industry has had a proactive response to market-place concerns about on-farm milk quality for decades, and has tried to enhance farmers' awareness of good practice associated with mastitis.

There has also been a focus within the global dairy industry to encourage milk suppliers to provide on-farm milk exceeding the international trade standards. This occurs in New Zealand, particularly from smaller milk companies whom implement both penalties for breaches of standards, as well as incentives for the supply of superior quality milk, (Fairweather, 2012; McIntyre, 2012; Van Boheeman, 2012; Williams, 2012). In 2012, the international-trade standard for bacteria in raw milk was less than 100,000cfu/ml⁷, however, the New Zealand dairy industry standard was 50,000cfu/ml, and the industry imposed demerits beyond this⁸. Milk quality, is dependent on an animal's health, the production

⁷ Cfu/ml is **CFU** stands for '**Colony Forming Units**' and refers to the number of viable bacterial cells in a sample per unit of volume. For example: 50 **CFU/100 mL means 50 Colony Forming Units per 100 mL** of sample.

www.cascadeanalytical.com/resources-downloads/faqs

⁸ An example of the Fonterra quality tests and standards for milk supply in New Zealand (2008) can be found in Appendix A.3.

environment and hygiene, (Auld, Walsh, & Thomson, 1998). Because milk can grow pathogens, how these factors are managed is a concern for New Zealand's trading partners. The main bacteria associated with milk come under four families⁹ (Barbano, 2004; DairyNZ, 2009), and research has determined that while somatic cells in milk do not pose direct health risk for humans, their presence is an indication of poor farm hygiene which can elevate risks to humans¹⁰ (National Mastitis Council Inc., (NMCI), 2005).

Mastitis is an inflammatory response that increases blood proteins and white blood cells, which pass into the milk as somatic cells¹¹. This response destroys the irritant, repairs the damaged tissue and returns the udder to its normal function, (Jansen, Schalk, Renes & Lam 2010). Even though the regulatory limit for bulk tank somatic cell count (BTSCC) in New Zealand meets the trading standard of 400,000 cells/ml, it was considered that 100,000 cells/ml is an appropriate target, as levels higher than 150,000 cells/ml can indicate a mastitis infection, (Agriculture and Horticulture Development Board, (AHDB) 2012; Anon(a), 2012; DairyCo, 2012).

DairyNZ research has established clear guidelines for best practice to deal with mastitis on farm, through publications such as the SAMMPlan¹² and more recently SmartSAMM. The assumptions therefore are that further improvements in OFMQ were both desirable and feasible. However, despite this, the New Zealand dairy industry has continuously failed to reach its target BTSCC of <150,000 cells/ml that it set in 1992, (Blackwell, & Lacy-Hulbert, 2012; Lacy-Hulbert, 2012). Accordingly, this disparity became the focus for formulating the central questions for this thesis.

⁹ *The main bacteria associated with milk come under four families thermophilic, thermophilic, psychrotrophic and coliforms and a summary of their relevance to milk-quality is in Appendix A.4*

¹⁰ *One such example is the significant link between staphylococcus-aureus a common bacterium associated with mastitis and enterotoxin, a known human pathogen, Oliver et al (2005).*

¹¹ *The number of somatic cells per ml of raw milk tested and are measured as a "somatic cell count" (SCC)*

¹² *See Chapter 2. for further details regarding SAMMPlan and SmartSAMM*

1.3 The lens for eliciting research questions

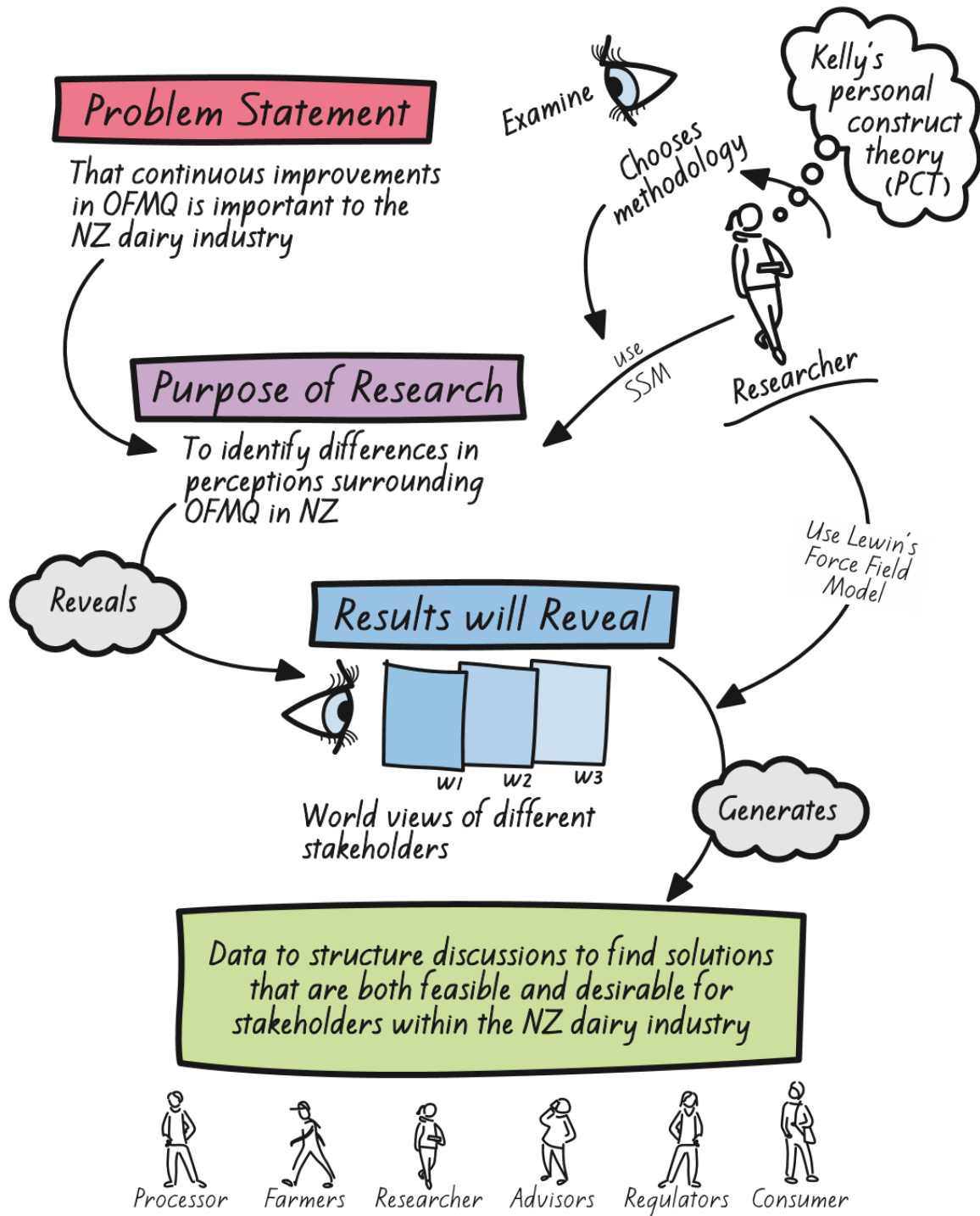


Figure 1-a A rich picture as a lens for the Researcher to generate the research questions for this thesis

1.4 Research Questions

Question 1: What do stakeholders perceive to be the drivers or restraints for further improvement in on-farm milk quality in New Zealand?

Question 2: What events and ideas may have influenced perceptions surrounding on-farm milk quality in New Zealand?

1.5 Source of materials

“The voyage of discovery is not in seeking new landscapes, but in having new eyes”

- Marcel Proust- ‘The Captive’ - Remembrance of Things Past

The material used to answer the central questions included data from a series of interviews conducted in 2012. These interviews initially aimed to elicit stakeholders' beliefs surrounding how the New Zealand dairy industry might successfully gain improvements in OFMQ, in particular with reference to somatic cells and bacteria. During the course of the interviews, it became apparent that the soon to be released SmartSMM document¹³ by DairyNZ would comprehensively cover the “how-to” for this goal.

However, on reflection, the transcripts revealed an additional context to discuss the problem statement. The interesting finding was that perceptions surrounding OFMQ varied both between stakeholder groups but also within them. Re-examining this data and recognising that individuals would have countless experiences in formulating their constructs for examining the central questions is essentially, what this thesis now focuses upon. The timing of the interviews became less relevant and differences in perceptions became the key.

¹³ See Chapter 2 pg. 27-31 for further details about the SmartSMM programme.

DairyNZ was decentralised, and instead acknowledged as just a part of the New Zealand dairy industry with a diversity of stakeholders. An assumption was that, the stakeholders including farmers, researchers, processors, and advisors would all be acting purposefully and their perceptions surrounding on-farm milk quality, would be largely due to their own world-view of the problem statement. A gap was identified for clearly eliciting stakeholder viewpoints within this context, where both the on-farm and off-farm influences and the fluid nature of changes over time was considered.

Questions were then formulated that examined the events and ideas that may have influenced perceptions of milk quality for the stakeholders within the New Zealand dairy industry. The research focused on the period 1992-2012, although historic information also contributed to the context. This timeframe also encompassed the beginning and end of the mastitis management programme, SAMMPlan, developed by DairyNZ.

1.6 SSM as a framework to examine problem statement

“We see the world, not as it is, but as we are—or, as we are conditioned to see it.”

Stephen Covey¹⁴

Human behaviour is complex and difficult to analyse and predict. While it is possible to implement action on our own, the assumptions we rely on for this action will only be a reflection of our own constructs at best, consequently:

(Businesses)... “too, are bound by invisible forces of interrelated actions, which often take years to fully play out their effects on each other. Since we are a part of that lacework ourselves, it is doubly hard to see the whole pattern of change. Instead we

¹⁴ This quote is thought to be a derivative of a quote coined by Anais Nin who attributed this to the Talmudic reference: “We do not see things as they are. We see things as we are.”— Rabbi Shemuel ben Nachmani, as quoted in the Talmudic tractate Berakhot

tend to focus on snapshots of isolated parts of the system, and wonder why our deepest problems never get solved. Systems thinking is a conceptual framework, a body of knowledge and tools, that has been developed over the past 50 years to make full patterns clearer, and to help us see how to change them effectively", (Senge, 2006 p.g 7).

Systems thinking is valuable because the modern world is overwhelmingly complex.

Organisations have the means to create more information than they can ever absorb and to accelerate change faster than they can keep pace. What can be gained by SSM is the learning gained from the feedback. The reflective nature of feedback allows an opportunity to reduce complexities and provide a better lens to guide meaningful action for improving problematic situations, (Senge 2006).

Humans have habitual ways of thinking and perceiving. Thinking freshly however, requires us to revisit this. In this context, valuable insights can be gained by examining Kelly's Personal Construct Theory (PCT)¹⁵ to acknowledge that our perceptions will be shaped by not only our own experiences, but also the experiences we share with others. For this reason PCT is considered a useful lens (Simpson 2004).

This thesis is not full of exemplary practice. Rather, it aims to provide a new lens for the New Zealand dairy industry to examine milk quality and recognize that all stakeholders are critical components for changes to occur. It is essential that there is an engagement with all stakeholders and in doing so opportunities will arise from these differing world-views. Added, opportunities could arise to find solutions that may be feasible and desirable for all involved.

¹⁵ *Kelly believed that individuals act very much like scientists studying personality: they create constructs, or expectations about the environment and people around them, and then they behave in ways that "test" those beliefs and expectations. For Kelly, the personal constructs are more important than actual reality, since it is the construct that guides cognition and behaviour, not the actual situation, (retrieved from: <https://cnx.org/contents/jAUWBxcT@1/Cognitive-Perspectives-on-Personality>).*

SSM is suitable for researching complex and messy¹⁶ problems and Chapter 3 discusses this in detail. Because SSM relies on holisms rather than parts, new paradigms for change may be enhanced by using such an epistemology.

1.7 The thesis outline

Because events both precede ideas and create new ones; and because ideas are created in a similar fashion, both primary and secondary sources were used to generate the data.

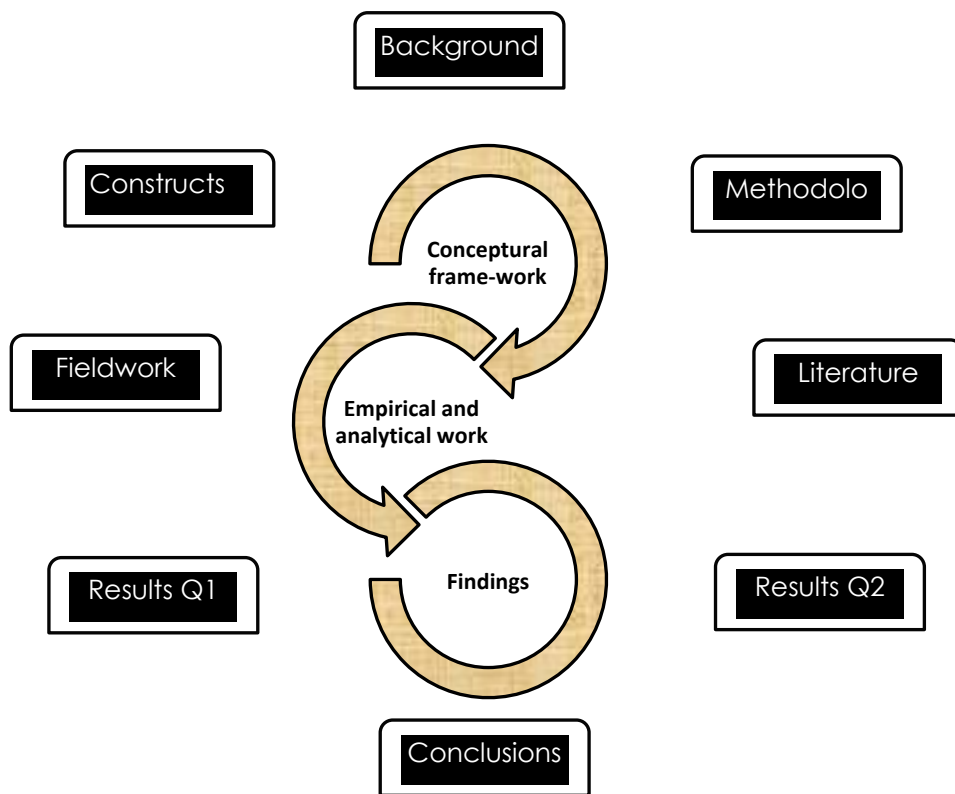
The subsequent chapters address these topics:

- Chapter 2 provides a brief background about the history of efforts to improve milk quality in New Zealand with an outline of the SAMMPlan and SmartSAMM.
- Chapter 3 discusses the theoretical constructs used to analyse the results generated by the research and a description and justification of the methods employed to elicit the results.
- Chapter 4 gives further details about these methods. Chapters 5 and 6 present the results for each question separately.
- Chapter 5 presents results for Question 1
“What do industry stakeholders perceive to be the drivers or restraints for further improvement in on-farm milk quality in New Zealand?”
- Chapter 6 presents the results for Question 2
“What events and ideas may have influenced perceptions surrounding on-farm milk quality, in terms of somatic cells, bacteria in New Zealand?”
- The final analysis in Chapter 7, combines the two sources of data with a summary that utilises the theoretical constructs' methodology plus a statement of the research's limitations and a discussion of the findings: with a caveat that the interpretations are the personal constructs of the subjects, the researcher, and the reader. Here the

¹⁶ *Messy problems are defined as: situations in which there are large differences of opinion about the problem or even on the question of whether there is a problem, (Ackoff, 1974, described in: Ramage and Shipp, 2009).*

driving and restraining forces stakeholders perceive surrounding somatic cells in on-farm milk are the context for documenting their worldviews. The purpose is to provide insights of the “multiple world-views” as suggested by Checkland's SSM model that could then perhaps be used to identify forces that could either drive change towards improvements in OFMQ or create barriers to impede this.

- The thesis ends with conclusions in Chapter 8.



Chapter 2

Milk Quality programmes: SAMMPlan and SmartSAMM

“Consequently, disciplines like sociology, economics and marketing may offer new methodological approaches to veterinarians as these disciplines have understood that accounting for individual differences is central to motivate change, i.e. 'know thy customer'”, (Kristensen & Enevoldsen, 2008, pg.50).

This short chapter provides a brief explanation of the DairyNZ mastitis management programme for the management of mastitis in the New Zealand dairy industry. In 1992, because the European Union (EU) reduced the acceptable trading standard for somatic cells in raw milk from 750,000 cells/ml to 400,000 cells/ml, the New Zealand dairy industry introduced the SAMMPlan (Seasonal Approach for Managing Mastitis Plan) as a strategy to control mastitis and reduce bulk milk somatic cells (BTSCC). In June 2012, the successor to the SAMMPlan: SmartSAMM provided a more targeted approach to improve farmer motivation to lower BTSCC levels.

SmartSAMM was collaboration between DairyNZ and the National Mastitis Advisory Committee (NMAC), and key rural professionals involved in milk quality and herd health. Compared to its predecessor the SAMMPlan, the new version SmartSAMM promoted a more collaborative and interactive approach, based on the Australian model “Count Down¹⁷,” and the “British 5-Point Plan”¹⁸ (Blackwell & Lacy-Hulbert, 2012; Lacy-Hulbert, 2012). It combined research from both Australasia and Europe for mastitis prevention, which also aimed to reduce both bacteria and inhibitory substances, (Malcolm, D. 2012).

¹⁷ A summary of the Australian Countdown models and the British 5-Point Plan can be found in Appendix A.5

¹⁸ Information from conversation with Malcolm, D. (2012), Interview at DairyNZ, Ruakura. R. Cox. Hamilton.

SAMMPlan's aim was to reduce mastitis and therefore SCC levels in raw milk with an industry target BTSCC of 150,000 cells/ml. After its introduction in 1992, significant reductions in BTSCC did initially occur, but the industry never reached its target. Subsequently, BTSCC levels rose from 1996-2011, hence the development of the updated model called SmartSAMM, (Blackwell and Lacy-Hulbert 2012, Lacy-Hulbert 2012).

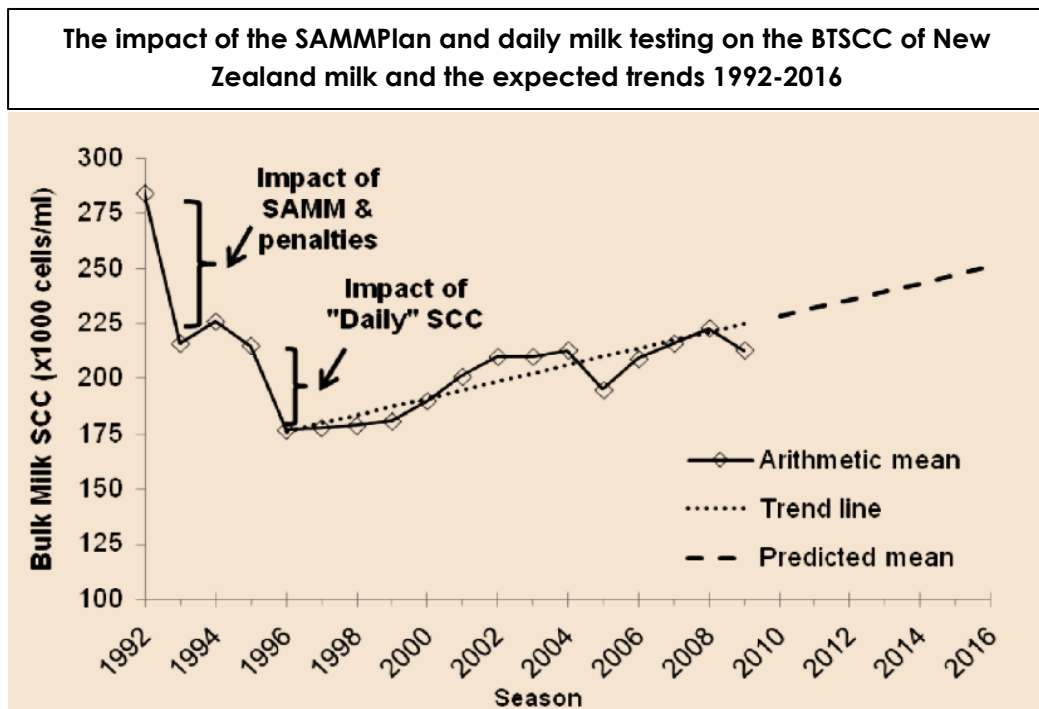


Figure 2-a Changes in bulk milk somatic cell count (SCC), averaged arithmetically for each season, for New Zealand since 1992, modified from: Lacy-Hulbert et.al, (2011) ¹⁹

The following contains a summary from the DairyNZ online site: SAMM stands for the Seasonal Approach to Managing Mastitis, a mastitis extension programme that operated in New Zealand between 1993 and 2010. SmartSAMM builds on the success of the SAMM Plan, now refreshed for modern information systems and updated for today's dairy farm systems. The SmartSAMM project team is collaborating through NMAC (National Mastitis Advisory

¹⁹ From: SmartSAMM: The smart approach to minimising mastitis, Jane Lacy-Hulbert, Mark Blackwell and Scott McDougall, 2011 pg. 17.13.2

Committee) with stakeholders and service providers responsible for mastitis control and milk quality in New Zealand.

The SmartSAMM support programme aimed for New Zealand bulk milk somatic cell (BMSC) counts to be reduced annually by 10,000 cells per ml, and all milk from all herds below 400,000 cells per ml by 2016. Additionally, it aimed to develop systems to measure and monitor clinical mastitis, linked with Dairy Data Network by 2012. By achieving these targets, the New Zealand dairy industry hoped to gain in excess of \$100 million operating profit per annum, to enhance its international competitiveness, and to improve animal welfare and working conditions on farm²⁰.

DairyNZ compared farmer goals for the incidence of clinical mastitis with the actual incidence and found more than 80% of farmers had more mastitis than they were aiming for. The gap between desired goal and actual incidence leaves many farmers frustrated with the costs and losses associated with this disease according to researchers at DairyNZ, (R1, 2012). These concerns prompted the development of an updated mastitis management programme, SmartSAMM.

The following are extracts from: Blackwell & Lacy-Hulbert, (2011, pg. 7.03.3):

“Continuous improvement is most associated with W.E. Deming in revolutionising quality management and competitiveness in the post-World War Two Japanese car industry (Deming 2012). Dr. W. Edwards Deming taught that by adopting appropriate principles of management, organisations can increase quality and simultaneously reduce costs (by reducing waste, rework, staff attrition and litigation while increasing customer loyalty). The key is to practice continual improvement and think of manufacturing as a system, not as bits and pieces”.

²⁰ Links to the updated Smart SAMM see: <http://www.dairynz.co.nz/Search/Results?Term=smartsamm>

“Deming’s four step PDCA cycle of ‘Plan, Do, Check and Action’ is reflected in the 4-step continuous improvement process (Figure 3-b) employed in both InCalf (Blackwell, 2008) and SmartSAMM. The intention for SmartSAMM is to assimilate continuous improvement into all programme elements, so users follow good process even if they do not realise it”.

Figure 2-b

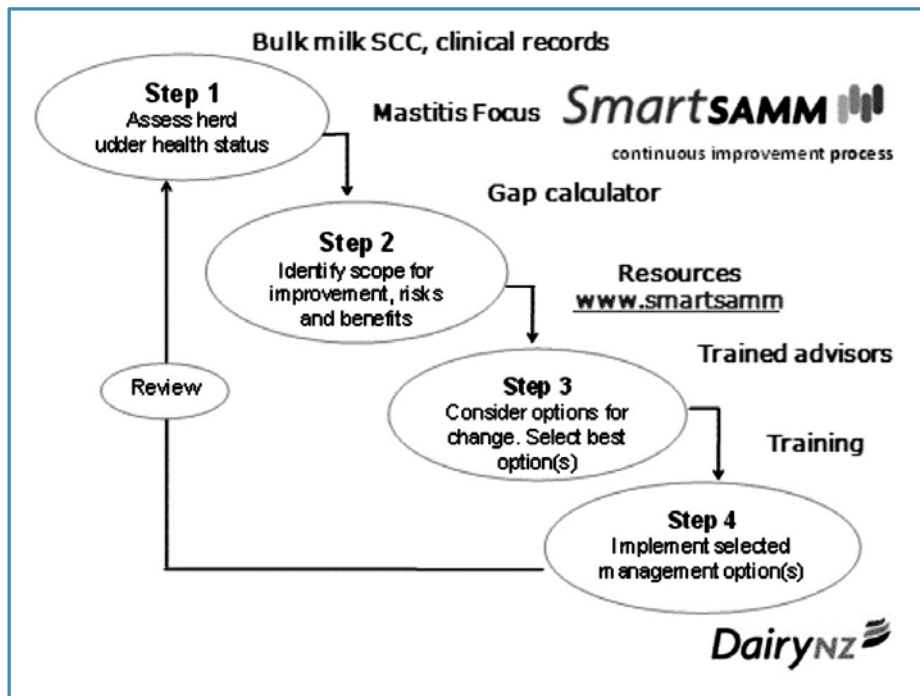


Figure 2-b Continuous improvement process and SmartSAMM elements, (Blackwell & Lacy-Hulbert, 2011, Figure 3-b, pg. 7.03.3)

The most significant change for SmartSAMM²¹ was the greater emphasis on intrinsic motivators such as teamwork, rather than extrinsic factors such as penalties, and regulations, and the DairyNZ research focus has changed from authoritarian to collaborator, (Blackwell & Lacy-Hulbert 2011; Lacy-Hulbert, 2012; Tarbottom, 2012).

²¹ Links to the updated Smart SAMM see: <http://www.dairynz.co.nz/Search/Results?Term=smartsamm>

The EU researched issues surrounding farmer motivation for on-farm quality management programmes, (Creamer, Pearce, Hill & Boland, 2002; Klerkx & Jansen 2010; Velthuis, Flores-Miyamoto & Reij, 2011; D'Mello, 2012). This research was influential in DairyNZ's plan to approach the integration of the new SmartSMM material, (J. Lacy-Hulbert, personal communication, May 9, 2012). International research indicated farmers' motivations were often misunderstood and tension between farmers and support-networks such as veterinarians, could result from this, (Kristensen & Jakobsen, 2011). Research from (Huijps, Lam & Hogeveen, 2010) and (Jansen, van Schaik, Renes & Lam, 2010), supported the view, in that they espoused the "human factor" was overlooked when interactions between farmers and researchers took place.

The assumption that constructs that framed perceptions were analogous needed to be re-examined and instead acknowledged that this was unlikely. These ideas were pivotal in the acknowledgement from DairyNZ, that new approaches and understanding for farmer education programmes would be required if on-farm milk quality was to improve, (J. Lacy-Hulbert, personal communication, May 9, 2012).

Chapter 3

Theoretical constructs for analysis

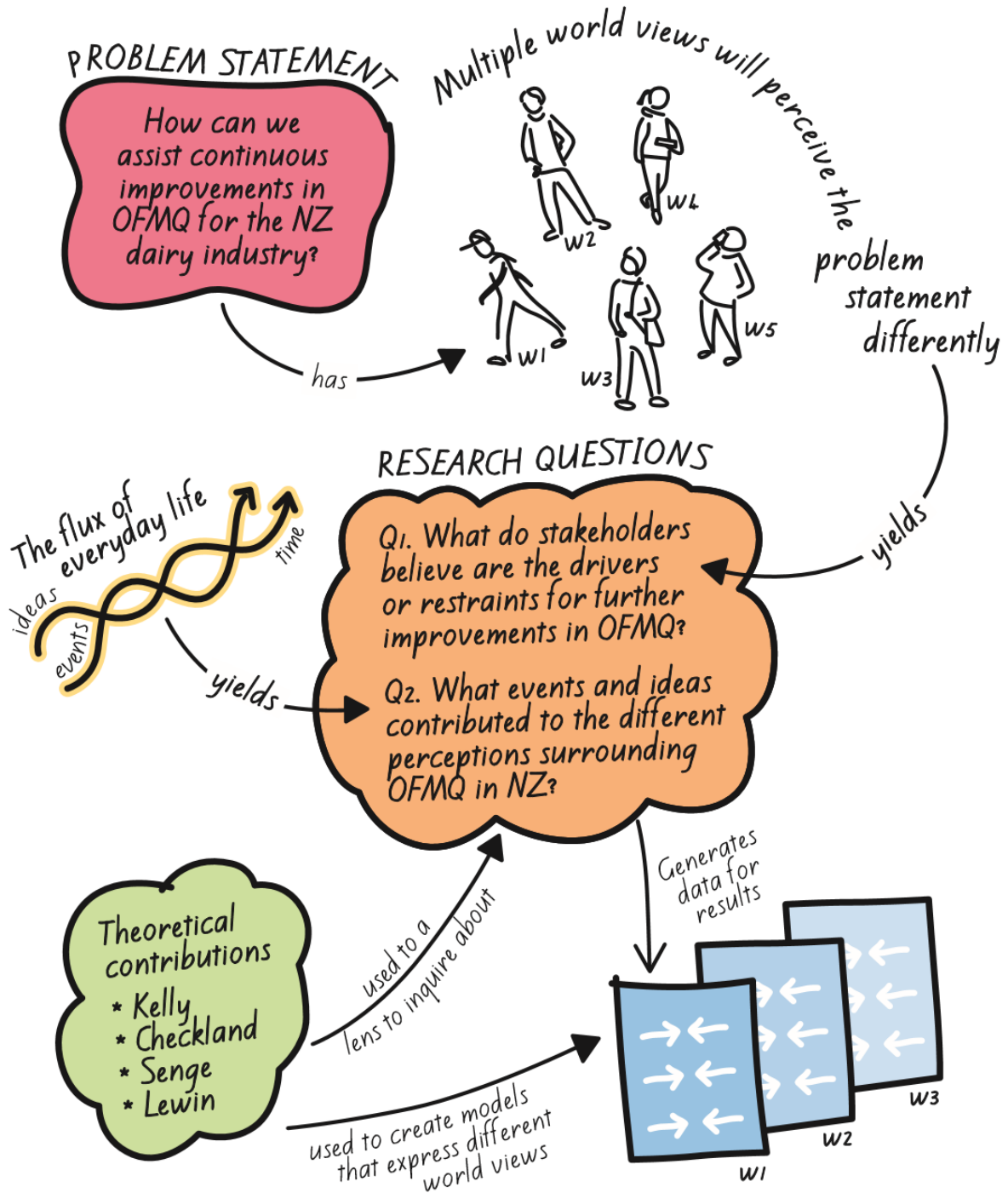


Figure 3-a Researcher's lens for selecting constructs for analysis of the research questions

3.1 Introduction

“Ontology, epistemology and methodology, and methods are all connected and must not be viewed in isolation,” (King & Horricks, 2010, p.g.10).

This chapter outlines the reasoning behind using an interpretative framework as the method for this research. An interpretive approach is commonly used to address issues of description, interpretation, and explanation, whereas quantitative research is considered to be better suited to address questions of prevalence, generalizability, and calibration, (Gough & Scott 2000; Kim, 2003; Bluhm, Harman, Lee & Mitchell, 2011; Walliman, 2011). An interpretive view of research that seeks to understand phenomena and to interpret meaning within the social and cultural context of the natural setting (King & Horricks 2010), which was considered an appropriate lens for the analysis of the data collected for this research.

According to King & Horricks, (2010), two paradigms exist in research: qualitative and quantitative. The major difference is not the type of data collected, but the foundational assumptions, the givens that are true. However, it is necessary for a researcher to outline both the philosophical and theoretical positions that will underpin the research project and in addition to identify the paradigm, the epistemology and ontology, (King & Horricks 2010).

This chapter examines the theories providing the framework for data analysis. Personal Construct Theory (PCT) considers the world-view of the stakeholders, 3.3 outlines this theory. Paradigms that fitted the problem statement were from Peter Checkland's 'Soft Systems Methodology', (SSM) and Kurt Lewin's 'Force-field model', described in 3.4 and 3.5 respectively. Stakeholders were an integral consideration both prior to data collection and during analysis and 3.6 summarises this.

3.2 Ontology and epistemology

Ontology and epistemology state a researcher's worldview. They work together in that, while epistemology is a philosophical theory of knowledge, the ontology is the framework of assumptions "embedded in the theoretical ideas which are used to guide the research" (Blaikie, 2007, pg.14). Blaikie (2007) asserted that without clearly defining our own perception in which reality exists then identifying what is relevant to the knowledge we are seeking from our research would be impossible.

Multiple views defining ontology exist. Guba (1990), in his work "the alternative paradigm dialogue," attempted to contain the possible variations as a split between realism and relativism. Blaikie (2007) suggested that social reality is split into two mutually exclusive categories: idealism and realism, with five variations of the latter; while Walliman (2007), described idealism as a sub-branch of relativism, (Small & Chapman 2012). While no view is superior to the other, a researcher's statement of their belief creates ramifications for the viewing and analysis of data (Guba,1990; Blaikie, 2007; Willis, 2007; King &Horricks, 2010; Walliman, 2011).

This thesis assumes there are multiple realities due to the varying human experience, including the knowledge, own interpretation and experiences of the participants within this research.

Epistemology enables the researcher to identify the decisions relevant to the problem and derives from the Greek words: episteme (knowledge) and logos (augmentation or reasoning), therefore, in the absence of reasoning it cannot be processed knowledge (Cua & Garret, 2009). The epistemology for this thesis draws upon the interpretative rationale, and implies an ontological belief that reality is socially constructed, and data derives from an interactive relationship between researcher and participants.

In summary: this research entailed a personal and interactive mode of data collection where the enquirer (researcher for this thesis) and the inquired (authors of literature and key informants) interlocked in an interactive process. The social contexts of the experience shared by the stakeholders will have influenced the interpretations of the described events. Therefore the validity of any generalisations made were dependent on the cogency and logical reasoning applied when annotating, describing, or drawing conclusions from the data gathered, and would be interpretative at best, (Cepeda & Martin, 2005).

3.3 Personal construct theory

“All our knowledge is the off-spring of our perceptions” - Leonardo da Vinci

George Kelly was the initiator of personal construct theory (PCT) and his principal premises fit the belief that our interpretation of the world comes from the constructions we create to make sense of these experiences. Bannister & Mair (1968), when discussing Kelly's personal construct theory (PCT) stated:

“He makes three assumptions about the universe - that it is real and not a figment of the imagination; that it can be understood only on a time line; and that it is integral, so that in the light of complete knowledge and a broad enough perspective, all events can be seen as inter-related. Each of these points has important implications for the kind of psychological theory he originated.”

“In accepting that the universe contains real events and objects, Kelly also assumed the events internal to a person were equally real, so that thoughts or ideas about external things have a reality which is as convincing as the things themselves. Man, comes to know something about the universe only in so far as he can make interpretations of it, and approaches an accurate awareness of events by successive approximations,” (Bannister and Mair, 1968 pg. 4-6).

Bannister and Mair (1968) continue by stating:

“Man can only come to know the world by means of the constructions he places upon it and will be bound by events to the extent that his ingenuity limits his possibilities for reconstructing these events,” (Bannister and Mair, 1968 pg. 4-6).

“At one point Kelly likened constructs to sets of goggles through which a person could view sections of the world”, (Bannister and Mair, 1968, pg.25).

Kelly identified several corollaries as the architects of these constructions: each having a different effect on the outcome of the personal construct. This theory was fitting as each of the stakeholders provided data from on their own constructs. However, the constructs of the researcher, would also influence the outcome of both the data, and the interpretation of it. Personal construct theory has been introduced to the reader as a context for understanding the underlying thinking behind Checkland's soft-systems methodology (SSM), (3.4) rather than a framework for analysis as such. Its relevance serves as 'background understanding' for SSM, Lewin's Force Field (3.5) and Senge's expansion of systems thinking (3.8)

3.4 Soft-systems methodology (SSM) and Checkland

“Systems thinking enables one to progress beyond simply seeing events to seeing patterns of interaction and the underlying structures which are responsible for the patterns. And, once we understand the real foundations for the situations we experience, we are in a much better position to respond in an enlightened fashion,”

(Gene Ballinger, (n.d), as cited in: O'Connor & McDermott, 1997, foreword, pg. x)

Peter Checkland while not formally acknowledging personal construct theory, alluded to the existence of multiple realities. Checkland developed Soft Systems Methodology (SSM), as an alternative to the positivist approach to what he called 'Hard Systems'. The overarching principle of SSM is that problematic situations are derived from the fluxes of life – where events, ideas and perceptions all contribute to the “problem” (Checkland & Poulter, 2010) .

One of Checkland's key principles was the importance of world-views and their related views of multiple realities. In simple terms, SSM is a systemic methodology to learn and solve problems that are subjective in nature. From Checkland's perspective, reality is complex and the "system" is a concept to organise our thoughts about the reality rather than as a way to engineer and control it. SSM was developed for use in what Ackoff would describe as a "messy problem" where there is no clear view on what "constitutes the problem", (Ramage & Shipp 2009).

The analysis of this thesis used SSM to gather, interpret, and present data.

Checkland describes this in the following three points:

- *"The complexity of problematic situations in real life stems from the fact that not only are they never static, they also contain multiple interacting perceptions of 'reality'. This comes about because different people have different taken-as-given (and often unexamined) assumptions about the world.....These people have different worldviews."*
- *"All problematic situations, as well as containing different world views, have a second important characteristic. They always contain people who are trying to act purposefully, with intention, not simply acting by instinct or randomly thrashing about- although there is plenty of that too in human affair."*
- *"The previous two points- the existence of conflicting worldviews and the ubiquity of would-be purposeful action, lead the way to tackling problematic situations. They underpin the SSM approach", (Checkland & Poulter, 2006, pg. xv-xvi)*

Checkland uses hand-drawn diagrams (rich pictures) and these were the starting point for the following research plan²². Figure 3 b page 38, illustrates this.

²² A copy of Checkland's hand-drawn model and the researcher's own interpretations of the "world-view" of the problem statement for this thesis can be found in Appendix A.11 and on page 38 respectively.

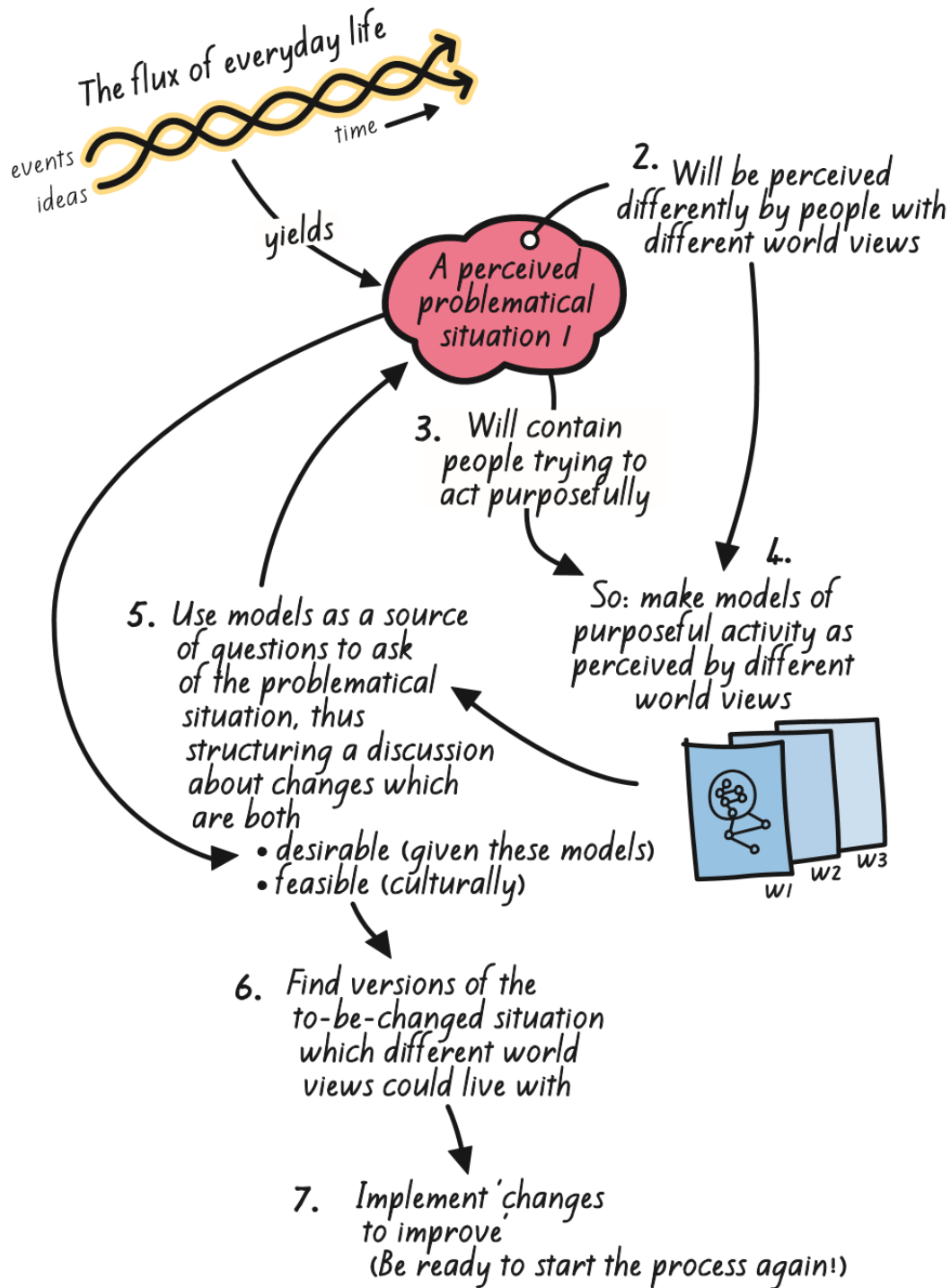


Figure 3-b: SSM's cycle of learning for action 1, Adapted from: Checkland and Poulter, (2006, pg. xix).

Checkland developed a 7-step process, the areas of this model that this thesis will draw on those areas labelled 1-4. In summary Checkland brief outline of SSM is provided below.

The flux of everyday life” (events and ideas over time) yields:

1. *A perceived problematic situation;*
2. *This (1) will be perceived differently by people with different world views;*
3. *This (1) will contain people trying to act purposefully;*
4. *So: make models of purposeful activity as perceived by different worldviews;*
5. *Use models as a source of questions to ask of the problematic situation, thus structuring a discussion about changes which are both:*
 - o *Desirable*
 - o *Feasible;*
6. *Find versions of the to-be-changed situation which different worldviews could live with;*
7. *Implement 'changes to improve' (Be prepared to start the process again!)",*

(Checkland & Poulter, 2006, pg. xix).

This thesis aims to provide material (as shown as steps 1-4) for the New Zealand dairy industry to implement their own steps, (as shown as 5-7) towards attaining continuous improvement in on-farm milk quality.

3.5 Lewin's force field model

"The risk of doing the same old thing is far higher than the price of change" Bill Clinton²³

Kurt Lewin, a pioneer of social science research, recognised the importance of the perceptions of the stakeholders within a research paradigm. His early influence was within Gestalt Psychology which maintains there are experiences, objects and relationships that are fundamentally different from mere collections of sensations, parts, or pieces, (Ramage and Shipp 2009). He developed many models for organisation change management and the model this thesis used was his 'force-field analysis' model. A representation of the force field model is shown below:

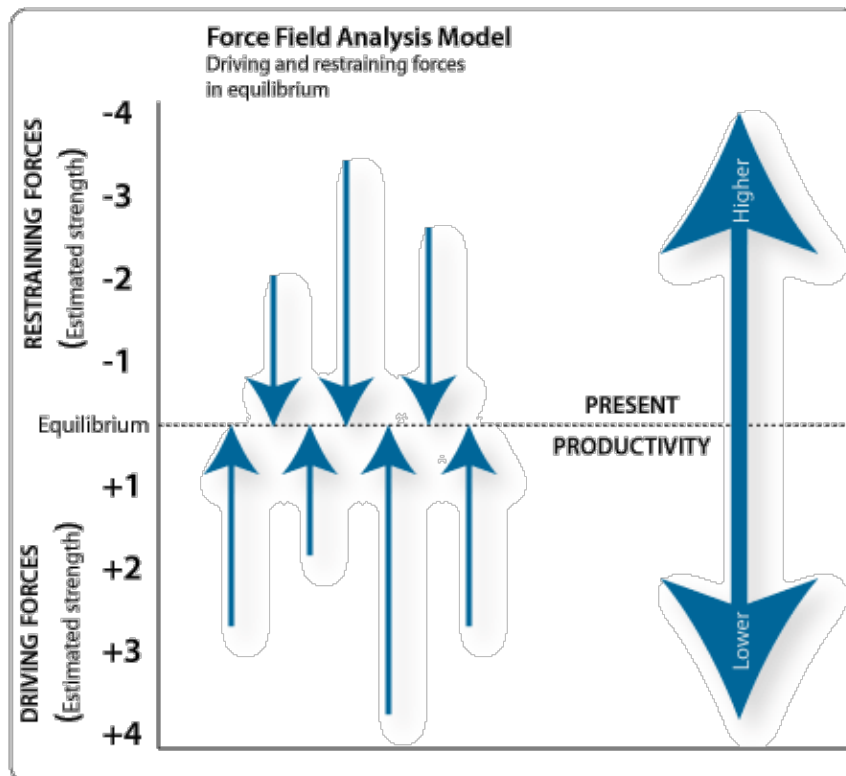


Figure 3-c: An adaptation of Kurt Lewin's Force Field Analysis Model ²⁴

²³ From: *The President's Radio Address, USA, (February 13th 1993)*. Retrieved June 6 2013, from: <http://www.presidency.ucsb.edu/ws/?pid=47121>.

²⁴ Sourced from <http://www.accel-team.com/techniques/images/forceFieldAnalysis.gif>

Kurt Lewin believed that an issue is held in balance by the interaction of two opposing sets of forces - those seeking to promote change, (driving forces) and those attempting to maintain the status quo (restraining forces)". Lewin's view was that one needs to plot and establish the potency of these forces, before understanding why individuals, groups and organizations act as they do, and to establish what forces would need to be diminished or strengthened for change to occur, (Ramage & Shipp, 2009).

The overarching assumption of Lewin's postulate, is that for any group or organisational situation there will be interplay of driving and restraining forces acting creating inertia towards a preferred state. The basic premise is that people will always seek equilibrium therefore to create change, an imbalance of forces has to occur, (Barkema, Van der Ploeg Schukken, Lam, Benedictus & Brand, 1999). A driving force can be either an external force compelling change or an internal problem creating a desire for change. Restraining forces can be either barriers from negative experiences of past changes, or the fear of loss, (Bozak, 2003). These driving and restraining forces can only represent the perceptions of the stakeholders involved, because one stakeholder's driving forces, may be restraining forces to someone else.

Lewin asserted that for an organisation to generate change towards a goal or vision, three steps are required. Firstly, an organisation has to unfreeze the driving and restraining forces holding it in quasi-equilibrium, (identification of these forces is therefore required), and secondly, an imbalance to the forces is required for change to take place, either by increasing the drivers, reducing the restraints, or both, (Ramage and Shipp 2009).

To interpret the results required frameworks for analysing this data, the 'force-field model' created by Lewin was used as a starting point to organise the research data prior to analysis, (Ramage & Shipp, 2009). Lewin's model was the framework to identify the forces stakeholders perceived to be the driving or restraining forces of change for further

improvements in OFMQ. The purpose for using of these two models (SSM and force field) together, was to provide a synergy of available information to provide a platform for a deeper understanding of the issues surrounding OFMQ in New Zealand.

3.6 Stakeholders

Freeman quoted that:

"...a stakeholder refers to any individual or group that maintains a stake in an organisation in the way that a shareholder possesses shares. From the numerous definitions, two dichotomous views emerge- the 'claimant' definition and the influencer definition of what it is to be a stakeholder- plus the combinatory definition: any group or individual that can 'affect or is affected by the achievement of an organization's objectives", Freeman (1984, pg. 46), quoted in: Fassin, (2009, pg. 116).

Freeman's stakeholder model was the starting point for the researcher to identify the stakeholders and their relationships both in and around the New Zealand dairy industry. Although his model has been criticised as being too basic by researchers such as Fassin (2009), it both simplified and aggregated the stakeholders identified. However, Fassin's caveat below was a consideration:

"However, one should be aware that all synthesised representations, models and schemes are social constructions that inevitably simplify and reduce reality," (Fassin, 2009, pg. 115).

Fassin, (2009) introduced new terminology relating to stakeholders with the categories: stake-watchers, (pressure groups) and stake-keepers (regulators). Real stakeholders, he stated, have a claim on the firm; pressure groups only have an indirect claim and regulators have no claim. After considering Fassin, (2009), and his justifications, stakeholders were extended to include NGOs, regulators and the media as sources of information.



3.7 The analytical framework

As the research questions are exploratory in nature and are not linked with specific hypotheses; it was considered they were best suited to a qualitative framework, (Patton 2002; Cepeda & Martin 2005; Koszalka 2005; Walliman 2011). Silverman (1998), cited in Cepeda & Martin, (2005), argued that:

"there is no agreed doctrine underlying all qualitative social research".

Silverman (1998, pg. 7) quoted in: Cepeda & Martin, (2005, pg. 851).

Cepeda & Martin, (2005), continued by stating:

"the common element of qualitative research is the collection of data in the form of words and statements, which is analysed by methods that do not include statistics or quantification," (Cepeda and Martin 2005, pg. 852).

This study is an example of an inquiry which is grounded in a qualitative, interpretive research paradigm, (Walliman, 2011). Research Question 1 required an interpretive analysis, as the data collected involved conjecture from key informants and therefore, in turn was more subjective. Personal construct theory governed the iterative phase for the analysis of the stakeholders' responses. Research Question 2, combined the findings from Q1 and an historic account of the ideas and events that shaped the on-farm milk quality criteria in New Zealand. Therefore, the information needed to be analysed from both primary and secondary sources.

Data was synthesised using both literature reviews as secondary sources, and primary data from multiple key informants. By maintaining an interpretive epistemology, triangulating the data aimed to lessen the effects of conjecture and subjectivity within the analysis.

Triangulation relates to the use of multiple methods, or multiple sources of data collection, (Patton, 2002; Yin, 2009, King & Horricks, 2010; Bluhm, et al. 2011; Walliman, 2011), and this

method was implemented to reduce the potential problems of what Yin, (2009), describe as 'construct validity'.

The research questions were generated by modifying templates based on models from Peter Checkland and Kurt Lewin, both of whom were advocates of using visual codes for analysing research problems. Checkland's 'cycle of learning for action model', an organisational tool for Soft Systems Methodology, (SSM) provided the framework for the identification and collection of the data.

"...all scientific systems of definition and classification are perceptual, artificial and arbitrary. Whose definitions prevail at any given time and place is a matter of politics, persuasion, and preference," (Patton, 1989, pg. 179).

Using an interpretative framework, it assumed that knowledge is comprised of multiple sets of interpretations of social and cultural context in which they occur. It required an openness in the understanding of stakeholders and an acknowledgement of the preconceptions of the interviewees, (Patton, 1989; Gough & Scott, 2000; Patton, 2002; Kim, 2003; Weed, 2005; Willis, 2007; King & Horricks 2010; Walliman 2011). This relevant as the key informants would have had conceptions of past events based on their own experiences.

3.8 Peter Senge

“Reality is made up of circles but we see in straight lines” Peter Senge²⁵

Peter Senge's book *the Fifth Discipline* (Senge, 2006) is considered by Harvard Business Review to be one of the seminal management books of the past 75 years²⁶. Systems Thinking, is said to be the one discipline where the focus of change management should be due to its ability to bind together the other aspects of organisational change.

“Ultimately, it simplifies life by helping us to see the deeper patterns lying behind events and details” Senge (2006, p.g.73)

In essence systems thinking attempts to comprehend and examine the interrelationships within Learning Organisations. These are listed as - the shared vision, team learning, personal mastery and 'mental models' (the deep ingrained assumptions and generalisations that influence how people act). In the Fifth Discipline (which is Systems Thinking) Senge encourages managers to look at problems from a holistic perspective. It is this perspective that will shape the conclusions within this research. Hence, the use of pictorial summaries used in this document provide a framework for examining these holisms.

²⁵ Peter Senge, (2006), p.g. 73

²⁶ Boston Globe- quoted on back cover of Peter Senge (2006).

Chapter 4

Methods

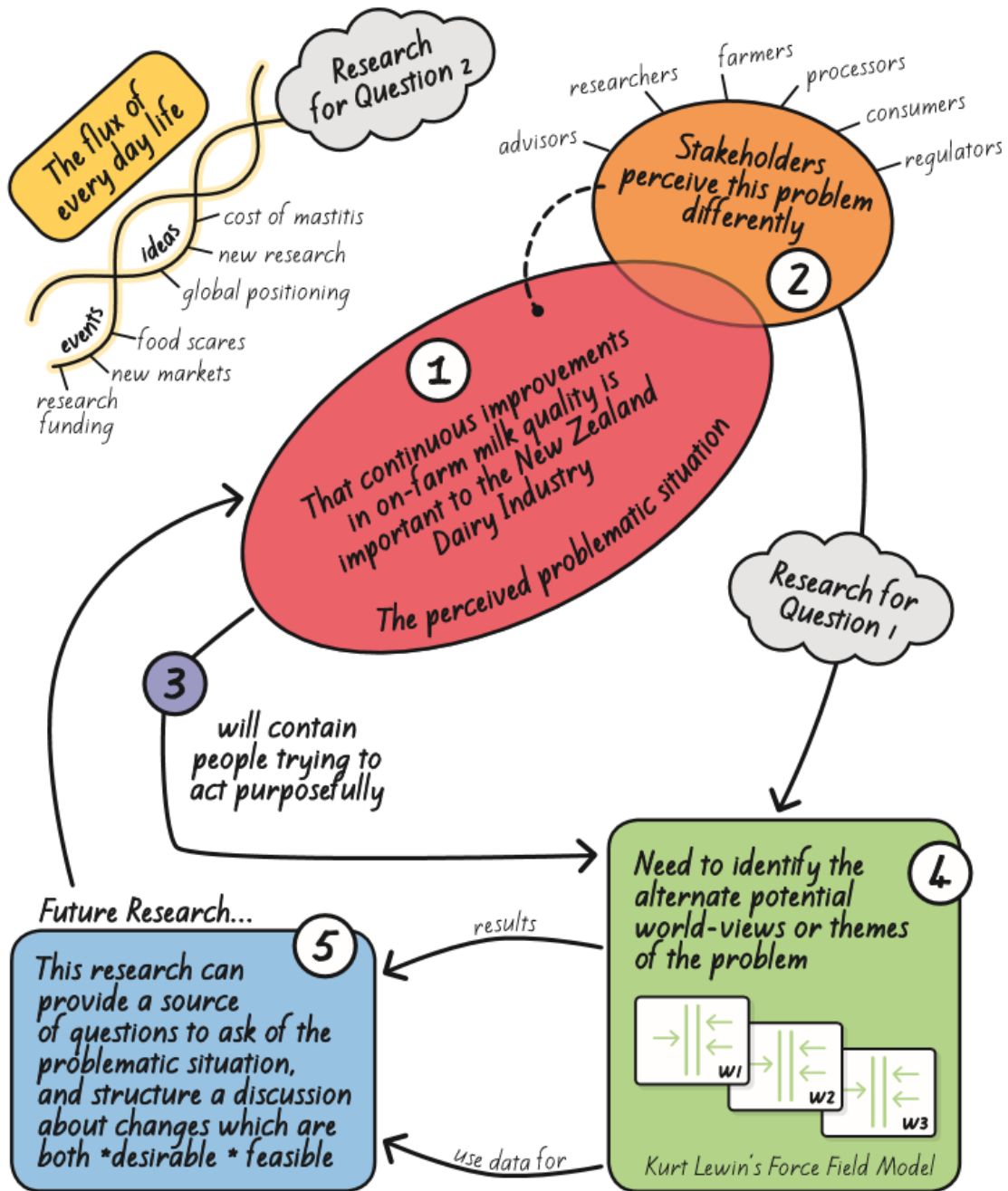


Figure 4-a: SSM cycle of learning model, adapted from Checkland (2000) and Researcher's lens for developing research method.

“It is easier to select a method for madness than a single best method for evaluation, though attempting the latter is an excellent way of achieving the former”- Holcom,
(Holcom, (n.d) quoted in: Patton, (1989, pg. 177))

This chapter outlines the qualitative research design and methods of analysis.

The first section provides justification for choosing a modified case-study as a framework for the research. This is followed by a description of the sample frame and how the stakeholders were identified. The final section of this chapter provides justification for choosing elite interviews as a primary method of data collection for this research.

4.1 The Case Study

“The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result”, (Schramm, 1971, pg. 22, cited by Yin, 2009, pg. 17)

Given the interpretive position adopted and the nature of the research questions, a modified case study methodology was considered to be appropriate. According to Salkind (2012), case studies are ideal if the research needs to ask how an institution has endeavoured to achieve its primary mission. The context for the ‘case’ was the New Zealand dairy industry, the subjects for this research were key stakeholders in the dairy industry, and their perceptions of the drivers and restraints for the industry to improve OFMQ, provided the data for this thesis.

The diagram from Yin, (2009, p.2), was a starting point for the case study design. Yin, (2009) and Cepeda & Martin, (2005) emphasised the importance of clearly defining the paradigm for the research study prior to confirming the research questions. By examining the process as a whole, rather than incremental and sequential parts, the relevance of what this thesis was aiming to achieve, and what was required to achieve this, became more apparent.

Pan and Tan, (2005), extend the work of Klein and Myers, (1989), Walsham, (1995) and Yin, (2003). They modified a model by Eisenhardt, (1989), that has been cited as a “road-map for building theories from case-study research”, (Eisenhardt 1989, pg. 531). Figure 4-a provided the procedural framework to conduct this case study and was taken from Pan & Tan, (2011) who modified the model from Eisenhardt,(1989).

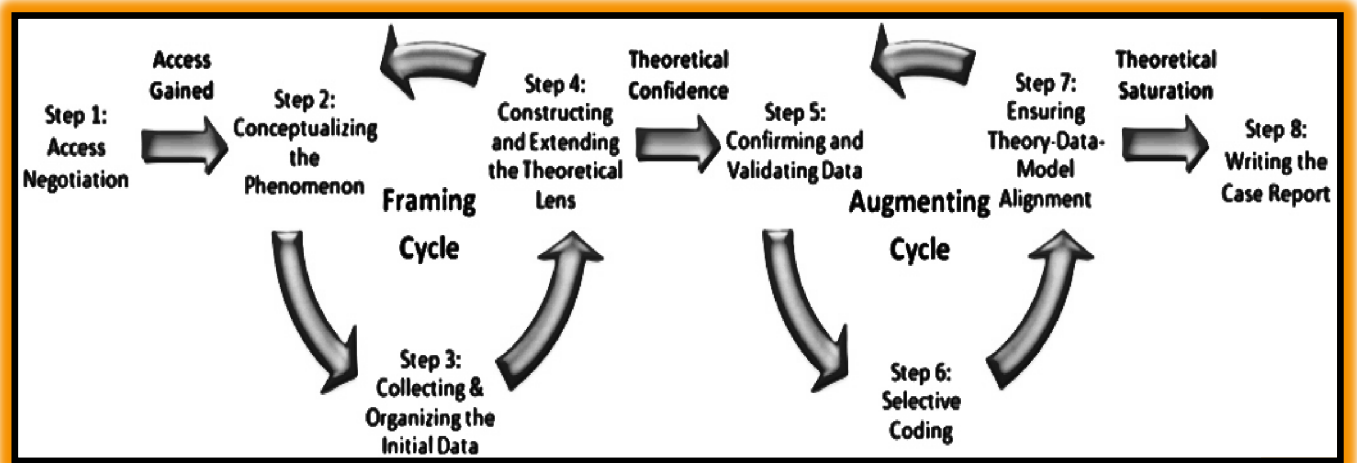


Figure 4-b A structured–pragmatic–situational approach to conducting case studies, taken from Pan and Tan (2011, pg. 164)

By using a case study methodology this research provided:

- A variety of participant perspectives;
- An opportunity to use multiple data collection methods such as interviews, email, on-site visits, data provided by key-note speakers at the milk quality conference and existing literature;
- An opportunity to draw conclusions from a variety of contexts such as scientific research, manufacturing, marketing and on-farm practices.

4.2 The Sample Frame

Determining who, what and when: identifying the 'gate-keepers' of knowledge.

The background for this thesis initially came from secondary sources by reviewing literature surrounding milk quality and its management. Secondary information are sources of data and information collected by others, (Willis, 2007; Lombard, 2010), and this provided an opportunity to establish the known, and the events and ideas unknown, surrounding OFMQ in New Zealand.

In addition, primary data-collection came from initial interviews with key informants. The purpose of interviewing according to Patton, (2002) is to:

"...allow us to enter into another person's perspective ... to find out what is in and on someone else's mind," Patton, (2002 pg. 341).

Initially, informal discussions with people working within the dairy industry were a starting point for advice in seeking primary data sources in the form of additional key informants' names,

"i.e. those in the organization thought to possess greater knowledge about the phenomenon under scrutiny than others may possess", (Bluhm et al. 2011, pg.6.).

These informal discussions provided different perceptions about OFMQ and provided both new ideas for further literature research, and names of additional key informants. Further, the literature established background knowledge, of the phenomena underpinning the proposed study.

4.2.1 Identifying Stakeholders and assigning their codes

"But it does remind us that all our present perceptions are open to question and reconsideration, and it does not broadly suggest that even the most obvious occurrences of everyday life might appear utterly transformed if we were inventive enough to construe them differently," George A. Kelly (1966), quoted in Bannister & Fransella, (1986, pg.5).

The New Zealand dairy industry has a diversity of stakeholders and their stakes are varied. The stakeholder groups that are producers of raw milk include farm owners, farm managers, and sharemilkers. The producers of processed milk for sale, the processors. Industry-good personnel include researchers and advisors, and regulatory stakeholders include government personnel and their milk-quality testing agents.

Because each of their stakes will govern their decision making for improving milk quality, their perceptions about how to frame a problem statement for milk quality will also vary. Peter Checkland who developed soft systems methodology (SSM) asserted that problem statements derive from the events, ideas, and perceptions of stakeholders within an entity, and multiple perceptions of reality will create assumptions not necessarily shared. The ubiquity of these assumptions creates complexities for reaching solutions that are both feasible and desirable for all stakeholders, and unless acknowledged, problems are rarely resolved, (Checkland & Poulter, 2010).

Selected key informants were sent an outline of the initial research proposal. They then assisted in arranging formal talks with milk quality experts and the management team at the DairyNZ site in Ruakura, and Milk Test NZ at Te Rapa in Waikato. As the key informants were purposefully selected, this research, is partly the 'voice' of those key informants identified and interviewed, (Patton, 2002).

For this study, individual stakeholders were assigned to a group defined by their key involvement in milk quality.

- P= processors: milk quality managers for processing companies, (P1, P2)
- F= farmers, (F1, F2, F3, F4, F5, F6, F7)
- R= researchers (R1, R2, R3, R4)
- C= advisors, (C1, C2, C3, C4)
- G= regulators: Milk testing agents (G1) and Government officials (G2)

If an individual stakeholder was involved in more than one group simultaneously, the dominant group, prevailed, (judged by their identified responses during the interview process).



Because this research aimed to interpret responses from stakeholders within each of the assigned groups as listed above, it is important to acknowledge some of the limitations for this methodology. Each individual stakeholder was neither a discrete entity within a group, nor could they define the collective organisation, this is a viewpoint shared by researchers including: Latour, (Blok & Jensen 2011); Kelly, (Bannister & Mair, 1968); Lewin, Ackoff and Checkland, (Ramage & Shipp 2009). This is because an organisation is relational in that its stakeholders, both individually and collectively are defined in some part by their relationships with other elements within the stakeholder network. For researchers, such as Latour these extended beyond human relationships to non-human factors such as technology. Latour, developed actor-network theory (ANT), (Blok & Jensen, 2011) and while his view presents implications beyond the discussion in this thesis, it does share the seminal work of George Kelly's Personal Construct Theory (PCT) as discussed in 3.3.

4.3 The interviews

This study used in depth interviews for gathering primary data. Given that multiple perceptions were expected to prevail, each stakeholder group had more than one representative interviewed for this research.

A series of elite interviews were used to provide access to existing knowledge that either has yet to be published, or which access to published material was difficult to procure, (Gillham, 2005). Gillham, (2005) described the elite interview as:

“talking to people that are especially knowledgeable about a particular area of research or about the context within which you are researching. They are commonly impositions of authority or power by virtue of their experience or understanding.” He continues by stating: “They are not naïve subjects so will not submit tamely to a series of prepared questions. It is in this respect that the interview has to be loosely structured at best,”

(Gillham, 2005 pg. 54).

Liamputtong & Ezzy (2005, pg. 56) suggested:

“in-depth interviews in qualitative research draw on an interpretive theoretical framework which emphasises that meanings are continually constructed and reconstructed in interaction.”

In addition, they continue by quoting Holstein and Gubrium (1994, pg.4):

“respondents are not so much repositories of knowledge - treasuries of information awaiting excavation - as they are constructors of knowledge in collaboration with interviewers”, Liamputtong and Ezzy, (2005, pg. 57).

The interviews undertaken were 'elite' Gillham,(2005), and had a semi-structured format described by King & Horricks (2010) and Liamputtong, & Ezzy, (2005). Whereas an unstructured interview would occur in conjunction with the collection of observational data,

semi-structured interviews, can be the sole data source for a qualitative research project and scheduled in advance at a designated time and location outside of everyday events. Semi-structured interviews are generally organised around a set of predetermined open-ended questions, with other questions emerging from the dialogue between interviewer and interviewee (Liamputtong & Ezzy 2005), and this was the framework used for developing the interview questions. In addition to having a semi-structured format, the interviews became in-depth interviews with some of the key-informants.

The preliminary research provided two valuable outcomes: a deeper and varied discussion of the underlying issues surrounding milk quality management in New Zealand since 1992, as well as providing additional names of key informants for further information. Known as the 'snowball effect', this method of growing samples for case studies can be a valuable technique when the initial key informants are well networked to provide assistance.

However, because it can also "compress" the sample frame to those that share the views of the initial respondents it needed to be approached with caution, and consideration of these risks were acknowledged and discussed during follow-up face to face interviews with the respondents.

4.3.1 Conducting the interviews

The interviews ranged in length from 35mins to 3 hours for all stakeholder groups. The length was on an average, one hour. Participants granted permission for the interviews to be recorded. The taped interviews enhanced the accuracy of data and provided a permanent record. The interview schedule used in the semi-structured interview guided and helped to steer the interview, and ensured all areas required were covered,(Gillham, 2005).

Prior to interview, the recipients were sent a questionnaire²⁷ where they responded to questions relating to on-farm milk quality (OFMQ) in New Zealand, specifically using somatic cells counts (SCC) and bacterial counts (TBC) as a context for their responses. The view was that, as the researcher was relatively naïve about OFMQ these interviews could provide a richer picture of the perceptions that may exist among these key informants. The researcher's openness about this naivety also prompted a willingness from the participants to provide even richer pictures of their own perceptions. During the discussions, the interviewees demonstrated evidence of worldview variation within their own stakeholder groups; as such, the results reflect individuals rather than collective views in parts.

What these reflections collectively did, was lead to further interpretative thinking and prompted follow-up emails and face-to-face interviews some five months later. This time the interviewer was better informed and was in a stronger position to ask meaningful and in-depth questions for deeper analysis of the problem statement. In total, some key informants were interviewed up to 3 times over a 7-month period.

4.3.2 The interview questions are summarised as follows:

- Total years associated with the dairy industry
- Please list your various roles within the dairy industry over this time period

Questions:

1. What are the milk quality issues that you perceive to be most significant for the NZ Dairy Industry at present?
2. If the rules suddenly changed for dairy trading where the acceptable limits for bacterial contamination need to be less than 10,000 cells/ml or SCC levels below

²⁷ A full copy of the Questionnaire can be found in Appendix A.7

150,000 cells/ml how quickly do you think the New Zealand Dairy Industry could respond to this?

- a. What are likely to be the greatest obstacles to overcome?
 - b. DairyNZ set an aimed target of BTSCC to be less than 150,000 cells/ml in 1990.
 - What are your feelings about this target?
3. The NZ Dairy industry has had fluctuating results in their SCC levels over the past 25 years.
- a. What would be the main factors that would be preventing the achievement of a continued lowering of the BTSCC levels in NZ?
 - b. What do you believe to be the key driving or success factors that would result in BTSCC improving?
4. For the elements below please assign a number from **0-5** that **would best describe** the significance of the following as a **barrier for NZ** farming enterprises to *effectively manage* milk quality.

Thereafter, a series of Likert-like scales were presented to each interviewee to respond to.

A full set of questions and the responses provided can be found in Appendix

5. Rank each of the factors below in terms of **negative restraining** factors for reducing **SCC levels** in raw milk on New Zealand Farms?
6. Using the same ranking- Rank each of the factors below which do you think are the **negative restraining** factors for reducing Bacterial raw-milk contamination levels on New Zealand Farms?
7. Rank each of the factors below which do you think are the **positive driving factors** that would help reduce **SCC levels** in raw milk on New Zealand Farms
8. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement

9. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement
10. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement

Each interviewee was then interviewed and further clarification for each response was sought. The results of the questionnaires and follow-up interviews can be found in Chapter 5 and Appendices: A 12- A16

4.4 Analysis

The analysis of interview transcripts and field notes used an inductive approach geared to identifying patterns in the data by means of thematic codes.

*"Inductive designs begin with specific observations and build towards general patterns",
Patton, 1989, pg. 194.*

A two-pronged strategy was employed for data analysis. Firstly, a quasi-quantitative analysis was carried out to analyse the responses from the questionnaire the respondents completed prior to the in-depth interviews. The word "quasi" has been used, as while the interview may appear to be equated to a Likert Scale, it became apparent during the in-depth interviews, what constitutes a "strong response" could vary between a score of 4-5 depending on the respondent. Therefore, these responses were further clarified by analysing the interview transcripts before presenting the final judgements about the relative importance of their opinions surrounding OFMQ. The information from the interview recordings had portions coded using key areas identified from the research questions and then transcribed before it was collated for the final results.

Sentence, and paragraph segments of the transcribed interviews was analysed, field notes and a review of the secondary data sources ascertained the patterns evolved from the data. Comparisons between interviewees to identified similarities, differences, and general patterns. Themes gradually emerged due to the combined process of becoming intimate with the data, making logical associations with the interview questions, and considering what was learned during the initial review of the literature.

It was acknowledged that was imperative throughout the process, to ensure rich discussion, debate and could then highlight concerns, problems, symptoms as well as solutions. The

overarching aim was to present a tool to find ways to reduce the restraining forces and to capitalise on the driving forces towards these improvements.

Finally, the data was presented both as a generalised narrative as well as a summative model using modification of Kurt Lewin's Force-Field Model. This could then be a visual tool for establishing the drivers and restraints towards further improvements in OFMQ based on the perceptions from various stakeholder groups. Summarising the methodology of the process²⁸

1. **Defining the goal:** that further improvements in OFMQ is desirable for the New Zealand dairy industry.
2. **Establish the Driving Forces** - those that are favourable to change. These were recorded on a force field diagram.
3. **Establish the Restraining Forces** - those that are unfavourable to, or oppose change. These were recorded on the force field diagram.
4. **Evaluate the Driving and Restraining forces.** Each force was rated by analysing questionnaire data and by using face to face interviews to holistically formulate the perceptions of the impact they may have.

This information could then provide information for the New Zealand dairy industry to then:

5. **Review the forces.** To decide which of the forces might have some flexibility for change or which could be influenced by their actions.
6. **Strategize.** To create a strategy to strengthen the driving forces or weaken the restraining forces, or both.

²⁸ Modified from <http://www.change-management-coach.com/force-field-analysis.html> retrieved June 12, 2012.

7. **Prioritise action steps.** To identify the action steps that would achieve the greatest impact?

And to identify the resources they would need, and decide how to implement the action steps.

A visual of the forces would be created. The size of the arrows will be representative of each force's degree of control it potentially exerts based on interviewee beliefs. A table would be developed as a summative statement. For each force, the New Zealand dairy industry should gain better knowledge regarding the perceptions that surround each force and this could be useful when prioritising resources to address that force.

4.5 Ethical considerations

All interview participants received a document outlining how the information would be collected, collated, and published, and an opportunity for the amendment or removal of any material sensitive to them. Key informants were interviewed in their professional capacity, and sensitive or personal information was not required, therefore under Lincoln University guidelines it was not necessary to seek approval from the ethics committee prior to the interviews.

Chapter 5

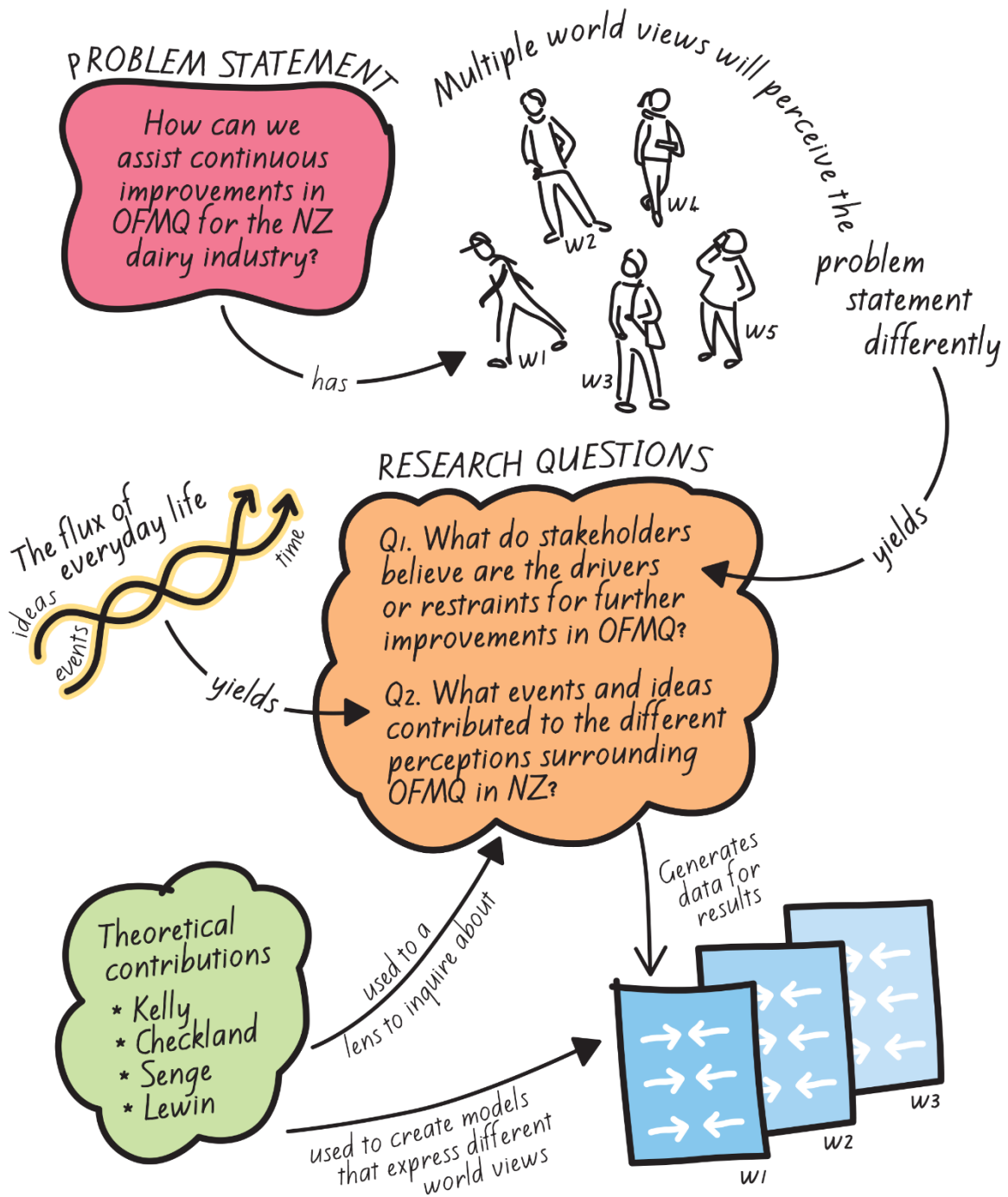


Figure 5-a: The Researcher's lens for answering research Q1

Results Q1. What do stakeholders perceive to be the drivers or restraints for further improvement in on-farm milk quality in New Zealand?

5.1 Introduction

As has been outlined, this thesis is an attempt to understand the perceptions of stakeholders surrounding on-farm milk quality in the New Zealand dairy industry. This led to an inductive process to make sense of these perceptions ((Checkland 2006, Senge 2006), and they have been presented as worldviews for further consideration in the pursuit of solutions for further improvements in OFMQ in New Zealand.

As discussed in Chapter 4, stakeholders' participants completed a questionnaire followed by a semi-structured interview. From the researcher's perspective, the aim of these subsequent interviews was to allow the opportunity for each participant to engage freely in conversations surrounding OFMQ and provide further questions and or opinions not addressed in the questionnaire.

Because these results were from personal interviews, they were interpretive. The perceptions both within and between stakeholder groups varied considerably in places, both in terms of the magnitude and the priority of the identified barriers for further improvements in OFMQ and the drivers for these improvements. Overall, while the perceptions within and between the stakeholders' groups varied, there were also common threads of belief. The extracts presented provide evidence of either differing viewpoints, or points emphasised strongly during the interviews. The extracts presented represent a small sample from the thirty-five hours of recorded dialogue analysed for these results.

The chapter begins with three tables: Tables 5.a, 5.b, and 5.c. These tables present the findings of the questionnaires and from evidence gathered during the subsequent interviews of these stakeholders including dairy farmers, dairy advisors, and dairy researchers within the New Zealand dairy industry.

The next subchapters: Subchapters 5.4- 5.5 present excerpts from the interviews that are evidence for the summaries presented for each stakeholder group. Finally, subchapter 5.7 presents an example in Figure 5.c, which firstly depicts the possible drivers that researchers

could identify to gain insight towards further improvements in OFMQ for the NZ dairy industry. Secondly, Figure 5.d depicts the possible restraints that might prevent the dairy industry moving away from what Lewin describes as quasi equilibrium, or the status quo.

5.2 The questionnaire results

The results presented in Tables: 5-a, 5-b and 5-c, use an adaptation of Kurt Lewin's Force Field model. A force field diagram as explained in Chapter 3.5, is a model built on the idea that forces e.g. persons, events, ideas, or technology both drive and restrain change within organizations. The diagrams below represent pictures which can be likened to a "tug-of-war" between forces surrounding a problem statement. The varying arrow sizes represent the relative size of tug force for an identified driver or restraint away from, or towards a point of equilibrium.

The term driver used by Lewin, is given to the forces that can drive towards a desired outcome. The term restraint, is given to those forces that are an obstacle an organization has to overcome or minimize, for it to shift away from its current state, of what Lewin describes as "quasi-equilibrium". Specifically within the diagrams below, drivers are the enablers for further improvements in OFMQ and the restraints, are those forces that keep the status quo, (Londeix, 1995).

Before change occurs in any organization, the reasons behind the desire to change must first be established. And as such, identifying the stakeholder perceptions of this desire (or lack of) is essential. If a strong motivation for change is identified, one could consider this for example, a driving force, which is a force that enables the New Zealand Dairy industry to move forward towards further improvements in OFMQ. The NZ Dairy industry however, must also consider those factors (forces), that prevent improvement and identifying these restraining forces could assist in this goal. The knowledge gained from identifying these conflicting forces, might then become enablers for the New Zealand dairy industry to implement a meaningful action plan, as discussed further in Chapters 7 and 8.

It must be noted, that for ease of presentation, the results have been grouped and generalized within the group. However, in some instances, these views were not as strongly supported by some members within the group.

Table 5-a: Stakeholders' perceptions of the drivers for improvements in OFMQ based on questionnaire and subsequent personal interviews, ²⁹

| Drivers | Skills | Relations | Penalties | Incentives | Education | More research | Technology |
|--------------------|--------|-----------|-----------|------------|-----------|---------------|------------|
| Stakeholder | | | | | | | |
| Processor | → | → | → | → | → | → | → |
| Farmer | → | → | → | → | → | → | → |
| Advisors | → | → | → | → | → | → | → |
| Researcher | → | → | → | → | → | → | → |
| Regulator | → | | → | | → | | → |

| | | | |
|------------|------------------|------------------|--------------|
| Key | → | → | → |
| | Driver but minor | important driver | major driver |

²⁹ Summarized Interview analyses can be found in Appendices: A.12-A.16

Table 5-b: Stakeholders' perceptions of the for improvements in OFMQ based on questionnaire and subsequent personal interviews

| Restraints | Skills | Relation-ships | Building herd numbers | Incentives | Education | Quality research data | Technology |
|-------------|--------|----------------|-----------------------|------------|-----------|-----------------------|------------|
| Stakeholder | | | | | | | |
| Processor | ← | | ← | ← | | | ← |
| Farmer | ← | ← | ← | | ← | ← | ← |
| Advisor | ← | ← | ← | ← | ← | | ← |
| Researcher | ← | ← | ← | | ← | ← | |
| Regulator | ← | | ← | | | | |

| | | | |
|------------|---------------------|---------------------|-----------------|
| Key | ← | ← | ← |
| | Restraint but minor | Important restraint | major restraint |

Figure 5-b: Stakeholders' perceptions of the restraints for further improvement in OFMQ

5.3 Farmers' perceptions about the drivers and restraints for further improvements in OFMQ

Seven farmers completed a survey³⁰ and were subsequently interviewed from the Canterbury region, between the Rakaia and Waiau Rivers.

The following provides a summary of the personal communication dates with each farmer. Details regarding the location and dates of the interviews can be found in Appendix A.12. For ease, the farmers are simply anonymously referred to as F1 (2001) – F7 (2012)

The interview transcripts revealed that there were two key barriers for the effective management of milk quality in New Zealand. Firstly, they believed that the relationships between owners, managers milking staff and the skill base of these staff was an overwhelming factor in the ability to effectively manage OFMQ. Secondly, they thought that the rapid build of the Canterbury and Southland herd numbers had created a significant issue for milk quality management. On further discussion during interviews, there was an agreement that these were closely connected factors, rather than discrete problems.

5.3.1 Growing Herds

Canterbury was the fastest growing dairy region in New Zealand in 2012,³¹ due to access to large areas of flat irrigated land and the resultant longer growing season comparative with other areas. As a result, the procurement of both milking herds and the staff to milk them has been challenging and this has created many problems for dairy farmers. These problems included the lack of choice of animals for sale, and therefore the need to either purchase, or retain cows that may have a history of mastitis infection. Added to this, the average dairy herd in Canterbury was almost twice the national average, and had the highest production

³⁰ See Appendix A.14 page 96

³¹ DairyNZ report 2012-2103, retrieved from: <http://www.dairynz.co.nz/publications/dairy-industry/new-zealand-dairy-statistics-2012-13/>

rate per hectare (LIC 2013). Because of this rapid growth, animals within herds often came from varying districts, each with their own potential historic problems.

"I think the growth of the dairy industry in the last 10 years has been a significant reason that our somatic cells have fluctuated in New Zealand. Yes, definitely cow growth. Because cows have been kept, especially in Canterbury and Southland, which has been a big factor," F5

What this farmer (F5) was referring to, was the hesitancy to cull cow with high somatic cell counts, due to the difficulty in finding replacements, and the financial impacts because of the high costs to replace them. Another identified barrier by farmers was the high production rates in Canterbury as this farmer (F2) explains below.

"In Canterbury we feed our cows too well in the winter. They get engorgement. They lie down in the winter so are exposed to soil bacteria and get more mastitis. You don't get that up North or on the West Coast. Here we have greater levels of production and that means that teat size is bigger and therefore more bacteria can get in, F2."

5.3.2 Money

Farmers also believed that the lack of financial incentive to further lower cell counts on-farm was a significant barrier. As well as this, barriers can exist because farmers are reluctant to cull cows, due to the need to maximise herd numbers, resulting in the retention of high SCC cows within the herd. These decisions are due to the significant financial burden resulting from both decreased production as the cost to purchase replacements.

"If you've got a high cell count cow and she's a good producer, you're gonna keep her. You're not going to spend \$2000 on another cow," (F5, 2012).

"Somatic cells are a low priority particularly from a culling perspective. You will cull for every other reason than somatic cells. It is probably one of the last things you will cull for.

So, if we get our in-calf rates better, then culling for cell counts would come more into the fore. A lot of farmers have a struggle," replacing empty cows without culling for counts. Farmers do not have a choice- it is taken away from them if they have a poor empty rate. They have to keep everything that is in calf," (F2, 2012).

"The main factors in sustaining a continual lowering of the target are economic incentives and growth in cow numbers. There were cows last year that I would have culled because of somatic cell counts but didn't because we couldn't induce as many cows. We aren't culling the cows that we want. Some of the vets are ignoring it. I had to keep cows we wouldn't normally have kept. It hasn't helped somatic cells at all," (F1, 2012).

All farmers interviewed acknowledged that tensions existed between the desire to meet their personal production and financial targets. This could have a significant impact on OFMQ depending on an individual's financial circumstances and their prioritisation to lower in-herd somatic cell counts beyond threshold limits. As such, pushing for high herd-production figures could limit further improvements in on-farm milk quality for financially constrained farmers.

"I know myself when we were growing, when we were share-milking: if she had 4 legs and 3 tits she was a keeper. Once your herd has consolidated you can cull high cell-count cows. I know for us once we did this we got our cell-count down from over 300,000 to under 150,000 and dropping," (F5, 2012).

"Somatic cell count is not an effect that is seen. You look at a cow with a high cell count with high production and you have to keep her even if she has a high cell count. She's making money despite the count," (F2, 2012).

Farmers did not identify their own level of debt as a significant barrier. However, financial incentives payments for providing milk of premium standards was considered to be key driving force as would the desire to avoid penalties for not meeting standards.

“The biggest obstacle would be the implementation of knowledge and there is also a financial implication – you would need to cull animals out of the herd. If we saw a financial gain it would happen a lot faster”, (F2, 2012)

“150 (,000) cells (/ml) is a realistic goal if we saw a financial gain we would do it a whole lot faster – incentive not penalty. Farmers don't want the same income for more effort. The better farmers will pick up on incentive and the poorer farmers will respond to penalties,” (F2, 2012).

“The key driving success factors would be if we had to do it – regulation and penalties. Incentive payments for lower counts would get me more interested but they tend to go for penalties for those that do get high counts. People who don't see themselves as getting the incentive payment will vote against it. If someone is getting an incentive someone else is not getting something,” (F1, 2012).

While both penalties and incentives ranked highly, on further questioning, the fear of penalties were considered to be a larger driving force when the interviewees reflected on the potential outcomes to them. For all farmers interviewed, grading for bacteria held a greater “fear of penalty” and consequently the motivation to not “grade” for bacteria exceeded the determination to achieve a low BTSCC of under 100,000cell/ml³². While they accepted that there were potential savings from good SCC management, the significant costs to achieve this provided little financial incentive to do so. Conversely, due to the significant cost benefit from avoiding penalties they considered being graded for bacteria an important to issue to avoid.

5.3.3 Relationships and skills

Overwhelmingly, farmers identified staff skill and attitude as the key reasons why high BTSCC or bacterial incursions occurred, and exacerbated by time pressures or poor routines. There

³² A level deemed to be attainable and indeed a level some companies incentivise production to be: retrieved from <http://idealog.co.nz/venture/2012/12/where-theres-muck-theres-mastitis>, Owen Poland, 19 Dec 2012.

were clear links made between the quality of staff knowledge and skill in OFMQ. Added, the attitudes of workers after training can have a serious impact on the outcomes for OFMQ. A poor routine or attitude, could be a significant restraint. Conversely, a dedicated and informed staff member could be a significant driver as the three quotes below demonstrate.

"Inexperienced workers may milk $\frac{3}{4}$ cows so counts go up," (F3, 2012).

"We have systems and procedures around quality. We don't grade for bacteria – it is all manageable," (F4,2012).

"One of my managers is particular because he realises that he is responsible for grades – it comes out of his pocket as he is a variable-order share milker so the cost comes out of his pocket. He also knows that there is about \$10,000 worth of opportunity lost by having a high cell counts. It is economic as well as he is trying to prove a point as he wants to get to the next level – to work his way through the industry. A good share milker will get to farm ownership but only the top 10% so you have to be in that top 10%. His reputation is at stake," (F3, 2012).

However, the farmers interviewed did not consider relationships with their own family or with advisors such as veterinarians, to be a barrier for further on-farm milk quality improvement. While this was not specifically identified in the survey, when questioned further, they all considered the relationships with their own family and veterinarians to be positive. This differed from the perception of the advisors as shown in 5.4.

5.3.4 Education and training

Concerning driving forces for further improvement in somatic cells in on-farm milk, staff relations, skills, and attitudes was the most significant driving force. Added, the need for good education programmes for their milkers rated relatively highly by the majority of interviewees.

"I actually had my manager convince me to use blanket dry cow therapy. He gave us a short course to start us. He always has lots of great ideas and has really raised my awareness," (F5, 2012).

In the following example, education, training and relationships all had a part in the success of OFMQ for F5.

“Our staff have had training. We have turnover like everyone else. Most of our staff is foreign – Spanish but also Fijian, Zimbabwe, English, Chilean, and Uruguayan. Only one of our team is a Kiwi – a sign of the times and the industry. It is an issue for the industry. The industry will need another 10 > 12,000 people by 2020. We need the right people. The people that really understand agriculture is what is needed – scientists – soil, plant, geneticists - of all kinds as well as financiers did. There has been a huge vacuum for 25 years. It is all about lifestyle as well as the industry,” (F3, 2012).

In the case above, a lack of skilled trained staff from New Zealand created issues with the ease of training when English was a second language, or when staff turn-over is high and foreign staff was required to fill the gaps in the industry.

While lack of advice was considered to be an important barrier for advisors and researchers, farmers did not share this view. However, some farmers believed that the quality of advice could also be a barrier in some cases as shown in the conversations below.

“All staff are responsible to the sharemilker – I pay for things that affect our asset, the cows as they are ours. ITO is a proxy for everything – we delegate all our training to them. AgITO³³ is not achievement orientated - it is all participation orientated, you attend and you pass. People expect a lot more than what it delivers and assume it is more than what it is. Key managers are also adding their own on-farm training to improve this” (F3, 2012).

“If trading rules changed and bacterial contamination levels needed to be less – our farm would be able to respond. For the industry – if it becomes a condition of supply – they won't like it but they will change. The biggest obstacle will be attitude – just like everything else, we have real challenges with compliance because we are

³³ AgITO, now incorporated into PITO, provided assessment in the workplace that supported learning and provided evidence of achievement to the required standard. Typically, farmer trainers were the teachers and primary assessors of trainee learning, retrieved June 16, 2014, from: <http://www.nzqa.govt.nz/nqfdocs/provider-reports/8105.pdf>.

swamped with regulations and requirements about certain things and become punch drunk and take no notice. Simple and easy ways of educating people to do it are needed", (F3, 2012).

Mainly due to human error. Hardly ever get coliforms. Once off water problems. I can't remember grades for years – a once off and easily fixed as it is mainly due to stupidity. We have reasonably good systems. We can ring the company and ask what to do," (F1,2012).

What was common between the two measures of milk quality identified, was the significant barrier that inadequate staff training, or care in the skills required for improving on-farm milk quality, posed for further reductions in both somatic cells and bacteria in on-farm milk.

"A key barrier for me is to get labour to effectively implement the known science. The research is there; the knowledge is there. But actually getting the guys to do it is a problem for me", (F7, 2012).

The general belief was that if required, there was ready access to resources and advice surrounding further improvements in OFMQ. However, the perception that the reduction of somatic cell was an unnecessary priority for some farmers, particularly share-milkers, may have prevented the implementation of this advice. An exception to this view was one farmer whom was share-milking 940 cows in an in-house barn operation.

"In house presents new problems. SCCs are the number one problem and will continue to be once more of these in-house" cow systems go up. We had massive somatic trouble as soon as we put them in the shed, because we hadn't been given the right information", (F7, 2012)

5.3.5 Technology

Farmers considered that technology was a barrier, particularly if either the plant was old or there was ineffective chemicals use. Conversely, modern methods such as teat spraying,

automated detection of mastitis, and the ability to draft mastitic cows using computerised gates was identified as a vehicle for further OFMQ:

“There is a huge benefit from teat sealing technology. Have gone from 30% infection rate to less than 10%. The effect on production and cost has been huge,” (F2, 2012)

“Technology has been a driver for improvement. Advantages in milking – applying teat sanitisation spray. Having plans for cows that are repeat offenders – testing the infection to get the right bacteria and the right spectrum to use. We start taking samples at the beginning of the season and use what the vet says to use,” (F3, 2012)

“We have really robust systems. You can’t put a penicillin cow on until the light is red so the tap position is on dump. Each cow is identified. Before treating, she must be marked. We contract out for the auditing of our shed. In my experience, the people that try the traditional approach on this scale (herd size: 5000), don’t last,” (F4, 2012)

5.4 Advisors (C1-3) and researchers (R1-4) perceptions about the drivers and restraints for further improvements in OFMQ

The milk quality advisors and researchers interviewed for this research work in a collaborative partnership therefore, it was fitting that interviews occurred simultaneously with representatives from both sectors. While some variations in emphasis existed, they did however, agree on the key drivers and restraints for improved, OFMQ. This group shared three significant factors with the farmers interviewed: staff relations, staff skill, and the building of herd numbers.

“Each person is driven by three things: more milk solids, less penalties - there’s the money driver; stockmanship, you have happy cows and pride in what you are doing; and then there’s time”, (R1, 2012)

5.4.1 Money

“Whereas the building of SAMM and the use of monitoring data built a shared consensus on what ought to be done among actors in the sector, it was the introduction of penalties that encouraged farmers to methods for managing mastitis. Farming became a game of production and quality management, and change

emerged when economic incentives (penalties) were connected with an ability to perform using the general rules of SAMM and monitoring", (Paine, 1997, pg.125)

When asked if the New Zealand dairy industry could reach the target BTSCC of 150,000 cells/ml two enablers were identified by advisors and researchers: the improvements in the skills of the milking team and the provision of incentives for farmers to reduce their SCC.

"Fairly quickly we could segregate suppliers for separate collection. The guys that couldn't meet the (new limit) today would be able to meet it tomorrow by cleaning. Initially they would be in a proxy group and a lot could then graduate quickly into the proper group. The bulk would be able to meet it," (C1,2012).

Below are excerpts from a dialogue between advisors (C1 and C2), where one advisor (C2) believed that there were many aspects to reducing BTSCC while the other (C1) believed a larger stick was all that was required.

"It's super easy to get to 150 (000 cells/ml) - apply a penalty at 300 (000 cells/ml). Disincentive is the only driver" (C1,2012).

"Disincentive is not the only driver, make sure you get your facts right. It might be a major driver, but not the only one", (C2,2012).

"My early contention is that penalty limit and amount is the primary driver. We can prove that by what has happened at Tatura over the last two years. Tatura dropped the limit from 400-350 three years ago, and blow me down their average is 80,000 less than Fonterra" C1

"They repositioned the stick from 400-300" (R1, 2012).

"I've been closely associated with the introduction of incentives for smaller companies. Big stick little carrot, some lovely graphs were presented at the milk quality conference three years ago that showed they (carrots) made no difference. So incentives don't work" (C1, 2012).

"Stop making such black and white statements", (C2,2012).

"In my opinion there are limits as to how a penalty applies. The reason why the average has climbed is due to farmers being able to manage non-compliance better" (C1, 2012).

"Now that's a different issue and I quite agree," (C2, 2012).

"So if I go onto a farm because the tanker is not going to come because he is over 400,000, his aim is to get to 399,000 and get as much in the vat as he can sell. So they know what cow to look for and they know how many (cows) they can leave in the herd to get the vat to 350,000", (C1,2012).

"Schukken at Cornell³⁴ said that it required a seven-fold difference in the value of incentive to drive the same behavioural change of one-unit of disincentive. You won't be motivated by something you haven't got as much as losing something you already have," (R1,2012).

One advisor did wonder that incentive payments might actually demotivate the tail-enders of milk quality if the goal seemed too far-reaching, which could then negate the overall goal to achieve BTSCC average of 150,000cells/ml. This would be because incentives might only drive the behaviour of those farmers already operating within these limits, rather than the target laggards. A view supported in research by Huijps et al, (2010).

"Additionally the farmers were more sensitive to penalties rather than bonuses aimed at stimulating desired behaviour," Huijps et al (2010, pg. 553.)

High on-farm debt and milk pay-out fluctuations were also identified as being notable barriers for effective management of milk quality in New Zealand. Again, this was possibly reflective of the dialogue these advisors experienced with their own client base; as it was not an important factor for the farmers interviewed from Canterbury. The "Gap calculator"³⁵ was

³⁴ Dr. Ynte Hein Schukken is the director of the Cornell Program for: Applied Research in Mastitis. For further information see: www.vet.cornell.edu/popmed/bios/schukken.cfm.

³⁵ The Gap Calculator estimates the potential economic benefits of 'closing the gap' between your herd's actual performance and your target performance, for udder health and milk quality. It makes no allowance for the marginal costs of achieving target performance. Actual performance relates to the previous or current season. Target performance relates

considered by some researchers as a significant change in the presentation of information to farmers and offered a strong driver for farmers to continuously aim for further improvements in BTSCC even when they consistently⁶ met the market requirements of <400,000 cells/ml.

“One of the restraints is to justify why the targets are changed. If there is no justification it is harder. The case study in the latest ‘Inside Dairy’ = the guy chasing the production, he loves his cows and takes pride in his cross-bred herd – his cows are pumping out 500 kgs of milk solids. His cell counts were at 300 and he thought that was normal because he was chasing production and this was an accepted cost because he was fond of his cows and this was an acceptable cost of this system. He had a paradigm shift when he talked to his vet neighbour who said let’s use the Gap calculator to see what this cell count and the clinicals³⁶ are costing you. He got in the experts and halved the cell count and the clinicals. Until the farmers work out what the counts were costing him he didn’t see the need to change,” (R1,2012).

5.4.2 Relationships

The human factor was both the number one driver and barrier identified, in terms of both relationships and skills. What this means is that positive relationships were considered to be a driver for OFMQ improvements and negative relationships a barrier. In addition, the attitudes they could bring, might significantly affect the skills of the worker to implement steps to improve OFMQ.

“Whatever the barrier is – sometimes a mental headspace. This will continue until they have a paradigm shift to see their way through that blockage. Some just don’t give a shit,” (C1,2012).

to the desired performance, (Retrieved: April 13, 2013, from <http://www.dairynz.co.nz/animal/mastitis/tools-and-resources/smartsamm-gap-calculator/>).

³⁶ Clinicals are animals with clinical mastitis which is an inflammatory response to infection causing visibly abnormal milk (e.g., colour, fibrin clots), Retrieved from: <http://www.merckvetmanual.com/>, November 2013.

"You have to have confidence that you can change, awareness that you can change and the systems that allow you to change," (R3,2012).

"The biggest thing is for them to see where they are going and can reflect on where they are going" (R1,2012).

"The best thing that has happened to milk quality is to get rid of the people they were employing due to labour shortage and have hired foreign labour who want to make a new life for themselves – they will follow procedures and the job is done properly. They don't always recognise a problem though," (C1,2012).

How researchers and advisors' perceptions differed from farmers however, was their broader definition of relationships. For the advisors, they acknowledged that their own experiences as an advisor frequently involved situations where the family and staff relationships were a significant barrier for their clients. What was also different was the geographical location of these advisors compared to the farmers, and this factor has not been further analysed. While all interviewees in this segment (advisors and researchers), both travelled and consulted widely, their residence, and therefore many of their clientele were from the Waikato region, compared to the farmers who all resided in Canterbury.

"There has also been a slow realization that farmers cannot be considered to be part of a homogenous group and that their primary sources of information will vary. Part of the rationale of the wider communication plan within the programme was to have all advisors expressing opinions on mastitis control with a similar view of best practice," (Penry, 2011, page 40).

The importance of the varying needs and varying priorities of farmers has been well documented in Europe, and may have influenced the significance placed on relationships by interviewees. It became apparent that this European research had been very influential in the perceptions about the importance of relationships between farmers and the professional organisations by current researchers.

"We had a one-size fits all model- we needed to change that", (R1, 2012)

It was the belief of one researcher that the order of priorities of farmers were misunderstood, and this may have been a contributing factor for the apparent lack of traction for the SAMMPlan in the past.

"Farmer priorities are: 1= teamwork, 2=animal welfare, 3=knowledge and then 4=production. Vets perceive it to be in reverse – production is greater than knowledge, welfare, and then teamwork. Vets perceptions are different to farmers", (R1,2012).

"The guys that are in trouble generally aren't motivated by money cos they're losing heaps on penalties, I find the biggest driver is the lack of hassle, if you've got 40 cows in the mastitis herd, it takes as long to deal with that as milk the whole herd," (C1,2012).

"Some farmers are motivated more by the financial thing. There has to be a primary reason to change – for others they just need reassurance. It has to affect them personally. Those motivated by the dollars you need to reassure them that will happen. But also - will the system work for them 'will I get out of the shed quicker?' What we are asking them to do must have personal benefits – that is the bottom line," (R1,2012).

"15/20 years ago we created external motivation – a top-down approach. Imposed penalties as an external motivator to get on and comply. Now it is more to create incentives although that is overseas. Fonterra does not do incentives. Our challenge is to create more internal motivation for the farmer to improve – better teamwork, better animal health, a bit more understanding and as a bonus, you will get better production. Up until 'yesterday' we used the Gap calculator," (R1,2012).

5.4.3 Research education and training

While research can act as a driver, as new knowledge and training roll-out from these findings, for some researchers, the timing and accuracy of research data collection was also considered to be a potential barrier:

"Timely data collection is a driver but also an obstacle, because it's not in real time," (R4, 2012).

"We want to be able to have technology that's easy to use, and everything is automated so we are collecting data in real time. So yes, I think technology is also a driver in terms of being able to catch data early on rather than being on the 'back foot'. We want to be proactive rather than reactive", (R4, 2012).

R4 claimed that there can be up to a 25-30% misidentification of the sire or dam of calves. When LIC looked at several bulls' data and recalibrated the information just using progeny that had been DNA proved to him, there was a reasonable difference between the data. This can influence the use of genetics to reduce mastitis and therefore improve OFMQ.

"There are now issues surrounding who's managing the herd and sometimes they're not vigilant. The biggest issue is that the herds are getting bigger and it's so easy to get up in the morning and 10 cows have calved and they have swapped calves and you don't know who belongs to who," (R4, 2012).

However, overall, herds continue to improve and with continued culling, the industry can achieve further improvement.

Another barrier identified was the prevalence of misinformation however, as discussed below by both an advisor and researcher. Below are examples of misinformation they have personally heard from famers struggling with their high SCCs.

"That it's a waste of time teat spraying unless done in a certain time frame so why bother? Another one the other week was that the cup pressures had to be a certain level for milk let down. This created a massive problem with teat damage. These are just two examples but there are heaps out there," (C2,2012).

R1 believes that the new format in SmartSAMM should help the issues associated with the poor technical information that exists within the industry.

"We need to get what we want as normal behaviour becoming normal," (R1, ,2012).

Researcher R4 stated that she believed there was a degree of complacency among farmers about milk quality issues

"Somatic cells are significant but I don't think the perception out there is that they are significant. There is definitely complacency, it's more about getting the milk into the vat," (R4,2012).

However, as stated in the dialogue below some farmers interviewed claimed that rather than complacency, relevance was an issue. The barriers identified by many Canterbury dairy farmers was that there was a lack of relevance of the advice for regions outside the Waikato; they also believed there was an apparent numbing towards the programme from a lost momentum; and they voiced that poor coordination existed between training providers and the milking teams within their region. Overall, there was a perception among some famers interviewed, (F1, F2, F4, 2012), that a myopic view from the Waikato prevailed.

"The killer still is that until us, (Canterbury) get to 50% of NZ's milk flow the Dairy Industry won't take us seriously. It is particularly relevant to the South Island becoming 50 to 60% of dairy production in the next 25 years," (F2, ,2012).

Table 5-c: A comparison between advisors' and farmers' perceptions of the drivers and restraints for further improvements in OFMQ in New Zealand.

| Drivers (➡) Restraints (←) | Bacteria | | Somatic Cells (SCC) | |
|---|----------------|---------------|---------------------|---------------|
| | <u>Advisor</u> | <u>Farmer</u> | <u>Advisor</u> | <u>Farmer</u> |
| Staff Relationships | ➡ | ➡ | ← ➡ | ← ➡ |
| Staff Skill level | ➡ ← | ➡ ← | ➡ ← | ➡ ← |
| Poor routines in the shed | ← | ← | ← | ← |
| Complacency and poor attitude | ← | ← | ← | ← |
| Education programmes for staff | | | ➡ | ➡ |
| Poor weather | ← | ← | ← | ← |
| Poor detection of problems | ← | ← | ← | ← |
| Ineffective use of chemicals in milking shed | ← | ← | ← | ← |
| Time pressures | ← | ← | ← | ← |
| Plant and machinery age and condition | ← | ← | | |

| Drivers (→) Restraints (←) | Bacteria | | Somatic Cells | |
|---|----------------------------|----------------------------|------------------------|--------|
| | Advisor | Farmer | Advisor | Farmer |
| Organisational skills | → | → | → ← | → ← |
| It isn't a priority | | | ← | ← |
| Pride in achieving targets | → | → | → | → |
| The fear of penalty | → | → | → | → |
| Incentive payments for low SCC | | | → ← | → |
| Building up Herd Numbers | | | ← | ← |
| The opportunity to share best practice | | | → | → |
| The desire to have happy healthy cows | | | → | → |
| Cup pressure settings | | | ← | ← |
| Miscellaneous e.g. accidental causes, power cuts, teat liners | ← | ← | | |
| Key | | | | |
| | Driver/restraint but minor | important driver/restraint | major driver/restraint | |

Figure 5-c: A comparison between advisors' and farmers' perceptions of the drivers and restraints for further improvements in OFMQ in New Zealand.

5.5 Supply managers from processing companies perceptions about the drivers and restraints for further improvements in OFMQ

The aim of a supply manager in a processing company is essentially to maximise shareholder returns by producing large volumes of product for sale, while at the same time, protect shareholder returns by ensuring stringent quality control systems are effectively utilised. This requires the supply manager to balance these forces while sustaining supply. Two milk supply managers provided insights to this question (P1 and P2), one from a large New Zealand milk supply company, and another from a relatively smaller one. The transcripts revealed that for a large cooperative dairy company there is no real driver to reduce the somatic cell levels below tradable limits. This is because there would be a resultant negative impact on the volume of milk available for sale³⁷, thus there is no financial reason to reduce BTSCC further.

5.5.1 Money

P2, stated that his company looked at paying premiums for lower SCC milk. However, he believed that if farmers responded to this incentive, this could result in the reduction of volume³⁸ supplied to his company. This would not be a desirable outcome, as presently they have an ability to maximise shareholders returns by selling as much (milk products) as they can, within the current thresholds as demand for their products presently exceeds supply. In addition, in New Zealand they do not make significant amounts of caseinate cheese products. Unlike Europe, where the shelf life and quality of both raw milk, and cheeses are key concerns when made from higher SCC milk. Subsequently, in Europe they pay a premium for low SCC milk. However, in New Zealand, there was little opportunity to gain extra revenue and therefore no reason to pay a premium for lower SCC milk.

P1 also questioned the likelihood of farmers supplying low BTSCC milk without a significant price incentive. The only perceived benefits he identified were possibly the pride gained

³⁷ This reduction in volume would be due to farmers removing high SCC cows from their milking herd in order to keep their BTSCC within the bounds of the incentive payment criteria.

from achieving personal targets or the reduction in “the time spent on the hassle of mastitis and the ability to utilise these gains on-farm for other things.” When P1 examined the milk volumes per cow of two supplier groups from within his company, those with an average SCC of 170,000cells/ml, and those with an average SCC of 320,000cell/ml, he was surprised at the lack of significant difference between their milk volumes³⁹. He concluded that there was no advantage to the processor to provide incentive payments for low SCC milk to suppliers, beyond enticing suppliers from competitors that are motivated by being rewarded for best practice⁴⁰.

P1 explained that should the company he represents decide to provide incentives, they must also recognise that they would need to find markets prepared to pay a premium to raise the revenue that would be required for incentive payments. He believed markets were already there for premium milk and that these market segments are growing, particularly in China, due in part to the problems China recurrently experiences when imposing regulations for their own milk industry. He explained that standards in China have had to be relaxed due to the difficulty created from the majority of milk supplied within China being nowhere near international regulations for either SCC or bacteria. This has potentially provided an opportunity to meet this shortfall.

For the credibility of the dairy industry, and to uphold the integrity of New Zealand products P1's company emphasised that all New Zealand milk is very good, but their company could provide other benefits such as personalised access to farms and the processing plant. This strategy's justification was that by lifting the prices for all their products across a weighted average would eventually compensate for the incentive payments that would be required for the supply of a premium product.

³⁹ *In fact, contrary to what he expected to find, the group with the higher average SCC count had a slightly more consistent milk supply curve.*

⁴⁰ *The incentive to entice these suppliers is that they tend to produce quality milk with little intervention required by the processor.*

5.6 Government agencies and regulatory bodies' perceptions about the drivers and restraints for further improvements in OFMQ

The letter G represents interviewees that were in the milk testing business (G1) or responsibility for food safety at government level (G2). G2, considered that "getting the basics right" is the key driver for further success. The following extract came from a follow up email from a personal interview with G2.

"I mentioned in my presentation in the Milk Quality Conference that as an industry we still need to get the basics right. To remain economical, the size of the average dairy farm has been steadily increasing, with a focus on increasing milking efficiency. It is a requirement that cows' teats are clean at every milking, and in many countries, it is standard practice to wash and dry the teats and udders at every milking. In New Zealand, the practice of milking without washing has become the norm. This has been encouraged partly for efficiency and partly to minimise exposure to mastitis pathogens (poor washing being worse than no washing when teats are dry). In the past it was also considered that the massaging effect of washing the udder assisted with milk let down. When teats are clean at the time of milking, and often they are, then no washing is necessary. However, if the teats are dirty then they do need to be cleaned. We are concerned that this is not happening as it should.

Many countries also recommend or require the stripping of foremilk in order to identify any abnormalities before the animal is milked, which is typically a measure to detect clinical mastitis. In New Zealand, we have taken the approach that we want to act before sub-clinical cases become clinical, and hence the focus on SCCs. However, there will be occasions when milk harvesters should be paying attention to udder health and observing foremilk, for instance when a cow's behaviour indicates discomfort or when a very high SCC has been returned via herd testing. Although we would expect that a high SCC for an individual animal will result in immediate treatment (with milk withheld), we cannot assume that this will occur.

These basic farmer controls are not new by any means, but they are important and our trading partners expect that farm hygiene measures will be consistently applied. So our challenge is to ensure that they are applied as intended", (G2, personal communication, June 19, 2012).

5.7 Summary: How identifying drivers and restraints for improvements in OFMQ could be examined by the New Zealand Dairy industry

Each stakeholder will have perceptions surrounding both the feasibility and/or desirability of approaches for improving OFMQ. These perceptions will be governed by a myriad of factors: personal constructs of the problem statement, financial and human capabilities and simply their desire for change comparative to other priorities they might have.

Below, is an adaptation by Peter Senge (2006) of the Force Field Analysis model described in Chapter 3, (pg. 35-36)

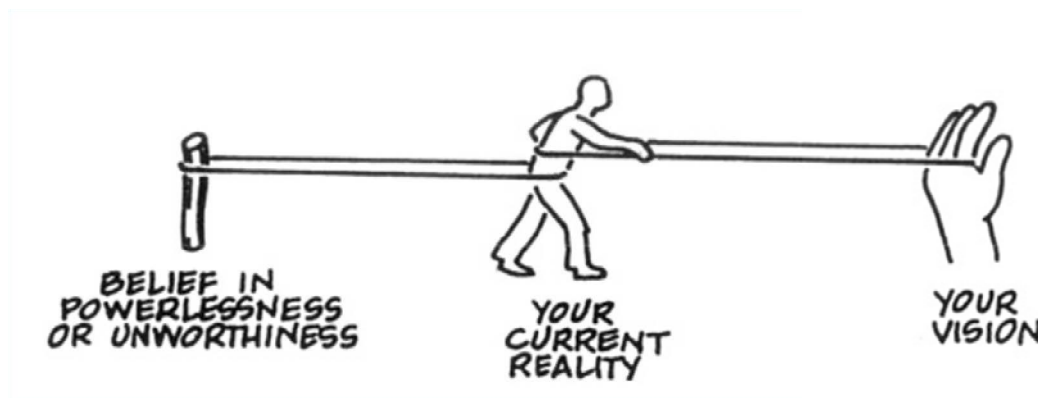


Figure 5-c: *The closer we come to achieving our vision, the more the conflicting forces can pull us away from our vision⁴¹*

The following Figure 5-c provides some examples of Force Field diagrams that could identify the drivers and/or restraints for further improvements in on-farm BTSCC in New Zealand. These could be done in the field using a highlighter, or in a brainstorm situation prior to, or during research. They represent only a small number of the 100s of possible tensions that could exist between stakeholders and their perceptions of the feasibility and/or desirability of solutions presented to them.

Note the counter restraint shown was identified from examples from both primary and secondary sources. Accordingly, they represent just a few examples of many possibilities.

⁴¹ Adapted from: "The Fifth Discipline: The Art and Practice of Learning Organization", Peter M. Senge (2006)

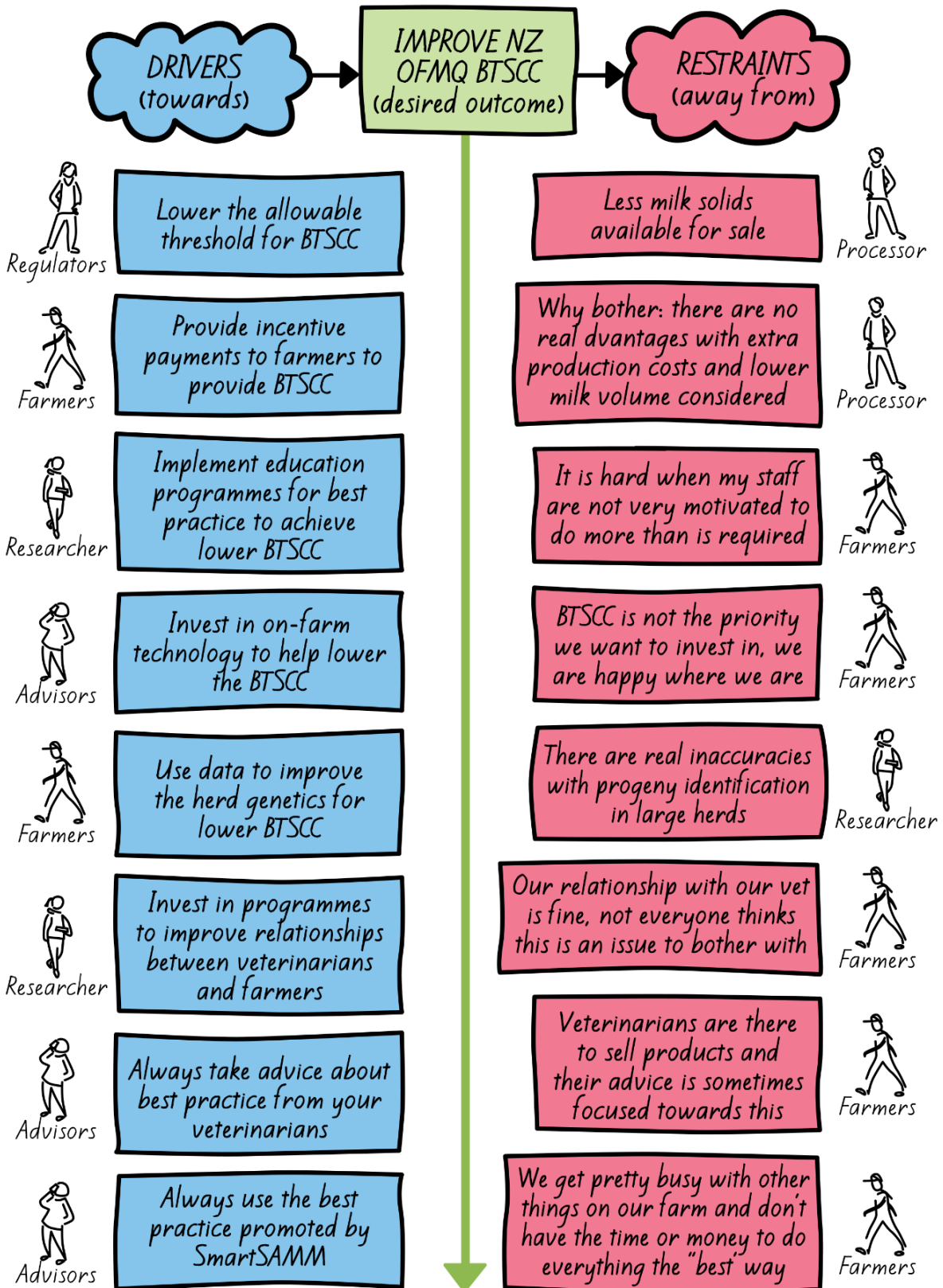


Figure 5-d: Examples of Force Field models for analysing the drivers and/or restraints for towards further improvements in OFMQ within the New Zealand dairy industry.

Chapter 6
Results: Question 2

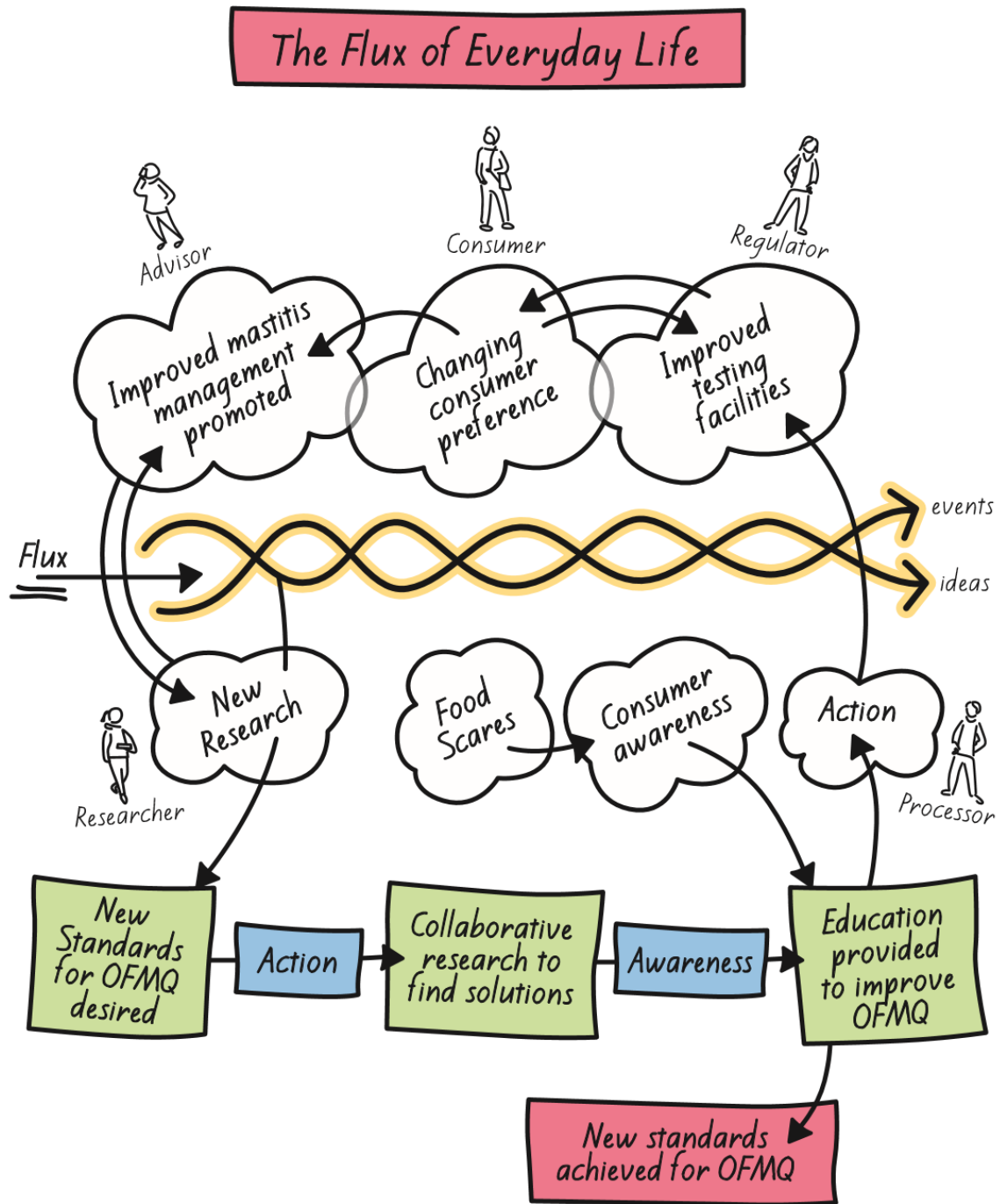


Figure 6-a: The Researcher's lens to view Research Q2

Q2 What events and ideas may have influenced perceptions surrounding on-farm milk quality, in New Zealand?

6.1 Introduction

These findings have a number of theoretical and practical implications for the identification of the events and ideas that influenced perceptions surrounding OFMQ between 1992-2012. The following chapter summarises the findings from question 2 above. The results are from both interview transcripts of key stakeholders in the New Zealand dairy industry and from secondary sources. Hence this section discusses these findings by combining the results from both primary and secondary data. To provide a richer picture of the data, material from primary sources that validated data is alongside the secondary sources. The key areas discussed are represented in Fig 6 (b) below.

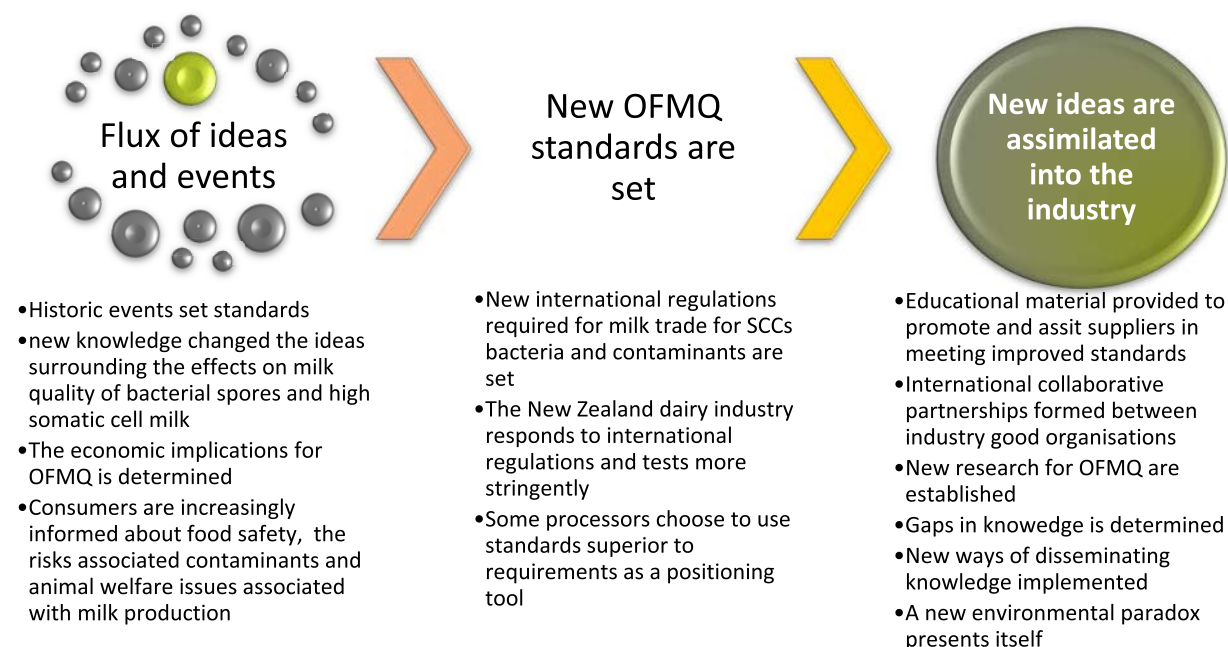


Figure 6-b: A brief summary of the flux of ideas and events from key findings.

6.2 Historic events in New Zealand that set standards

Milk somatic cell counts (SCC), are the international dairy trading industry standard for milk quality. As early as the 1960s the International Dairy Federation (IDF) discussed what constituted a healthy or unhealthy udder. During that decade, the dairy industry developed new diagnostic tools to test both the cytological (including somatic cells) and bacteriological status of milk. Until this time, specific knowledge regarding the exact status of SCCs levels in milk was unknown, (R. Franks, personal communication, June 18, 2012).

In the early 1970s, the New Zealand milk industry then re-examined their definition of quality milk. They tracked products from the farm gate to the retail shelf and were concerned with the results that they found. In these early days, almost half of all tanker samples had somatic cell counts over a million, as a result, the milk held overnight in the storage tanks deteriorated at a rapid rate. Subsequently, processed products made from this milk such as butter, quickly became rancid. Investigations identified that a few careless farmers were creating a problem for the whole industry and they concluded that a lax attitude about somatic cells, inadequate hygiene, poor cooling and careless administration of antibiotics were the reasons New Zealand dairy products did not have a long shelf life, (Franks, 2001). Below is a description of the early days, described by Franks from his experience in the national dairy lab testing for somatic cell counts.

“Testing suppliers’ milk using Wisconsin test, (but stopped as there were no gains from it) which was around 1981 when independent testing lab set up. During that time, it only covered milk fat testing, then the gradual move to milk grading for bacterial tests from factory labs. From that technology – we used to go to Denmark regularly – so were able to change testing from looking in millions to 200 then 100,000cell/ml. That was why there was no shelf life for dairy products – you could find sludge in your milk bottles (from SCC). At that stage town milk supply was separate. (We) Started improving quality on the manufacturing side – eventually the quality of manufacturing was better than fluid milk,” (R Franks, personal communication, June 18, 2012).

Franks had described this process previously in a conference paper. In that paper he explained that historically the New Zealand Government, rather than the farmer or processor, drove regulation. When the industry was deregulated in 1990, the accountability and responsibility was then the onus of the dairy companies, (Franks, 2001).

“Companies made approaches to government and in 1988; a dairy industry working party produced a very significant document, Milk Quality Assessment- Future Direction for New Zealand. This identified problems, responsibilities, and possible solutions in the milk quality area.... This has further evolved and we now operate under registered product safety programmes, which are third party audited,” (Franks 2001, pg. 62)

It was initially decided in the 1980s that 500,000 cells/ml from a single quarter should be a preliminary SCC threshold for the industry. However, research later indicated that this was too high and that quarter milk samples higher than 200,000 cells/ml were a strong indicator of an infection. The present requirements for BTSCC in New Zealand is 400,000 cells/ml the same as the EU standard, (Heeschen, 2010; E Hillerton, personal communication, May 4, 2012).

Currently, regulatory authorities such as MPI guide processors rather enforce BTSCC limits but this is constantly under review.

“Currently for products to be eligible for the EU each farm supply must not exceed 400,000 cells/ml over a rolling three months. In addition, MPI require that action be taken when any individual farm consignment exceeds 400,000 somatic cells/ml. This action may take many forms, but positive action to remedy the situation must be taken. In time the action limit of 400,000 cells/ml may be reduced to prompt earlier action, and at the same time an upper threshold would need to be considered,” (Barnao, 2012) .

6.3 Idea: the economic implications of poor OFMQ are determined

Research reinforced that mastitis reduced milk quality and yield, and created an associated risk of contamination from antibiotics, residues, and pathogenic bacteria. In addition, research surrounding the economic implications from mastitis and its associated issues found there to be significant financial losses for the New Zealand dairy industry. Financial losses were estimated to be in excess of NZ\$180 million per year from reduced milk production and the extra administration and loss of income from discarded milk. Research claimed that this would only be the minimum cost; because elements such as: penalties, insurance policies, lost colostrum sales, higher culling and dry-cow⁴² treatment costs were not included, (Malcolm, et al., 2006).

Hogeveen, Huijps & Lam, (2011) supported the view of European Union research on the financial impact of mastitis. Their research concluded that many farmers were unaware, and did not fully considered the added costs beyond direct costs. While they all agreed that not all measures to reduce mastitis are cost effective, they did not believe that farmers receive sufficient information that clearly outlines the economic impacts, (Halasa, Huijps, Østeras & Hogeveen, 2007; Huijps, Lam & Hogeveen, 2007; Huijps, Hogeveen, Antonides & Lansink, 2010)

More recently, an MPI representative (G2) supported this view, but was also mindful of the economic complexities of farmer and processor decision making surrounding incentivising the supply of low somatic cell milk.

⁴² Dry cow therapy (DCT) is the treatment of cows at the end of lactation with a long acting antibiotic preparation with or without a teat sealant. This is to treat for any intra-mammary infections (IMI) contracted during lactation and provides protection against new infections during the dry-period, (www.dairywellness.co.nz, retrieved Feb 11, 2013).

“Although professionals active in the field appreciate this, there has largely been reluctance on the part of farmers to act solely on the basis of what they may perceive to be a theoretical production benefit. In the absence of direct financial penalties or incentives, this will continue to be a challenge. There are potential functional benefits associated with milk from low SCC animals, but at this stage the economics are questionable for typical NZ dairy export commodities as opposed to liquid milk and some short shelf life chilled dairy products”, (G2, 2012).

6.4 Educational material is developed to reduce SCC

“While mastitis in cattle is well controlled in an historic context, there has been much debate about its apparent resurgence in recent years. In view of these recent changes, and the lack of a structured, coordinated approach to understanding and solving mastitis problems in dairy herds, it was felt that there was a need to modify the industry’s approach to mastitis control to encapsulate a diagnosis and a whole farm approach,”(ADHB, 2012)

Dairy companies in New Zealand reported that seasonal averages for BTSCC rose steadily after 1992, shortly after the implementation of the SAMMPlan, (Lacy-Hulbert, Blackwell & McDougall, 2011). A MPI representative G2, suggested that was likely to be because initially farmers received penalties for any individual consignment that exceeded 400,000 SCC/ml which generally prompted a rapid response. However, because many companies now instead penalised suppliers based on their period averages, there was now a greater opportunity for an individual farmer to correct their BTSCC before incurring a penalty, and subsequently there was less urgency given to the problem, (G2, 2012).

Researcher R2 said that research foci had changed considerably during the period 1992-2012. He maintained that they had:

“Spent decades trying to find ways to detect mastitis so that we could treat it”
(R2, 2012)

Moreover, he went on to explain that at around 2004, the focus had changed from treatment to identification of best practice.

"We were better off looking at the 40% of the cows that never get infected and work out what was so special about them? We then try to work out-why can that cow live for 7-8 years and never suffer an infection? We need to stop talking about the problem and start talking about the solution," (R2, 2012)

McLeod, (2008) identified significant gaps in both the knowledge and skill level of NZ dairy farmers relating to mastitis in general. In her research, she concluded that these gaps (ranging from: the causes and identification of mastitis; the relevant treatments for infections; the further prevention of; and the cost associated with mastitis), were seldom recognised by farmers. Because of this observation, she suggested the delivery of mastitis extension material needed adjusting.

"It is time to take a fresh look at mastitis - to shake the complacency and re-prioritise mastitis as a disease of national significance to the NZ dairy industry and with high costs to the social, emotional, and financial health of individual farmers. More work is required to evaluate current mastitis training programs and to determine appropriate extension activities that will lift awareness of the true cost of mastitis and result in practice changes that cause an overall decrease in the incidence of mastitis", (McLeod, 2008, pg. 173)

The SAMMPlan had been operating for over a decade, when McLeod (2008) presented her report that discussed the climbing BTSCC trends. The problems she had identified in her research ranged from the lack of implementation of the "best practice" advocated in the SAMMPlan, and farmer complacency about the need to focus on mastitis due to the difficulties in controlling it. Australian dairy researcher Penry shared these concerns in 2011.

“By 1998, there was also the realization, again at the milk processor level, that pricing signals to farmers were not enough to bring about altered milk quality through a reduction in mastitis levels and new infection rates. While the financial rewards were apparent there was a lack of consistent advice available to farmers being offered to farmers from different advisor groups, and within groups, was often poorly articulated and piecemeal in its technical content. The milk quality advice being delivered from the tanker driver was completely different from that on offer from the milking machine technician and the herd veterinarian. The net result was a significant degree of farmer confusion and widespread inaction. Against this backdrop Countdown⁴³ emerged”, (Penry, 2011, pg. 34-35).

During this research, DairyNZ was in several joint research partnerships within the industry, including research to try to determine a genetic indicator for mastitis resistance that could be incorporated into the commercial value of an animal through its Breeding Worth (BW) index. The early results of this research indicated, that while resistance to mastitis infection is a trait that is not as strongly genetically correlated as milk fat and yield it is still of value as a genetic indicator of likelihood of infection. As such, the SCC trait has now been incorporated to calculate a cow's breeding worth index, (R4, 2013).

Because funding approval may have been three years prior, adapting to changes as researchers gained new perspectives or philosophies, was described to be difficult and certainly a possible barrier for OFMQ improvement due to the unavoidable delay period. One researcher (R4) agreed that even if perceptions changed over this period, this was largely irrelevant, due an obligation to roll out the outcomes from this research. While this was her view, she believed the industry was in good heart and moving forward in a positive direction, through greater cohesion and a commitment for improvement.

⁴³ *Countdown Downunder was developed in 1997, when the Australian Dairy industry responded to a pressing need to lower milk cell count levels and clinical mastitis infections within Australian dairy herds, since then it has been updated and replaced by Countdown MAX and later Countdown2020, (<http://www.dairyaustralia.com.au/>).*

Researcher R2 suggested that one of the main changes in philosophy was that the New Zealand dairy research team recognised the need to change its philosophy of science to:

“stop thinking about the ‘cup being half empty’ and to start thinking about the ‘cup being half full’. To think about what we are doing well and what we can add value to,” (R2,2012).

6.5 New science regarding milk quality and processing

“It is also a general truism that once raw milk is defective, it is most unlikely that it can be improved during processing and those defects will more often than not become pronounced.” (Burgess, 2010, pg. 64)

Fresh milk is the starting point for a number of food products including cheese, evaporated milk, dried milk, yoghurt, and butter⁴⁴. The milk processing industry is reliant on a regular and consistent supply of high quality raw milk and if provided, it can produce high quality and safe processed products. A high quality raw product to processors is essential because they are unlikely to be able to successfully reverse the defects present in the raw state, (Burgess 2010).

Each processed milk-product has specific quality requirements, and foods such as infant formula and high quality cheeses demand premium milk quality standards, (Birker 1999, Williams 2012). The New Zealand dairy industry's philosophy is to aim for maximum quality and quantity, which it achieves by testing both frequently and stringently,(Franks 1994). All tanker-milk arriving at a processing plant in New Zealand undergoes testing for elements associated with milk quality including live bacteria (Bactoscan), thermophile bacteria, thermoduric bacteria, coliforms, somatic cells(SCC), colostrum, inhibitory substances, as well as a sensory quality test, (Williams 2012).

⁴⁴ See Appendix A.9 for a summary of processes that convert milk into a variety of end-products

Because mastitis influences the composition and quality of milk in a number of ways, these changes have consequences for the processor, in that high SCC milk may be unsuitable as an ingredient for some products such as cheese. Firstly, high SCC milk has less non-fat solids such as lactose, which is costly to add before processing, and secondly, the influx of blood proteins can affect the levels and composition of the proteins, especially casein, (O'Connor and McDermott, 1997, D. Williams, personal communication, March 12, 2012).

Somatic cells are important because they help an animal to fight infection by releasing enzymes capable of digesting bacterial components. Cell membranes in raw milk are denatured by centrifuging or heating, and these enzymes, if present, are released and remain behind in high SCC milk. The presence of these enzymes can then affect the milk quality through the indiscriminate digestion of the protein compounds in milk that are valued by processors, (Jamieson, personal communication, May 3, 2012). Ma et al., (2000) and Barbano, Ma, & Santos, (2006), concluded that milk with higher SCC levels (849,000 cells/ml), significantly affected the quality of pasteurised milk, and reduced its self-life compared to milk with lower SCC levels (45,000 cells/ml). High SCC milk therefore creates quality issues apart from the reduced yield.

“When starting with raw milk that has a low bacterial count and in the absence of microbial growth in pasteurized milk, enzymes associated with high SCC will cause protein and fat degradation during refrigerated storage, and produce off-flavours. As the ability to kill, remove, or control microbial growth in pasteurized refrigerated milk continues to improve, the original milk SCC will be the factor limiting the time of refrigerated storage before development of an off-flavour in milk”, (Barbano et al. 2006, pg. E15).

Research also indicates that the product's overall sensory quality can also be reduced which Barbano et al. (2006), concluded was from increasing levels of heat-stable proteases and lipases originating from the cow with high SCC. In addition, to reduced yields and reduced processing ability SCCs can cause spoilage from off-odours, putrid flavours and reduce the

shelf-life of milk-products, (Ma, et al. 2000; Barbano, Ma et al. 2006; Madureira, Pereira, Gomes, Pintado & Malcata, 2007; Adams & Moss 2008). It is therefore considered that processors could benefit from BTSCC levels at reduced levels. For this reason, some researchers recommended that processors should provide incentive payments to encourage low BTSCC levels (Ma et al. 2000).

However, a milk-processing representative interviewed for this research had a different perspective to that of Ma et al., 2000. In his opinion, for the dairy ingredient market, (which represents the majority of New Zealand's dairy trade); BTSCC below 400,000 cells/ml makes little difference to their own products with the exception of caseinate products and some cheeses. This is because the majority of New Zealand dairy products sell as ingredient rather than processed products affected by somatic cells. Their opinion was that the research mentioned above based its conclusions on the shelf life of fresh milk or raw cheese which represent the main end products for European milk and this is most likely the reason behind the European dairy industry pushing for further reductions of BTSCCs, (P1, Personal Communication, August 24, 2012)

According to P1, two processes alleviate many of the problems associated with BTSCC levels in New Zealand. Firstly, unlike in Europe, very little of the milk the New Zealand dairy industry sells is fresh milk. Secondly, because somatic cells generally tie to fat cells, the majority of them will separate off during the production of skim milk.

"It's not so much the customer or consumer that is pushing us towards higher quality; it's that there is a market opportunity to demonstrate higher quality. Much of what we do in New Zealand regarding milk quality is meeting country (trade) requirements rather than customer requirements.

However, there is no reason for our largest supplier aim for this. Their aim should be to maximise the price to farmers by selling as much as they can with the minimum of waste within the allowable thresholds of quality", (P1, Personal Communication, August 24, 2012).

P1 explained that in his opinion the key reason for a New Zealand milk company to pay a premium for low somatic cell milk would either be in response to competitor pressure, or as a

means to entice suppliers that would be attracted by this incentive. The premise being, a supplier producing low BTSCCs would also operate both efficiently and effectively in other aspects of their farming practices, making them attractive suppliers of milk. Added, P1 perceived that incentivising suppliers to lower their SCC would lessen the additional problems associated from antibiotic use treating mastitis.

At present, the global dairy industry encourages the supply of on-farm milk that exceeds international standards. This phenomenon is already occurring in New Zealand, particularly within smaller milk companies who have implemented incentives for the supply of low SCC milk by their suppliers. As a result, education programmes for improved mastitis management have been supported by milk processing companies and proliferated worldwide since 1992, (Fairweather, 2012; McIntyre, 2012; van Boheeman 2012; P1, Personal Communication, August 24, 2012).

Food –safety issues

An MPI representative (G2, 2012) stated that pathogens rather than processing quality were the main reason their department were encouraging reductions in SCCs in New Zealand milk.

“From a regulator’s perspective, mastitis, as indicated by milk somatic cell counts, is a production disease. While some pathogens of human health significance can cause mastitis, not all causes of mastitis are due to pathogens of human health significance and the SCC does not provide any differentiation. Therefore, at this time the primary driver for reducing BTSCC down to 150,000 cells/ml or below is a commercial one for dairy farmers. It is well documented that as mastitis (clinical and sub-clinical) within the herd is reduced, as indicated by the BTSCC, milk production will increase,” (G2, 2012)

Food-borne diseases are a major concern worldwide. The microorganisms in milk most concerning to human health include bacteria such as *Campylobacter jejuni*, *Salmonella* spp., and *Escherichia coli*. (Grant 1991), and because of the frequent presence of these

pathogens it is imperative that high standards of hygiene prevail right throughout the production and processing chain to ensure the safety of the product to the consumer, (Jooste & Anelich, 2008).

Researchers Oliver et al. (2005) found evidence of a link between e-Coli, Campylobacter, and Listeria, and the milk of asymptomatic cows. Their claim was that the risk of foodborne illness has in fact increased markedly rather than decreased over the preceding 20 years, due to the increasing mobility of food products within and across borders. Dairy farms, they concluded, were an important reservoir of foodborne pathogens and this can be from direct consumption of raw or processed milk with pathogens present. While consumers generally consider drinking pasteurised milk removes the risk of illness from these sources, their research indicated that pasteurisation alone would not guarantee public safety. Their conclusion was that the dairy industry should be very concerned about food safety, due to an expectation that food supplied to consumers is free of foodborne pathogens, (Oliver, et al. 2005).

6.5.1 Food Safety Standards for New Zealand OFMQ

“Foodborne pathogens, mastitis, milk quality, and dairy food safety are indeed all interrelated.” (Oliver et al., 2005, pg. 126).

New Zealand upholds its food safety reputation by adhering to international standards. The framework for these standards was developed in partnership with Government bodies such as MPI in consultation with industry, and the standardisation bodies such as the Codex Alimentarius Commission,⁴⁵ (Smith & Hogan, 1998; MAF, 1999).

⁴⁵ www.fao.org/fao-who-codexalimentarius/en/. Codex established in 1962, to facilitate rather than restrict trade, by developing standards based on scientific knowledge, to protect both the health of consumers and to ensure fair-trading practices. The Codex standards also restrict countries imposing criteria beyond Codex as a non-tariff barrier as well as preventing inferior standards becoming an economic barrier for fair trade, (Smith & Hogan, 1998)

In 1999, the MAF Dairy and Plant Products Group, a former branch of MPI, produced a discussion paper for the risk management of dairy products. It outlined the importance of ensuring New Zealand had a sufficient risk management policy that was useful both economically and practically. The methodology used was the Hazard Analysis and Critical Control Point (HACCP) system developed by the Codex Alimentarius Commission.

“Risk analysis will be the cornerstone for developing standards for food in international trade. Its adoption for New Zealand dairy products will provide logical, cost effective, and scientifically defensible mechanism for delivering credible food safety assurances to New Zealand consumers and overseas regulatory authorities. Differences in food safety programmes among countries are becoming a priority in the international trade in food”, (Ministry of Agriculture and Forestry (MAF), 1999, pg. 1)

The New Zealand dairy industry decided that Codex standards would be the benchmark decisions rather than an ad hoc approach in response to competitor trade.

“Members shall accept the sanitary and phytosanitary measures of other Members as equivalent, even if these measures differ from their own or from those used by other Members trading in the same product, if the exporting Member objectively demonstrates to the importing Member that its measures achieve the Member's appropriate level of phytosanitary protection”, (WTO, quoted by MAF, 1999, pg. 12)

A contributor to this research G2, echoed this in her statement below:

“From a food safety perspective the BTSCC provides an indication of the general udder health of the herd, but is not a direct link to food safety. However, it is already a base requirement that milk from animals with clinical mastitis (abnormal milk) cannot be supplied for human consumption. At a regulatory level, MPI would not like to see BTSCC acceptance thresholds reduced significantly from the current 400,000 cells/ml. That isn't to say that we don't want to see the New Zealand national average

reduced, but we would not advocate the discarding of milk without there being a genuine food safety imperative", (G2, 2012).

6.6 Contaminants

A New Zealand Government official interviewed for this research stated that there is an increasing awareness among consumers worldwide of the risk of contamination in milk.

"I think the public are becoming more aware and concerned about the adulterations of milk. People are now worried about what else we're going to stick in milk,"(G2, 2012).

The presence of contaminants in food is undesirable, as this could have a direct effect on the consumer of that food, and milk has the potential to be contaminated with a diverse range of contaminants, (GHK 2011).

"Whereas most dairy products, processed to modern standards of hygiene, have excellent safety record, consumers are demanding increased surveillance and control of all foods, including dairy. The contamination of animal feed with dioxin in Belgium (1999) highlighted that consumers place the absence of toxic chemicals in their food alongside microbiological safety in importance. There will be no lessening in the demands on food producers to control risks and deliver assurances of safety", (Creamer, Pearce et al. 2002, pg. 7190).

6.6.1 Veterinary Medicines

Mastitis and public health are linked because of antibiotics for its treatment and the possible (though unproven) implications of an increased risk of antibiotic resistant strains of bacteria. Recent concerns about a new strain of MRSA⁴⁶ in milk (Garcia-Alvarez, et.al, (2006) discussed

⁴⁶ *Methicillin-Resistant Staphylococcus aureus (MRSA)- relevance: Staphylococcus aureus is a known major cause of foodborne illnesses, and raw milk and dairy products are often contaminated by enterotoxigenic and antimicrobial-resistant S. aureus strains.*

in: Green, et al., 2011), ignited debate in the UK and gained significant attention in the media⁴⁷. As a consequence the use of antibiotics for dairy cows is being scrutinised throughout Europe, (Kraft, 2011).

Veterinary drugs are widely used in the dairy industry because they can enhance productivity and reduce the morbidity or mortality from illnesses. However, because of the potential contamination from products such as anthelmintics, sulphonamides, or antibiotics, strict traceable protocols need to be followed when drugs are used in the New Zealand dairy industry. The negative effects of antimicrobials for processing milk products such as cheeses and yoghurts is well documented, and result in poor quality unstable products (Birker, 1999; Creamer, et al. 2002; European Commission, 2006).

This makes New Zealand milk products desirable to processors offshore partly because of the assurances of the absence of antimicrobials. A key concern to consumers about antimicrobials in products such milk world-wide, is the possible impact antimicrobial resistance could create for human antibiotic therapy and the increased sensitivity and allergic responses that humans may have from overexposure to antimicrobials (Nag, 2010; R2, personal communication May 2, 2012; G1, personal communication May 3, 2012). There has been a significant amount of international research since 2006 that examined the human health issues associated with antibiotic resistance connected to dairy herd health. The results from this research are polarised. While there was an acknowledgement that antibiotic resistance was a genuine concern, (Oliver, Murinda, & Jayarao, 2011). Oliver, et al., (2011) found no evidence a problem with the widespread resistance to antibiotic drugs among pathogens isolated from dairy cows, However, there were others such as Wang, (2006) and Wang & Schaffner, (2011) who considered the implications for resistance in the

⁴⁷ For an example of such a response, see Appendix A.10

future, as not only a serious concern, that they believed the industry underestimated and provided an inadequate response to the dangers.

Wang and Schaffner (2011) stated:

“As pointed out by Turnidge (2004), the real difference between these two positions is whether action should be taken, or should have been taken to effectively deal with bacterial antimicrobial resistance developed in food-producing animals. This on-going debate has led to important changes in perceptions and priorities of federal regulatory and public health agencies throughout the world with regard to antimicrobial usage--in particular, use of antimicrobials as growth promoters and as prophylactic agent”, (Wang and Schaffner, 2011, pg. 338).

6.6.2 Other contaminants

In 2008-2009 there was an incident known as the “melamine issue”, for the New Zealand dairy industry, brought about by the deliberate adulteration of milk for financial gain by the Chinese business Sanlu Dairy Company. While New Zealand had nothing directly to do with this adulteration, its largest milk exporter “Fonterra” was implicated due to its financial interests in the Sanlu Dairy Company, Yan, (2011). The consequence of that one event is that international markets have become increasingly sensitive to the slightest hint that milk integrity might be compromised.

A similar incident occurred in Taiwan in 2011, when the country's soft drinks industry had a contamination incident in which potentially toxic phthalate compounds were illegally added to a common clouding agent used as an additive in some products as a substitute for palm oil, a common clouding agent.

“Phthalates are a family of chemicals typically used as plasticisers to make plastics softer and more flexible. Unfortunately, some phthalates have been identified as of concern because of their potentially adverse effect on reproduction and development. There were a number of similarities to the melamine case – the phthalates were being added as a clouding agent to give the product the appearance that palm oil had been added. So it was very much a case of adulteration for financial gain,” (G2, 2012).

This incident created a response for international food testing authorities to develop tests for the detection of phthalates. When the New Zealand testing authorities developed these for the milk industry, they detected extremely small traces of phthalates, which prompted an immediate response from the MPI to find the source of this contamination. After stringent testing and a widespread investigation, they identified new rubber liners for milking teat cups as the source. Subsequently new protocols surrounding teat liners has been implemented to avoid any contamination that may affect future milk exports from New Zealand, (G2, 2012).

6.6.3 Regulations and recommendations are debated surrounding allowable levels of contaminants for tradeable milk

The increasing concerns about antibiotic resistance and the potential for human health problems has prompted organisations such WHO to call for regulations at national and international levels, (WHO, 2011)

“WHO has long recognized that antibiotic use in food animals, which seems to outweigh antibiotic use for human therapy in many countries, contributes importantly to the public health problem of antibiotic resistance? This necessitates increased awareness and specific policy guidance on containing antibiotic resistance from a food safety perspective”, (WHO, 2011, Page xi)

The findings from this research indicated that there is a growing perception among some dairy industry stakeholders in New Zealand that contaminants rather than the traditionally viewed somatic cells or bacteria, are its greatest risk. Notably, the stakeholders that shared this view operated outside the farm gate, whereas those operating within the farm gate still perceived traditional risks such as somatic cells and bacteria as the greatest risk. Possible reasons for this view are because these new risks are not widely publicised and according to one milk quality stakeholder (G1), who stated when interviewed that this was intentional to avoid any overreaction from farmers as well as to avoid further scrutiny from consumers, if a risk was not yet actualised.

G1s perception is contaminants such as phthalates⁴⁸ have become an emerging issue largely because “if you look for it you’re likely to find it”. What he meant was that detecting contaminants of any description whether they be bacteriological, chemical, or other adulterations, are constantly being refined on behalf of the New Zealand Dairy Industry, and because of the increasing sensitivity of the technology, more and more contaminants are able to be detected than in the past. Traces that were previously unable to be detected are now apparent, it is not so much that milk has a greater problem with contaminants, it is more that we have a greater awareness of their presence (G1, 2012).

While G1 is primarily involved with the direct testing and monitoring of raw milk, G2 in her role as a regulatory authority supports this in her following statement:

“In the case of chemical residues and contaminants the laboratories now have very sophisticated test equipment available, and the limits of detection are several orders

⁴⁸ www.foodsafety.govt.nz/.../dairy-national-chemical-contam-surveillance-12-13.pdf

Testing for contaminants by MPI in 2012/2013 detected a phthalate compound: DEHP. This compound was known to have been included in the formulation of milk liners to provide the required flexing on the component during milking. These milk liners were found to be the primary source of DEHP in milk products. Consequently, DEHP was removed from use in the formulation of rubber components for the milking plant.

of magnitude lower than they were 20 years ago. Many substances of concern were being measured in the parts per million (mg/kg), but now many are measured in parts per billion or, for some, routinely measured in parts per trillion. As the labs drill lower, compounds are found that have not traditionally been associated with milk. In addition, many importing countries are now very well equipped to monitor at the border using highly sophisticated equipment and highly qualified staff. The downside of this is that in some cases the labs will monitor for parameters that are not relevant to the particular commodity. This can result in disputes at the border with delays or possible rejection of consignments for exporters. Although this is not a common issue, for small exporters such delays can impose a serious financial burden," (G2, 2012).

G1 described the 2008 melamine contamination of infant milk formula in China, where the New Zealand media quickly responded with inferences that Fonterra, New Zealand's largest exporter of dairy products, was somehow guilty through their business association with the San Lu Dairy Company where the melamine adulteration occurred.

"We had a calibration to detect melamine in an ml of milk within a week. That is not something the industry as a whole, or the community, or the average dairy farmer would know. Out of that, we have put in place a number of tests for adulteration of milk. If you asked an average dairy farmer, what the (milk quality) problems are in the world they would have a completely different bend on what we focus on in the lab. We are constantly adjusting our focus for emerging issues," (G1, 2012).

Melamine is regularly tested for in New Zealand and while contamination of melamine is not a problem within New Zealand, what this testing did said G1, was to build credibility, when companies demanded this of their suppliers outside the New Zealand environs.

Similarly, animal feeds are becoming an increasing source of contaminants including *aflatoxins*, a group of mycotoxins that are naturally occurring. Because they are also known carcinogens, feeds including corn and copra can be a risk to human health because when fed to lactating animals, aflatoxin M1 (AFM1) could be secreted in milk. Fittingly, because of the transfer of aflatoxin from feed to milk, testing is of critical importance for the New Zealand dairy industry it is banned in most countries above 50parts/billion, (Kissell, Davidson, Hopkins, Smith & Whitlow, 2012).

"Animal feeds are routinely subject to contamination from diverse sources, including environmental pollution and activities of insects and microbes. Animal feeds may also contain endogenous toxins arising principally from specific primary and secondary substances produced by fodder plants. Thus, feed toxins include compounds of both plant and microbial origin. Feed contaminants and toxins occur on a global scale but there are distinct geographical differences in the relative impact of individual compounds. The term "feed" is generally used in its widest context to include compound blends of straight ingredients as well as forages. Legal control of certain feed contaminants and toxins is in place and operating within a continually evolving framework", (D'Mello, 2012)⁴⁹.

In 2010, Fonterra banned bulk copra supplements for dairy herds because of the associated risk of aflatoxins. Additionally, they considered the risk augmented because the toxin is heat-stable; i.e., it cannot be destroyed by pasteurisation or processing of milk. The cooperative stated that if farmers intended to use a compounded feed containing copra, it should not make up more than 15 per cent of the feed and that the supplier should request laboratory

⁴⁹ D'Mello, J. (2012) Contaminants and toxins in animal feeds. Retrieved October 12, 2013, from: <http://www.fao.org/docrep/article/agrippa/x9500e04.htm>

certification that aflatoxin levels were below safe levels in the compounded feed, (Waugh, 2007).

"... this illustrates that the feeds being imported have the potential to bring chemical hazards that we haven't needed to manage in the past,"(G2, 2012).

C1 and C2 perceived contamination from cleaning compounds in milking sheds were an emerging and potentially serious concern. G1 responded to this, and explained milk-testing laboratories were presently testing and developing a response to this due to quaternary ammonium compounds commonly found in ammonia based cleaners and disinfectants, being an identified problem for the United Kingdom's milk industry. While farmers were yet to be informed about this testing yet, he believed farmers would be required to use best practices associated with any cleaning product and residues. He assumes that in the near future, the management of contaminants will be part of a farmer's on-farm audit process and these residues could be prohibited beyond yet to be determined levels, (C1 2012, G1 2012).

G1 emphasised that the low-key approach to disseminating this information prior to it being a mandatory requirement, aimed to reduce possible resistance to new auditing procedures. He described that rather than "a whole lot of singing and dancing, regulators wanted a "whole lot of quietly moving things through." The premise was that by using the approach the industry will provide workable solutions for contamination control that they can present to farmers, simultaneously to when or if, new regulatory requirements are compulsory, (G1, 2012).

G2 iterated the effect that improved testing and increased customers' expectations for low residue products.

"For pasteurised dairy products, the most frequent questions over the last few years have been in relation to chemical residues and contaminants. New Zealand dairy products dominate world trade and New Zealand product was constantly being

scrutinised by importing countries. There is also a growing demand for official assurances to be made regarding the status of milk and dairy product. This is particularly so when contaminant events anywhere in the world hit the media, and often there is an expectation by importers of New Zealand product that New Zealand will test to prove conformance, as highlighted by the melamine events in China. The New Zealand position goes beyond testing and where possible we resist end product testing as the sole means of confirming final product conformance", (G2, 2012).

The diagram below, (Figure 6-c) summarises some of the possible contaminants identified during this research

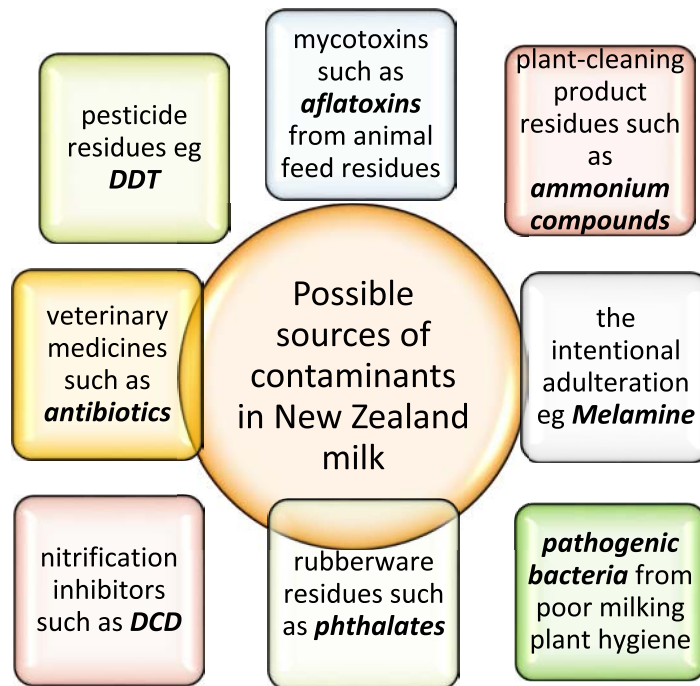


Figure 6-c Possible sources of contaminants for NZ milk identified from this research

6.7 Environmental paradox creates emerging issues for milk quality

An unanticipated outcome of improved environmental stewardship has created issues associated with somatic cell and bacterial contamination of New Zealand milk products. As farmers are encouraged to utilise water reserves more efficiently, the reduction in water use

in dairy sheds could result in yards not being cleaned thoroughly, a hesitancy to wash down cows, or a reduction in the effluent storage volumes.

“From the perspective of farm dairy practices, generally we are seeing more issues emerging related to effluent management and water use. Environmental drivers are encouraging farmers to re-think traditional practices such as yard washing. So a challenge for MPI is to facilitating novel effluent handling practices and innovative ways to reduce water use at the farm dairy without adversely affecting milk quality”, (Barnao, 2012).

Added, New Zealand was in the process of imposing nutrient caps on farms that may represented emerging issues. In response to the nutrient caps, the increasing use of feed-pads and in-barn cows could create new problems for OFMQ on New Zealand dairy farms. This would be due to the increasing use of imported feeds on feed pads and the decrease in pasture based farming. What became an emerging issue for New Zealand dairy products was the detection of Dicyandiamide (DCD) in milk⁵⁰. Tests indicated that very minute traces of DCD were detected in milk, Despite, that the levels detected were 100 times lower than the European food safety limits; the application of DCD to pastoral land was suspended in November 2012, and as a consequence, no further detections of DCD had occurred in products manufactured from milk produced 13 November 2012 -2013, (MPI, 2013). Added, even though traces found were considered to be harmless; the absence of any limit threshold within the Codex list⁵¹ created significant market access issues in 2012 for New

⁵⁰ DCD is a nitrification inhibitor that has the potential to greatly assist pastoral farming by reducing nitrogen loss to the environment and reducing the production of greenhouse gases when applied to pastoral land. In late 2012 the use of DCD was no longer permitted in New Zealand until international agreement is reached on a maximum residue limit (MRL), due to minor traces of this compound becoming detectable in concentrated dairy products. DCD is a chemical that inhibits for nitrifying bacteria in the soil that slows down the rate at which ammonia converts into soluble nitrate, and therefore also reduces nitrate leaching. www.foodsafety.govt.nz/.../dairy-national-chemical-contam-surveillance-12-13.pdf

⁵¹ The agreement on the application of Sanitary and Phytosanitary Measures (SPS Agreement) of the WTO provides guidelines to produce food for international trade, and recognised Codex standards are set standards for over 350 known pesticide contaminants alone including toxins such as: DDT, (Nag 2010).

Zealand milk. It was estimated that it could be up to three years (from 2013), until 'acceptable limits' for DCD would be established by the Codex Alimentarius, before this could be addressed (Cameron 2013)⁵².

When interviewed G2 stated that she believed that the increasing use of barn-style housing could also have an impact on increasing bacterial contamination of New Zealand milk. She outlined that the risks associated from barn-style housing were numerous and included the usage of non-traditional chemicals to maintain the housing environment; the likely changes in veterinary medicines to maintain animal health; as well as the changes in feed choice. As such, the risk of E-Coli contaminating raw milk could increase, which would create further implications for consumers of non-pasteurised raw milk, which is an increasing trend within New Zealand.

"MPI have paved the way for raw milk products to be produced in New Zealand through new specifications issued in 2009, and so any increase in pathogen exposure is highly undesirable. In addition, under the Food Act farmers may sell raw milk at the farm gate in quantities of up to 5 litres per household. Again, pathogen exposure is a concern. To ensure that farm dairy operators minimise the presence of pathogens in raw milk consideration will need to be given to the general farming practices employed along with the trends in feeding and housing," (G2, 2012).

The prevalence of mastitis due to *Escherichia coli* is low in New Zealand compared with the Northern Hemisphere, because cows live on pasture rather than being housed, (McDougall, 2002). However, Lacy-Hulbert, et al., (2012), suggest 'coliform bacteria', not normally associated with mastitis in New Zealand, could be an increasing concern. The risks their research suggested may heighten as herd numbers increase and cows housing and winter-feeding regimes change as we adopt systems more typical in the United States and Europe,

⁵² Personal communication, (2013) at Lincoln University.

(Lacy-Hulbert, et al. 2012). Should E-coli become more prevalent this could have serious consequences for the New Zealand dairy industry on two counts: the loss in production for infected cows plus the added risk to human health, (Altekruse, Cohen & Swerdlow, 1997; Smith-DeWaal, 2003; Lacy-Hulbert, et al. 2012).

Apart from pathogenic bacterial contamination from mastitis, non-pathogenic bacterial spores, particularly from supplementary feeds such as silage, can also affect both the processing quality and shelf life of milk products. The new housing and feed regimes proliferating in New Zealand may create a higher risk spores inflecting milk supplies. While spores are typically present in low numbers they can survive high-temperature, short time (HTST) pasteurisation, even at temperatures well above minimum pasteurization⁵³ They are problematic for processors due to the reduced shelf life, and because if present , the milk cannot be used as an infant formula ingredient, (P1, 2012).

“Some companies – want to stay ahead of the game so they said suppliers must be tested 3 times a month and they have consistently tighter standards”, R4 (2012).

6.8 Summary Table



⁵³ The grade A Pasteurized Milk Ordinance specifies minimum processing conditions of 72 degrees C for at least 15 s for high temperature, short time (HTST) pasteurized milk products, (Ranieri, Huck, Sonnen, Barbano and Boor, 2009).

Table 6-d- summarises the key events and ideas presented in Chapter 6 to answer Question 2: What events and ideas may have influenced perceptions surrounding on-farm milk quality, in New Zealand?

Figure 6-d: A summary of the secondary and primary data collected to support Question 2.

| Flux of ideas or events | Description of examples of influence on these perceptions surrounding OFMQ in New Zealand | Research data that supports this summary |
|--|---|--|
| The setting of milk quality targets | <p>Initially milk thresholds were set in classes of milk ranging from <400,000-<1.5 million cells/ml in the 1970s.</p> <p>As testing methodologies became more precise, SCC threshold levels were defined.</p> <p>New Zealand, adopted the standards for internationally tradable milk set by these authorities out of Europe of <400,000cell/ml</p> | <p>(Franks ,1994); (Grant, 1991); (Antle 1998); (Smith & Hogan 1998); (van Schaik, et al. 2002); ((National Mastitis Council Inc, 2005); (Tipton, 2006); (Heeschen, 2010);(Penry, 2011);(Pan & Tan 2011); (Hillerton 2012)</p> |
| Research demonstrated that reducing BTSCC was not only feasible but desirable economically | <p>Famer educational materials at conferences, farmer workshops and on-line through DairyNZ highlight the importance of economics as a driver for further reduction in BTSCC.</p> <p>The Gap calculator was developed to quantify individual farm savings associated with reducing BMSC.</p> | <p>(Antle 1998); (Gill, et al. 1990);(Hortet, Beaudeau et al. 1999); (Wilson, et al. 2004);(Halasa, et al. 2007;)(Huijps, et al. 2008);(Bar, et al. 2008);(Hogeveen, et al. 2011);(Stott ,2011);(Lacy-Hulbert, 2012)</p> |
| The knowledge that milk processing ability and shelf life might be reduced through high SCC | <p>Research shows that even when starting with raw milk that has a low bacterial count, enzymes associated with high SCC will cause protein and fat degradation during refrigerated storage, and produce off-flavors.</p> <p>Recommendations were made that the industry should develop incentives for farmers to produce low BTSCC milk.</p> <p>Promotion of differential payments systems for low BTSCC milk was advocated and some dairy supply companies initiated these.</p> | <p>(Franks, 1994);(Goff ,1995); (Birker, 1999);(Ma, et al. 2000);(Creamer, et al. 2002);(Santos, Ma et al. 2003);(National Mastitis Council Inc, 2005); (Barbano, et al. 2006); (Madureira, et al. 2007); (Nightingale, et al. 2008); More, 2009);(Burgess; 2010) (Williams, 2012)</p> |

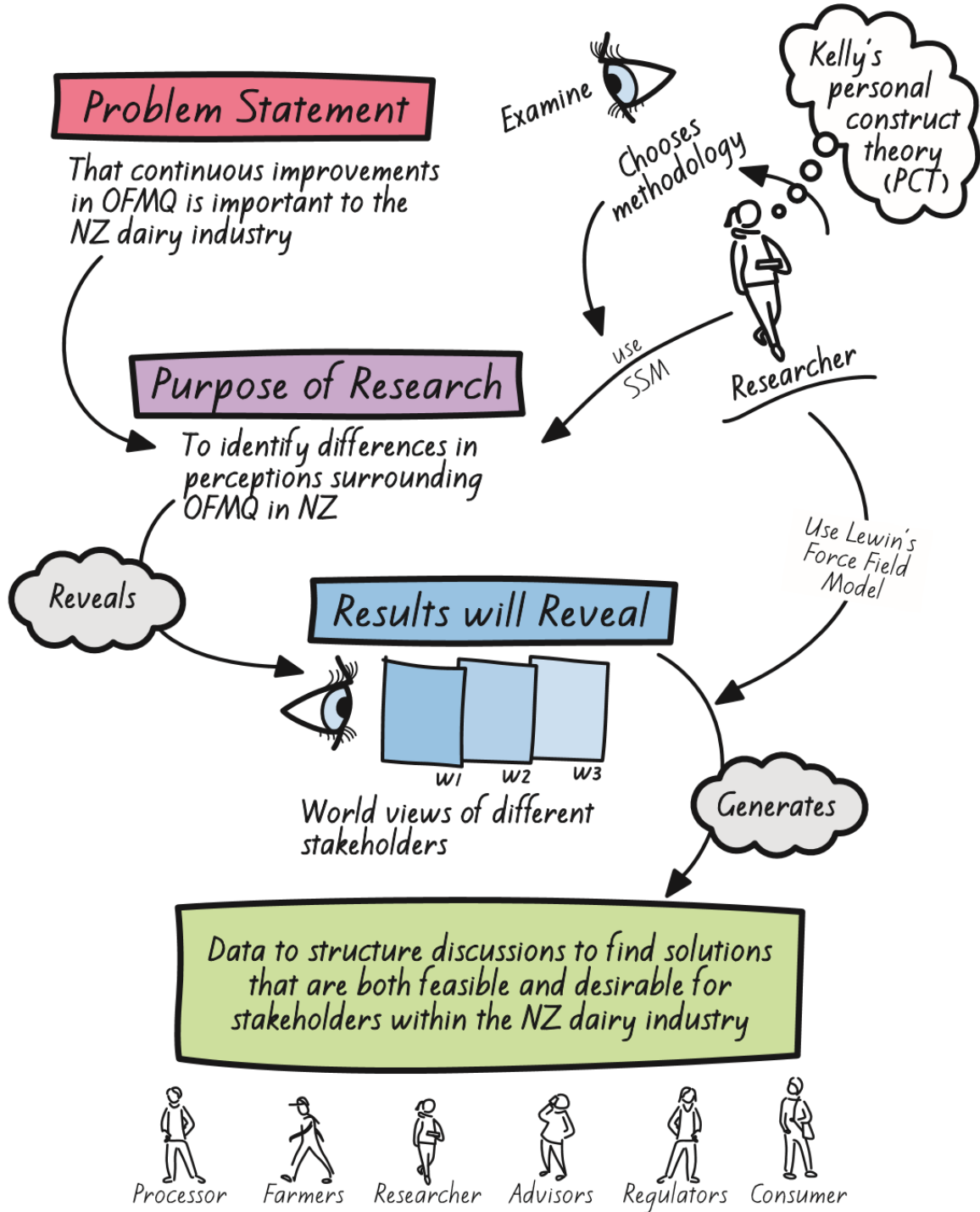
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| | | |
| <p>The increasing consumers' concern about the apparent safety of milk and the importance of animal welfare to consumers</p> | <p><i>Continuous cycles of what were deemed food-safety scares occurred throughout the world.</i></p> <p><i>Consumers' perceptions about the importance of quality food in excess of minimal requirement changed the view and value of products based on these standards.</i></p> <p><i>Increasing affluence in developing economies created a demand for products differentiated on attributes associated with good animal welfare, social responsibility, and food safety. Producers of food that exceeded food quality standards receive premium prices and access to premium markets.</i></p> | <p>(Smith-DeWaal, 2003);(Golan, et al. 2004);(Wilcock, et al. 2004);(Codron, et al. 2005);(Gehlhar & Regmi 2005);(Buzby, 2001;(Oliver, et al. 2005);(Calvin, et al. 2006);(Wang, et al. 2008) (Zhang, Bai et al. 2012) (Nicolau, Barker et al. 2013) (Small and Chapman 2012) (Verbeke 2009) (Kathholm and Bennedgaard 2011) (AHDB 2012) (Barnao 2012) (Goodwin 2012) (Malcolm 2012) (Saunders 2012)</p> |
| <p>The acceptance that reducing SCCs is important in terms of animal health</p> | <p><i>The "Holdaway Thesis", highlighted that animals with somatic cell levels at or above 150,000 cell/ml were likely to be suffering from mastitis. The correlation of BTSCC and SCC with intramammary infection led to an establishment of a threshold SCC. The target figure of 150,000 cells/ml was thereby adopted by NMAC</i></p> <p><i>The implementation of the SAMM plan and improvements in mastitis monitoring and reporting technologies resulted in a reduced overall prevalence of mastitis and reduced BTSCC in New Zealand dairy herds.</i></p> | <p>(Holdaway, Holmes et al. 1996) (Douglas 1999) (Franks 2012) (Hillerton 2012) (Jamieson 2012) (Lacy-Hulbert 2012) (Malcolm 2012)</p> |
| <p>Contaminants, including antibiotics are a key concern for</p> | <p><i>There is an increasing concern about the use of antibiotics in livestock farming including dairying. This prompts a shift of focus to prevent mastitis rather than treat.</i></p> <p><i>Phthalates, found in Taiwanese milk products in 2011- while the residues were minor and posed no concern for human safety in the amounts found this prompted</i></p> | <p>(Guardia and Hopper 1990) (Goff 1995) (Medeiros, Hillers et al. 2001) (Smith-DeWaal 2003) (Golan, Krissoff et al. 2004) (National Mastitis Council Inc, 2005) (Tenhagen, Köster et al. 2006)</p> |

| | | |
|--|---|---|
| <p>New Zealand stakeholders including Government regulatory bodies researchers and advisors</p> | <p><i>an immediate response from MPI and milk testing regulatory bodies to find the source</i> <i>E.g.: DCD residues in milk from nitrification inhibitors, again, while the residue levels were minor and posed no concern for human safety, have prompted new concerns for milk contamination</i></p> | <p>(Wang, Mao et al. 2008) (Pocknee 2009) (Young, Hendrick et al. 2010) (Velthuis, Flores-Miyamoto et al. 2011) (Eden 2012), (Franks 2012) (Goodwin 2012), (Hillerton 2012) (Jamieson 2012), (Lacy-Hulbert 2012), (Malcolm 2012) (Saini, McClure et al. 2012) (Saunders 2012)</p> |
| <p>The development of SmartSAMM by DairyNZ</p> | <p><i>A lack of traction of SAMMPlan and increasing trends rather than reductions in BTSCC were evident in the New Zealand dairy industry.</i> <i>Discussions regarding the shortcomings of SAMMPlan took place among stakeholder groups and research and ideas were collaboratively reconstructed for the new SmartSAMM programme.</i> <i>There is an acknowledgement of the heterogeneous nature of the New Zealand dairy farm milker and the requirements for new portals of information and the acknowledgement of the importance of the social factor in farmer motivation for change.</i></p> | <p>(McLeod 2008), (Pocknee 2009) (Botha, Lacy-Hulbert et al. 2010) (Jansen et al. 2010; Van Schaik et al. 2010) (Young, Rajić et al. 2010) (Lacy-Hulbert, Blackwell et al. 2011) (Mc Coy and Devitt 2011) (Mc Coy and O'Flaherty 2011) (Penry 2011) (Piepers, Lommelen et al. 2011) (Garforth 2011) (Mc Coy and O'Flaherty 2011) (Oliver, Fish et al. 2012) (Tarbottom 2012) (Blackwell and Lacy-Hulbert 2012) (Malcolm 2012)</p> |

Figure 6-d A summary of the secondary and primary data collected to support Question 2.

Chapter 7

Reflections and limitations



“People are actively engaged in the construction of their own subjective worlds, and one's perceptual processes are directed by the way one anticipates future events”, (Kelly 1966)⁵⁴



This study aimed to elicit stakeholders' perceptions of milk quality, and the drivers and restraints for further improvements. The context was the New Zealand dairy industry from 1992-2012. Key findings are listed below, and address the two research questions separately, followed by a summary statement that encompasses the thesis statement.

7.1 Question 1

What do stakeholders perceive to be the drivers and restraints for further improvement in milk quality in New Zealand?

7.1.1 Information and assistance

There has been revised interest in mastitis prevention programmes throughout the international dairy traders' world. Collaborative research partnerships between EU and Australasian researchers are reframing not only the focus of its mastitis prevention research but also how to deliver this information and support to farmers, (Penry 2011, Lacy-Hulbert 2012).

The EU has committed to changing antibiotic use within the dairy industry, due to the negative perceptions of their safety for humans, (GHK 2011; Oliver, et al., 2011). This is of significance to the New Zealand dairy industry as our own milk quality standards, and indeed

⁵⁴ Kelly (1968), Quoted by: Fransella, F. (Ed.). (2003). *International Handbook of Personal Construct Psychology*. Pg. 14.

the perceptions of consumers worldwide, are influenced by viewpoints within the EU. In response to the media hype about antibiotic resistant bugs and the risks to humans, the dairy industry focused its attention on preventing mastitis, rather than treating it.

It was the belief among the advisors and researchers interviewed that many of the problems in New Zealand associated with milk quality stem from the incorrect implementation of the advice given by industry professionals. Two examples were a lax approach to mixing chemicals such as detergents and cleaners, and the poor hygiene they frequently witnessed in the case of teat sealants. While many farmers interviewed were aware of the education resources surrounding best practice for mastitis prevention, and the animal husbandry required for meeting industry BTSCC targets, they did not consider these practices were being widely implemented. In their opinion, this was largely due to the perception of the "problem" itself- that is, their own definition of a BTSCC problem might differ from that of the processor, or indeed that of the researcher or advisor.

One factor not examined in this research was the relevance of the age of the interviewees. All farmers interviewed were aged between 35 and 60 years which covers Generation "X" and baby-boomers. The so-called generation profile shift since the SAMMPlan was implemented in 1992 could be relevant to the dissemination of information regarding milk quality and international research⁵⁵ over the past decade (since 2002).⁵⁶

Concurrently, over the two decades (1992-2012) there was an increasing cultural diversity on-farm in New Zealand. The rapidly growing dairy industry in New Zealand has created a significant shortfall of labour, requiring it to recruit widely throughout the world. In many regions within New Zealand, this shortfall was filled by migrant labour from the Philippines,

⁵⁵ (Creamer, Pearce et al. 2002, Klerkx and Jansen 2010, Velthuis, Flores-Miyamoto et al. 2011, D'Mello 2012).

⁵⁶ However, no research during this thesis in regards to this issue was done surrounding this issue; this is simply a further caveat for the reader and a possible opportunity for future research

Ireland and India. Both of these changes (generational shifts and cultural diversity) had the capacity to create issues around both the appropriate means for the distribution of information regarding milk quality, and present variations in the motivational factors of farmers to implement them.

There was also acknowledgement by researchers that multiple portals and modes of communication have become a necessity, because the so-called “typical dairy-farmer” their research once focused on is an illusion created by a myriad of factors, including high levels of stress from financial or relationship issues. Also farmers frequently exhibited stress from the demands of multiple ownership structures, multiple stakeholders and new pressures from environmental groups. All of these factors are likely to compete with milk quality as an on-farm priority.

DairyNZ considered these limitations when they changed both the appearance and the variety of educational support materials. Research from Europe, such as that by Kristensen and Jakobsen (2011), recommended increased modes of support be provided which farmers that recognize that they are increasingly heterogeneous in terms of their age, sex, ethnicity, financial burden, and education, as well as their desire to implement change. In response to this, the improved profile of mastitis management through the introduction of Smart SAMM and its support systems were designed to address issues for a more diverse collection of farmers, and the support material was developed with this awareness in mind.

7.1.2 Relationships and skills

The perceptions of farmers' need to reduce levels to or below the industry target of 150,000 cells/ml depended on many factors. Each farmer had a slightly different perception of the importance of- or indeed the value, of such a pursuit, and advisors echoed this with their own experiences with farmers. This research suggests that perceptions regarding the

importance, or indeed the ability to reach the industry targets- were largely to do with the existing relationships in the farmers' support networks. The farmers interviewed for this research all cited the importance of strong relationships with their milking staff as a key driver of further improvements. The advisors extended these relationships to include partners (not necessarily involved in the milking of the herd), professionals such as bank managers, regional councils, veterinarians, and indeed themselves. Relationships between researchers and veterinarians were acknowledged by R1 to be less collaborative in the past, and there has been a significant effort made in recent times to "mend bridges".

Advisors and researchers strongly identified the underestimation of the social factors as a significant barrier for further OFMQ improvement. However, many of the advisors questioned had had personal experiences where the breakdown in relationships both on-farm and off-farm had been a significant restraining factor for their own farmer clients. This view echoed research that has been done internationally on farmer motivations and abilities to improve farm milk quality. The gap that existed between the positive view of relationships, as suggested by the interviewed farmers, and the erratic view suggested by the advisors supports the premise that only farmers with the ability to run their business effectively and profitably can "afford" to prioritise milk quality.

All stakeholders agreed that campaigns such as the SAMMPlan and SmartSAMM provided a "shot-in-the-arm" for further improvements in BTSCC, as mastitis management again rose above the radar. Advisors who used the term "un-freezing farmer complacency" in relation to improving OFMQ support this response. This term fits the Lewin 'force field model' whereby change forward cannot occur in an organisation without first un-freezing the state of equilibrium, and then creating an imbalance through either increasing drivers or reducing restraints. One opinion advisors shared with farmers was that good practitioners could achieve extremely high milk quality consistently. In addition, while not effortlessly, they do not

require the same degree of intervention or coercing, compared to the practitioners with consistently poor milk quality.

7.1.3 The perceptions of costs versus benefits

McLeod (2008) suggested that farmers recognised that mastitis created significant time stress and financial costs to individuals and to the industry. She observed that there was a disconnect between farmers' general understanding of mastitis, and the reality of its potential costs to their farm (McLeod 2008). However, farmers interviewed for this research disagreed. They believed that they were all very aware of the costs associated with mastitis and some even commented directly about the value of the 'Gap Calculator'. This disparity could have been due to the increasing awareness in farmers' information and education of the economic costs of mastitis that have arisen since 2008, when McLeod's research was reported. The farmers described their own experiences of the financial costs as simply an informed choice about priorities, rather than a disconnect from the reality of cost. This restraint they believed was not due to a lack of knowledge, but to a lack of financial motivation to act.

To consistently achieve lower BTSCCs was widely perceived as costly and time-consuming, yet achievable. Interestingly, stakeholders acknowledged however that there were no real drivers to meet very low BTSCC targets without financial rewards from suppliers. This perception was universal among all stakeholder groups. They perceived that a significant financial incentive (premium payments) or disincentive (penalties) would be required for the New Zealand BTSCC average to fall below 150,000 cells/ml. Further, regulatory bodies and processors did not perceive the potential losses in production required would be justifiable in light of the fact the New Zealand dairy industry was presently operating well within the international limits set at < 400,000 cells/ml. These losses in production would occur if there was tighter management of mastitic cows, which could result in drying them off early or culling them.

Based on farmer interviews, observations by advisors and secondary sources from researchers, farmers overwhelmingly considered that BTSCC was the largest threat to the perception of milk quality in New Zealand. The reasons are connected to two overriding beliefs. First, because BTSCC was the factor they most widely saw identified by industry good bodies, therefore it must be so, and it is presently in the forefront of their minds because of both the promotion of the SAMMPlan and educational tool developed for farmers, and more recently SmartSAMM. Further, they perceived that living daily with the reality of somatic cells was a trigger for frequent discussion between farmers. BTSCC was a milk quality factor they responded to throughout the year, either actively or prophylactically.

One restraining factor that both advisors and farmers agreed upon was the significant effect the rapid growth in both herd numbers and herd sizes has had on the fluctuations of somatic cells in New Zealand in recent years. They both agreed that, as New Zealand herds consolidated, both herd size and numbers offered farmers a greater opportunity to reduce the somatic cell count in their herd.

A significant amount of research by Dairy NZ, and educational material such as advocating the use of the Gap Calculator, attempted to shift farmers away from drivers based on the fear of penalties (disincentive) to those based on their desire (incentive) to increase profit and reduced stress from managing mastitis. However, in general, advisors considered that farmers were still more likely to respond more strongly to loss prevention (disincentives) than to possible incremental gain (incentives). They justified this stance by noting that both bacteria and inhibitory substances are effectively self-regulated in New Zealand by the significant losses associated with penalties for breaches.

7.2 Question 2

What events and ideas influenced on-farm milk quality perceptions, in New Zealand during the period 1992-2012?

History is a series of punctuated events that frames our reality.

Throughout the period 1992-2012 the New Zealand dairy industry assured stakeholders that “industry good” was a priority of those entrusted with its care.

Before 1992, British and German researchers contributed prominently to mastitis knowledge from both a cytology and a disease control perspective. In general the EU historically initiated regulatory changes for tradable milk quality. Testing methodologies became more precise, which defined SCC threshold levels. New Zealand, due to its reliance on trade, adopted the international milk-trading standards set by Europe. It was perceived among stakeholders that failure to demonstrate that the New Zealand dairy industry was continuously aiming for BTSCC reduction could result in trade barriers arising from diminished consumer perceptions of its milk in terms of food safety, animal welfare and/or antibiotic usage.

The demand for premium products differentiated by food-safety assurances has increased for affluent consumers globally. As incomes rose in OPEC and Asia, so too did the demands for quality goods, in particular safe food. This triggered a significant shift towards these countries as a destination for New Zealand dairy products. The perceptions of quality remain constantly under the scrutiny of our traders however, and despite the advantages New Zealand's reputation for the delivery of safe premium goods has brought, the threat of new events could create unforeseen problems for the New Zealand dairy industry.

The increasing sensitivity of new testing technology has exposed areas of concern that were previously unknown, and correcting the stakeholders' perceptions could be both difficult and time-consuming. In 2008, the Sanlu melamine scandal prompted tighter testing for a large number of compounds in New Zealand milk. Moreover, new testing systems are constantly being developed and updated through international collaboration between milk testing agents. Three high profile contamination scares - melamine adulteration, DCD contamination and a botulism alarm during 2012-2013 prompted media speculation that New Zealand was "laissez-faire" about its food safety regulatory controls, (Smellie 2013). These scares resulted in significant interventions at the highest Government levels to assure New Zealand's trading partners that not only was New Zealand's food safe, but that its testing and monitoring systems were also both robust and under the constant scrutiny of government authorities.

The farmers questioned directly about the risks of contaminants did not see them as an issue of great concern. They also showed no concern about phthalates, ammonium compounds or pathogenic bacteria. The farmers all believed that organisations such as DairyNZ, and authorities such as MPI and Milk test NZ, had "this covered." However, in light of the milk safety issues - DCD contamination, Botulism scare that have arisen in New Zealand since the interviews in 2012, this stance may well have altered.

Since 1992 the definition of milk quality has expanded beyond chemical and biological qualities to include dimensions such as sustainability and ethics (genetically modified food, carbon footprints, animal welfare and employment issues). Animal welfare has become an increasing concern for consumers worldwide, as has food safety. Both are closely linked to mastitis management and the use of antibiotics to treat mastitis. There is also a close link between food safety and food quality, and as the range and sensitivity of tests for food quality and safety have expanded, the perceptions surrounding acceptable limits for food safety have contracted. Food safety crises throughout the world have meant that the public

no longer assumes that food is safe or that regulatory bodies can always be trusted on their assertions to deliver safe goods. The BSE scare in Europe broke down relationships of trust between the public and the science community, despite the exoneration of milk as a vehicle for BSE spread. Since then, milk has been under the scrutiny of both authorities and consumers. This increased the power of NGOs to influence perceptions of food safety standards particularly through social and other media. This power continues to be demonstrated today.

This thesis examined the following measures of milk quality: somatic cells, bacteria, and emerging factors such as contaminants. Regarding bacteria, farmers and advisors perceived that this was unlikely to become a significant problem now or in the future, due to the considerable “stick” (disincentives) wielded for breaches. Further to their opinion, the ability of a farmer to identify and correct bacterial contamination was relatively simple compared to the complexities of mastitis management. However, when this same question was posed to the researchers and to regulatory bodies such as MPI and MilkTestNZ, this view was not entirely shared. Among these two groups there was some concern about the increasing risk of bacterial contamination in the New Zealand dairy industry as the result of many factors, including changes in farming practices such as barn-housing.

Research between 1992 and 2012 showed that elevated levels of SCCs can radically decrease both the shelf life and general quality of milk, affecting milk for processing as well as the sensory experience for the end consumer (Ma Ryan et al. 2000, Barbano, Ma et al. 2006, Goodwin 2012). Processors in Europe frequently offer premiums for low BTSCC milk. While New Zealand's largest processor does not presently offer such incentives several smaller companies promote BTSCC milk as a market positioning strategy for products, and as a tool for enticing suppliers who can meet these targets.

European research into mastitis is presently (2012) focused on the costs associated for farmers, the importance of correct teat hygiene, and identifying farmer motivations for change. The economic impact of elevated somatic cells in herds in particular has become a growing rationale to farmers to reduce BTSCC. Further, regulatory authorities claimed they had frequent discussions around food safety and milk quality with governing bodies in other countries. While they were knowledgeable about the reduced processing qualities of high BTSCC milk, the stakeholders in this group considered that, based on international standards, New Zealand was producing premium quality milk well within the standards required for international trade. Therefore, while they recognised the importance of the New Zealand dairy industry focusing on continuously improving milk quality, they did not want to jeopardize the financial potential of the New Zealand dairy industry by imposing stricter standards than were required internationally. Partnerships currently exist between government regulators and testing authorities, and while they perceived BTSCC was an issue requiring a constant discussion and a desire for further improvement, this was because of the market access issues associated with animal welfare rather than a product fault as such. However, one government regulator stated that there was still a desire to be “ready” when and if stricter standards were required, and by doing so their intention was to encourage further improvement in OFMQ from both processors and farmers.

Finally, paradoxes exist between maintaining milk quality standards and the perceptions of consumers internationally. Certainly, the media seem to have adopted the view that the potential threats to human health are both real and largely unpublicised. As noted earlier, antibiotics are the subject of public debate, particularly in EU, where changes in antibiotic usage on dairy farms has been mooted, (GHK 2011). The concerns with this stance supported by Oliver et al. (2011) were that widespread banning or even significant reductions in antibiotic usage on-farm could inadvertently create further problems in trying to minimise the suffering of the animal. This poses an irony in that, on the one hand the public who claim antibiotic resistance needs to be addressed by governmental authorities are also those most

likely to be concerned about animal welfare. In this case, public perceptions often drive public policy. The paradox for the dairy industry is that addressing consumer concerns about antibiotic use inadvertently creates additional problems in the very same consumer about animal welfare.

This paradox mirrors the developed world's increasing concern for environmental sustainability. For the majority of the world, water is scarce and those nations that have access to clean and abundant water have a significant competitive advantage. However, with increasing scrutiny there is also an increasing responsibility for those entrusted with its conservation. Two Government stakeholders voiced just such a conflict between economic sustainability, environmental stewardship, and emerging issues about animal health arising from insufficient cleaning as a result of over-cautious water use. In 2013 DCD contamination of milk powder created trade barriers as a result of the industry trying to mitigate nitrate leaching and nitrous oxide emissions.

Like the trade-off between antibiotic use and animal welfare, there was a perception among regulators of an unexpected trade-off between nutrient management and improved environmental practices associated with water. Their belief was that prudent water management could create emergent problems for bacterial contamination for dairy farms in New Zealand, from using less water to wash-down yards, equipment and animals.

7.3 Limitations of research

The data gathered from key informants largely relied upon the “snowball” method and, as a result, there is an inherent risk that similarities by association may emerge among the interviewees. Kelly suggested in reference to his ‘sociality corollary’ that:

“To the extent that one person construes the construction process of another, he may play a role in a social process of another”, Kelly (1966, cited in Fransella, (ed), 2003, pg. 14)

Several of the key advisor and researcher informants were also either directly or collaboratively responsible for many of the secondary sources of information presented in these results. Variations in perceptions for much of the data may be less prevalent than if this was not the case. However, it did become apparent that this is not a phenomenon peculiar to the New Zealand dairy industry. Rather, a small group both carries out the decisions and the research surrounding somatic cells in particular, both nationally and internationally. Further, any new or ‘compelling’ research from members of this tight circle can dominate the direction for change.

Researchers interviewed supported the ‘sociality corollary’ whereby one person can construe the construction process of another. They perceived the social factor was underestimated and needed to be given more significance for milk quality education in New Zealand. However, the information the researchers quoted largely came from European studies and was as yet unproven in New Zealand. Further, the research supporting this view was in the forefront of their minds as they had recently been discussing these factors personally with the researchers responsible for these claims. This in itself supports the ‘sociality corollary’ but rather than for farmers, in this case it related to the researchers themselves.

Another factor was that the farmers interviewed were from sources previously known personally to the researcher. Again, their perceptions may not be representative of the

'average farmer', as they were all operating farms well in excess of the average herd size, all employed large numbers of staff, and all were educated to at least graduate level. In addition, they all farmed in the Canterbury region between the Rakaia and Waiiau rivers.

The importance of providing checks and balances to maintain the integrity of the results was identified early in the research process. Key informants were initially sought to assist with both the framing of the research questions and to provide direction for secondary and primary sources of information. The application of the following techniques maximised the integrity of the data gathered:

- Using key informants
- Prolonged engagement

The interview material employed a semi-structured technique and aimed to elicit prolonged engagement. As a result, much of the material used in the results became known beyond the initial questionnaire period. The interviews ranged in length from 35mins to 3 hours for all stakeholder groups. Interviews were time-consuming, but were the primary data-gathering method. New information and questions began to evolve as the interviews progressed and therefore it was important to allow the interviewees to range beyond the initial questions. Also the key informants, including researches, advisors and regulatory personnel, were all interviewed at least twice, this was followed up by emails seeking further clarification after the interviews were transcribed.

7.4 Summary

The results showed that many events and ideas shape the perceptions of New Zealand dairy industry stakeholders as to how they define milk quality, how milk quality should be measured, who should be responsible for its improvement, and how we package and present the information needed for further improvement. These results also indicated that some DairyNZ personnel believe the “one-size fits all” approach used in the past may have been a significant barrier to previous milk quality education programmes. The general belief was that, if required, there was ready access to resources and advice for further improvements in OFMQ. What prevented its implementation was the prioritisation of somatic cell reduction, and therefore the perceived need to seek such advice.

Consumers are increasingly concerned about food safety. These fears grow when a food crisis occurs and, as consumers' perceptions are significant for exporters, they constitute an important issue for New Zealand. NGOs and the media keep consumers well informed, and act as strong lobbying bodies to reduce the ‘acceptable levels’ set by industry bodies - such as the IDF. The New Zealand dairy industry needs to ensure that they can meet this regulatory challenge, and assure the public its products are of premium quality.

To attain maximum quality requires a collaborative and diverse approach, and all stakeholders identified the rapid growth of herd numbers and farmers' complacency as key impediments to OFMQ improvement in New Zealand. Whereas farmers and advisors saw a regulatory stick as the most effective driver, researchers said that improved stakeholder relationships would bring about improvements more effectively. All stakeholders agreed that promoting the perceived economic benefits could facilitate change.

While themes emerged, their relative rankings were diverse. The Lewin style force-field models presented in Chapter 3 describe worldviews of each stakeholder group. The identified barriers to further improvement may help the New Zealand dairy industry target its

efforts. For example, the Industry could develop a diagnostic tool for farmers to identify where they could gain assistance in solving their perceived problems.

For farmers and many researchers, somatic cells were the most important milk quality issue in New Zealand, whereas regulatory bodies and testing agents saw contaminants as the greater threat, and despite researchers acknowledging this threat the milk quality focus has continued to be SCC. In addition, the educational material provided to farmers by industry good bodies such as veterinarians is predominantly in regard to somatic cell management. Regulators kept research and development regarding contaminants “in-house” to avoid creating anxiety about new regulatory and auditing requirements, or it being misconstrued by the media. They vindicated their choice as a means to avoid widespread panic, by having the issue being ‘well under-control’. However, this assertion may now be obsolete in light of the highly-publicised contamination scares that have occurred in the New Zealand dairy industry since 2012. In 2013, the Government report on the botulism-scare improved transparency throughout the New Zealand milk industry is a recommended outcome.

All interviewees displayed a passion for the industry and a desire to improve on-farm milk quality. These findings imply that researchers' views may have become myopic because of their need to focus on research funding requisitioned years earlier, and through the frequent interactions among like-minded people in the industry. However, the opportunity for dialogue among researchers and other stakeholders infrequently presents itself. Each stakeholder in the industry needs to be aware of these limitations because, until this dialogue between stakeholder groups occurs, as Kelly predicts, these restricted realities will prevent the industry from recognising differences, and therefore risk failure to meet the needs of all stakeholders.

The discussion stated ‘history is a series of punctuated events’. Accordingly, further OFMQ improvements will continue to be influenced by events yet unknown. In addition, Kelly's PCT

provides an additional caveat to the reader, in that the world-views presented here are the constructs of the researcher and her interpretations of the events and ideas of the stakeholders used to elicit them. Further, industry stakeholders need to understand that their own constructs will create different interpretations, and recognise that only by presenting solutions deemed feasible and desirable for a variety of world-views will OFMQ improve.

“What you see and what you hear depends a great deal on where you are standing. It also depends on what sort of person you are.” – C.S. Lewis⁵⁷

⁵⁷ Lewis, C.S. (1955) *The magicians Nephew*, pg. 135 The Bodley Head, , London, England.

Chapter 8 Conclusions

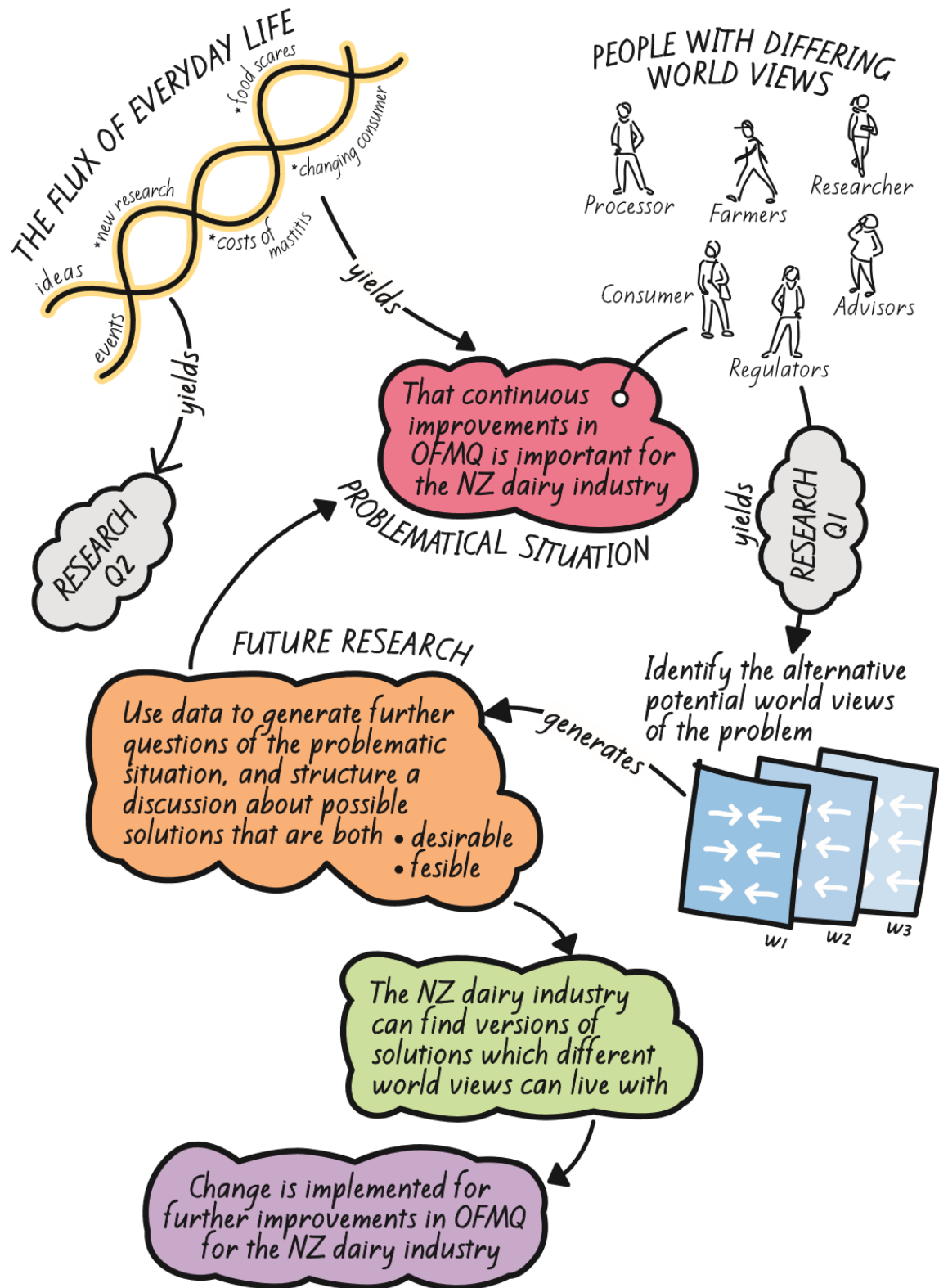


Figure 8-a: Researcher's Lens to draw conclusions from research questions

8.1 Conclusions

“An accurate, insightful view of current reality is as important as a clear vision”,
Senge (2006, p.g.144)

Many events and ideas shaped the perceptions of stakeholders about the definition of milk quality during the period 1992-2012 including how milk quality is measured, who is responsible for its safety, and how we package or present the information for on-going safety. DairyNZ acknowledged that the 'one-size fits all' approach was a significant barrier to the SAMMPlan. Accordingly a commitment to provide opportunities for discussions to establish the world-views of the stakeholders, may be an enabler of further improvements. This could assist with the implementation of solutions deemed both feasible and desirable for all. However, it is imperative that the New Zealand dairy industry continuously re-evaluates its research foci and informs stakeholders about milk quality issues in a timely, accurate, and relevant manner. Also any assistance for improvement should consider the diversity of the target audience.

How milk quality is defined by the marketplace has changed over the 1992-2012 period and rather than purely physical attributes encompassing chemical and biological qualities, dimensions such as sustainability and ethics are now included. In addition, the increasing awareness of food safety and food quality have resulted in the requirements for food quality to expand, and the limitations for food safety to contract.

Events in New Zealand after 2013 could undoubtedly have a more significant effect on perceptions of OFMQ than any other period in recent history, having created the new sense of urgency about milk quality evident among stakeholders. New Zealanders reported a sense of vulnerability in 2013 due to the media questioning their quality control systems, and raising the spectre of New Zealand's reputation for producing safe food products now being under question. Complacency about OFMQ was an overriding restraint identified by all stakeholder groups in the New Zealand milk industry. These new threats would have heightened

stakeholders' awareness of the importance of food safety, and so complacency may not impose the same restraint in the future.

For the New Zealand dairy industry to successfully negotiate improvements in on-farm milk quality (OFMQ) within an industry that is rapidly growing both in volume, and with more stringent customer expectations of quality, a collaborative approach is recommended to implement solutions both feasible and desirable for stakeholders in a confident and appropriate manner. Failing to do so could instead result in resistance from stakeholders whose viewpoints may differ from those disseminating the information.

This thesis has shown that SSM could be used to ascertain the diverse perceptions surrounding OFMQ. A gap was identified for clearly identifying stakeholder viewpoints within the wider context of the New Zealand dairy industry that reflected both on-farm and off-farm influences. Further it is considered appropriate that provisions are made to adjust research directions in response to events or to a change in ideas, due to the inherently cyclic nature of decision-making.

However, the lesson for the New Zealand dairy industry is not to dwell on these complexities.. Rather, it needs to accept that stakeholder perceptions are going to be fluid. The best it can do is be aware of these perceptions and be mindful that its own constructs will also determine the education and dissemination of the material it provides.

The key conclusions are that the NZ dairy industry requires more engagement with the complex realities of the various stakeholders surrounding OFMQ. Further, for the New Zealand dairy industry to attain maximum quality milk will require a collaborative approach, and recognition of the diversity of their target audience. As such, identifying the drivers and restraints towards further improvement in OFMQ, as presented in this research, could provide a starting point for future engagement.

It is significant that in all stakeholder groups interviewed there was a common desire for solutions towards further improvements in OFMQ. Yet there also needs to be an acceptance of what these solutions might entail for these stakeholders. What should be the foci and what should be prioritized will be a personal and for many stakeholders, a complex paradigm. It is therefore recommended that opportunities be provided for dialogue free of judgment, and which is re-evaluated regularly to take into account new events or ideas that might alter stakeholder perceptions. Such dialogue can see a new plan collaboratively formulated that is both feasible and desirable.

It is not important that the New Zealand dairy industry agrees on a single interpretation of reality, but rather that it acknowledges these world-views and be adaptable to changes within their organisation, that it coevolve from these changes and interact positively and collaboratively towards further improvements in OFMQ.

The next step would be to revisit the data, add new events and ideas to the pictures so far formed and reassess how these new ideas or events may have altered stakeholder perceptions. Once done, the relative importance of the factors surrounding the problem statement should be revised accordingly. Finally, a new plan needs to be formulated that is deemed both desirable and feasible for all stakeholder groups.

8.2 Key thoughts

We see the world not as it is but the way that we are.

1. The perceptions of stakeholders within the New Zealand dairy industry will continuously be influenced by the constructs of others,
 - a. Events and ideas are perceived by stakeholders differently, but all will influence their own personal construct,
 - b. Perceptions can be fluid, and the influences from outside the stakeholder circle can alter these world views.
2. Various actors will often assume that individuals within the dairy industry have similar priorities to themselves. However, such assumptions, unless clarified may inadvertently create barriers towards change,
 - a. What is perceived to be important to one stakeholder will not always be a high priority to another,
 - b. When people feel a part of a new movement or plan they are more likely to be influenced the perception of its importance, and as such collaboration for education material is vital
 - c. Any concerns or proposed changes about milk quality should be clearly communicated at the earliest opportunity to all stakeholders so that the reaction speed is maximized.
3. Creating a collaborative framework to identify differences in perceptions of stakeholders could enhance both the dissemination and uptake of new ideas that could assist further improvements in on-farm milk quality in New Zealand.



Appendices and References

A.1

Milk quality – The laboratory perspective: a summary prepared by Dave Malcolm (2008)

Background

All manufacturers of dairy products are required to have a Risk Management Programme (RMP) which assesses the risk of each stage of their operations to dairy product quality, and which implements procedures to control these risks. An integral part of this RMP is a Milk Quality Standard. A typical standard from Fonterra is presented in Appendix A.3

Milk quality standards rely upon random testing of milk samples at a frequency appropriate to the risk of non-compliance. This frequency may change seasonally when the risk changes because of seasonal influences, for instance inhibitory substances and thermotolerant plate count. An initial non-compliance is then followed up by daily testing until a defined number of compliant results are received, typically 3. Non-compliance is discouraged through the application of penalties, some of which may be severe including non-collection. Some companies are providing incentives for compliance with tighter standards.

The milk quality standard is designed to ensure that milk is harvested from healthy cows in a hygienic environment and plant, is free from contamination, and is stored in a manner which prevents deterioration in quality.

It is important to note that the milk quality standard does not necessarily reflect a danger to product quality, but rather to ensure hygienic production conditions. Most contaminating bacteria are killed in the pasteurisation step during processing and do not contribute to numbers in the finished product, although bacterial enzymes from grossly contaminated milk can survive processing to cause organoleptic problems during long term storage. The exceptions are chemicals such as DDE and antibiotics which can appear in the finished product at levels which can render the product non-compliant.

Bactoscan

The Bactoscan is an automated fluoro-optoelectronic instrument which gives an estimate of the total number of bacteria in a few minutes. It replaces, and is calibrated against, the traditional Standard Plate Count which requires 3 days of incubation before a count can be determined.

Although high bacterial counts in milk are generally due to poor hygiene, there are occasions, particularly in Spring, when *Strep. uberis* infections can contribute to the high count. The laboratories do a diagnostic test on each downgraded sample which gives a reasonable estimate of the likely cause.

Thermoduric plate count

This is a traditional plate count performed on a laboratory pasteurised sample. The causative hygiene issues in the plant (typically protein and milk stone deposits) can be hard to locate and, with the incubation process taking 3 days, correction of the problems can be a long process.

Coliform plate count

This is another traditional plate count using coliform selective media and designed to detect plant hygiene and milk cooling defects. The 24-hour incubation period removes a number of issues associated with delayed results facing the thermoduric plate count.

Organoleptic assessment

This assay is performed simply by assessing a heated milk sample by the senses of smell and sight. Typical odour defects arise from sour milk or feed taints, while visual defects include contamination with blood.

Sediment

The milk sample is filtered through a standard filter to detect unacceptable levels of contamination with dirt and faecal material. Unacceptable milk is routinely associated with the failure of the filter sock in the plant.

Inhibitory substances

A microbial inhibition assay is used to test the milk for inhibitory substances. If the growth of the test organism is inhibited, no colour change will occur.

Although by definition any inhibitory substance will cause a positive result, in practice the causative agent is always antibiotics and overwhelmingly one of the β -lactams. The presence of penicillin in every positive sample is determined by examining the sensitivity of the inhibitor to β -lactamase, and the concentration of the inhibitor is estimated using a zone diffusion assay against standard penicillin samples. The penalties applied to residues, particularly those in high concentrations, are very severe reflecting the risk to product quality.

Confirmation of the identity of the inhibitory substance and its concentration can be made using LCMS, however this is expensive and takes a large amount of time and is usually only performed in cases of dispute.

Somatic Cells

Somatic cells are routinely performed on every sample with a Fossomatic instrument, similar to the BactoScan, using flow cytometry.

Source: Malcom, D, Proceedings of the Society of Dairy Cattle Veterinarians of the NZVA Annual Conference, Proceedings of the Society of Dairy Cattle Veterinarians of the NZVA Annual Conference, pp 233-235, Jan 2008.

A.2 Summary of the management of antimicrobial inhibitory substances in New Zealand milk



INHIBITORY SUBSTANCES

The inhibitory substance test is carried out to detect substances that inhibit or reduce the growth of bacteria in milk. The test is performed by adding a standard bacterium to a milk sample. The presence of an inhibitory substance will stop the bacteria growing. This is indicated by a lack of colour change to a standard indicator dye.

Inhibitory substances are antibiotic residues from such things as mastitis treatment, pessaries, injections and other forms of antibiotic treatment there is the potential for residues to be left in the milk. Intramammary treatments are the predominant source of inhibitor substance downgrades.

Procedures to reduce the risk of Inhibitory Substance Grades

The following practices should be adopted by dairy farm operators:

1. Permanent records of all treatments administered to animals must be kept and this should include:
 - a. Animal Number
 - b. Type of Disease
 - c. The type of treatment used
 - d. Date of first and last treatment (including am and pm)
 - e. Date when animal allowed to return to the milking herd (including am and pm)
2. Keep treated cows in a separate paddock at all times. This paddock should not be directly adjoining that of the main supply herd in order to reduce the risk cows jumping. It should be securely fenced to prevent treated cows breaking out.
3. All treated cows need to be effectively identified. They should be marked with adequate paint and leg bands for quick identification. Also a record of cows under treatment should be available for all staff to see i.e. recorded on a whiteboard. This should include cow number, treatment used, withholding time and date clear for return to milking herd.
4. Milk treated cows separately from the main supply herd.
5. Remove the delivery line or otherwise divert it from the milk tank before milking the treated herd. This should be double checked and the milking herd should be clear of milking area.
6. Wash the plant with every milking to ensure any antibiotic residues have been removed from the milking system.
7. Mark and record cows that require antibiotic treatment before administering treatment. These cows should be drafted and treated once the main herd has been milked.
8. Wash your hands immediately after administering any antibiotic treatments.
9. Keep Dry Cow Therapy and lactational antibiotics well apart. Dry Cow Therapy only needs to be held in the farm dairy when cows are being dried off.
10. When administering Dry Cow Therapy – milk all the cows and after this has been completed return the cows to the milking area for treatment.



11. If drying off is staggered record the individual numbers of all cows treated along with the name of the product used. Mark the cows paint and put them in a secure paddock away from the milking herd. Paint should be reapplied regularly.
12. Record animals kept in the treated herd and/or dry cow herd and count herd regularly to ensure no cows get into the main supply herd.
13. Keep all antibiotics in a secure facility.
14. Dispose of old syringes and do not reuse for administering other treatments.
15. Follow the instructions on the labels of antibiotic treatments. This includes items like ointments, pessaries, and volumes of injectables.
16. Shake injectable antibiotics well before drawing from their containers.
17. Check or request records for purchased animals before milking to ensure that they have no antibiotic treatments in their system.
18. Discuss with vet – the withholding period of any cows having more than one quarter treated.
19. Discuss with vet – the withholding period of any multiple drug administrations to a cow.
20. Discuss with vet – the withholding period for treated cows that are only milked once a day.
21. Discard the milk from all four quarters of treated animals.

Article end.

Source: <http://www.qconz.co.nz/services.php?id=edit4b5625592ba3f>

A.3 Summary table of Fonterra milk quality tests and standards, 2008

| MILK QUALITY TESTS AND STANDARDS | | | | |
|---|---|---|---------------------------------------|---|
| Current for the 2007 / 2008 season | | | | |
| TEST | MINIMUM FREQUENCY | STANDARD | DEMERIT POINTS | NOTES |
| Bactoscan (Bscan) | 3 per month i.e. once every 10 days. | APC EQUIVALENT A+ Less than 10,000/ml A 10,000 – 19,999/ml B 20,000 – 49,999/ml C 50,000 – 99,999/ml D 100,000 – 199,999/ml E 200,000 – 499,999/ml F 500,000 – 7,999,999/ml R over 3,000,000/ml | 0 0 0 1 2 4 8 20 | * An "ALERT" will show on milk dockets where a B category result is obtained. C, D, E and F results may be further checked/ investigated. Following two consecutive results of R category, supply will be suspended until it is shown to be a D category or better. If "mastitis" is indicated with the grade notification then mastitis may be contributing to the grading event. |
| Thermoduric Plate Count (Therm) | 1 per month April – Oct plus 2 per month Nov – March inclusive (i.e. once every 15 days). | Less than 1,500/ml 1,500 – 4,999/ml 5,000 – 59,999/ml 60,000 and above | 0 1 4 20 | An "ALERT" will show on milk dockets for counts 500 - 1,499/ml inclusive. "THERM EARLY WARNING" will appear for counts >1,000/ml at 48 hours. Following two consecutive results above 60,000, supply will be suspended until it is shown to be less than 40,000 or better. "Spores" on the grade notification indicate that environmental factors (usually related to poor quality silage) may be contributing to the problem. Never discount hygiene as a factor in this situation. |
| Coliform Plate Count (Coli) | 2 per month i.e. once every 15 days. | Less than 499/ml 500 – 999/ml 1,000 – 1,999/ml 2,000/ml and over | 0 1 2 4 | An "ALERT" will show on the milk dockets for counts 300 - 499/ml inclusive. |
| Demerit relief is available for assistance with bacterial grading events. For more information, contact your Service Hub on 0800 65 65 68. | | | | |
| Organoleptic Assessment (Senses) | As required. | Finest Minor Defect Major Defect Serious Defect (includes Cress Taint) | 0 1 3 6 | |
| Sediment (Sed) | As required. | Category ABC Category D | 0 4 | |
| Colostrum (Colost) | As required. | 1.35% or less over 1.35% | 0 4 | Measured as IgG1 |
| Inhibitory Substances (I.S) | Minimum 7 per month (testing frequency increased at times of risk). | Less than 0.003 IU/ml 0.003-0.006 IU/ml 0.006 < 0.03 IU/ml 0.03 IU/ml or greater | 0 12 50 100 | If notified and tested prior to collection: Less than 0.003 IU/ml – no demerits 0.003 IU/ml or greater – is demerits Following a positive result, supply will be suspended until it is shown to be clear. For any non-notified positive result, supply is placed on daily testing for 12 calendar months. There is a charge for this testing of \$300 plus an audit fee of \$300. |
| You must notify Fonterra immediately if you ever suspect milk has been contaminated with inhibitory substances. There are rapid tests available that can determine the suitability of milk for collection. | | | | |
| Freezing Point (Fr.Pt) | Daily computer scan on Composition results. | Freezing Point - 0.513°C or lower Freezing Point - 0.512°C to -0.470 Freezing Point - 0.469°C or higher | 0 1 6 | Where computer monitoring for excess water shows a problem, the Freezing Point is checked on a Cryoscope. |
| Somatic Cell Count (SCC) | Per consignment. | 0 – 399,999/ml 400,000 – 499,999/ml 500,000 – 599,999/ml 600,000/ml – 799,000 over 800,000 | 0 1 2 6 20 | Following two consecutive results above 800,000, supply will be suspended until it is shown to be less than 600,000/ml. |
| Collection Temperature (Temp) | Per consignment. | 0 hour 18.0°C 1 hour 14.0°C 2 hour 10.0°C 3 hour 7.0°C | | Time is from end of milking, defined as 7.30am for morning and 6.00pm for evening. If you fail the temperature standard five times in one month, and a fault in the cooling system is found, you must improve your system within one month of the fault being identified or penalties will apply. |
| You must notify Fonterra immediately if you ever have problems effectively cooling your milk. Last task when leaving the farm dairy! Always check the refrigeration unit is on and working. | | | | |
| DDE | As required. | Above 0.3 mg DDE/kg Milkfat, penalties applied June to September inclusive. Above 0.5 mg DDE/kg Milkfat, penalties applied October to May inclusive. | \$1.20/mg DDE | All new supply properties must have weighted average soil level of 0.7 mg/kg or less for DDT and its metabolites. Collection will cease for any milk level greater than 1.0 mg DDE/kg Milkfat. |
| Reject milk | | Where milk is suspect or demonstrated to be unfit for purpose it will be rejected. | No payment | Disposal will be your responsibility. Make sure you comply with Regional Council guidelines. The Services Team can arrange for a letter to be written that may help you claim insurance for lost milk. |

Please note: there are specific requirements relating to the feeding of copra meal to cows. For more information, please contact your Service Hub.

| ORGANISATION | NAME OF PERSON | TELEPHONE NUMBER |
|--------------------------|----------------|------------------|
| Area Manager/Service Hub | | 0800 65 65 68 |
| AgriQuality | | 0508 00 11 22 |
| QCONZ | | 0800 7266 9583 |
| Vet | | |
| Detergent Rep | | |
| Electrician | | |
| Milking Machine Service | | |
| Chiller Unit Servicing | | |
| Power Company | | |
| Exotic Disease Reporting | | 0800 809 966 |
| Relief Milker | | |

If you ever suspect that the quality of your milk does not meet these standards prior to supply, contact the Service Hub immediately on 0800 65 65 68 for assistance.

NOTE: 1 demerit point = 5 % of the value of the milk supplied.

BOFP Don't forget to keep adequate records of all animal treatments and monthly plant inspections. These records must be filed in the BOFP manual. Please note, forms relating to BOFP are no longer sent out automatically. If you require replacement forms, please contact your Service Hub on 0800 65 65 68.

RDI LOW PRICE Guaranteed
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Customer Service Centre 0800 731 766

Fencepost.com

MILK SUPPLY **Fonterra**
Dairy for life

Source: Proceedings of the Society of Dairy Cattle Veterinarians of the NEW ZEALANDVA, 2008, pg. 233.

A.4 Summary Table: Bacterial families that can affect milk quality

| Family | Key features | Relevance to milk quality | Likely source |
|-------------------------|--|---|--|
| Thermotolerant bacteria | They can survive exposure to temperatures considerably above their maximal temperature for growth. In the dairy industry, the term is applied to those organisms which survive, but do not grow, at pasteurization temperature | They have an ability to create protective spores and these can then end up in finished products. Contamination of milk with thermotolerant bacteria can cause processing problems for the dairy industry through: reduced prices for products or unsuitability for processing such as for cheese or infant formula. | The sources of contamination are poorly cleaned equipment milk-stones (milk- residues) in rubber or pipes on farm and in processing plants or contaminated feed supplements such as silage. |
| Thermophilic bacteria | These are bacteria which grow in milk held at elevated temperatures (55 C or higher), including pasteurization, up to 72C. | When the milk is held at high temperatures for long periods, these bacteria rapidly increase in numbers and may cause flavours defects or problems with respect to bacteria standards. | The sources of contamination are poorly cleaned equipment milk-stones (milk- residues) in rubber or pipes on farm or from poorly cleaned equipment in the processing plant. |
| Psychrotrophic bacteria | Psychrotrophic is used to refer to the bacteria that are able to grow rapidly at 7 C and below. This group are generally non-pathogens | They can cause a variety of off-flavours, including fruity, stale, bitter, putrid and rancid flavours. The influence of psychrotrophic bacteria in the shelf life of pasteurized milk will depend mainly upon the number present after packaging, the rate of growth, the storage period, and the biochemical activity of the organisms | Psychrotrophic bacteria are rarely present in the udder. The numbers of bacteria depend upon sanitary conditions prevailing during production and upon time and temperature of milk storage before processing. |
| Coliform | They are universally present in large numbers in the faeces of warm-blooded animals, and therefore contamination occurs with lack of hygiene around faecal matter. These are used as an indicator for pathogenic bacteria that might also be present | While coliforms are themselves not normally causes of serious illness, they are easy to culture and their presence is used to indicate that other pathogenic organisms of faecal origin may be present. However, in many countries e-Coli can be a significant cause of clinical mastitis. | When this normally occurring, bacteria are allowed to spread unchecked because of dirty conditions in the milking shed. Also, occurring from not washing the teats well, not drying the udders and teats before milking, or not teat dipping before milking. |

Sources: Franks, 2012; Jamieson, 2012;



Lab, I. A. 2003: Retrieved from: <http://www.iandalab.com/bulletins/bulletin07.htm>.


A.5 Summary table of the history of mastitis control schemes in United Kingdom(UK) and Australia.

| <u>Name</u> | <u>Key Ideas and changes</u> |
|--|---|
| <p><u>U.K</u> DairyCo Mastitis Control Plan, (DMCP) 2008</p> | <p>This scheme was brought in to replace the 5-Point Plan initially devised in 1960s, which was considered to be the one of first nationally implemented mastitis control plans in the world. The 5-Point Plan was a breakthrough for the management s of both clinical and sub clinical mastitis which were a huge problem in the U.K. in the 1960s, (around 150 cases per 100 cows/yr.).</p> <p>As the majority of mastitis cases were from contagious pathogens, a quick and dramatic improvement were observed,(Neave, Dodd et al. 1966), however, it became apparent in the 1990s that the problem was reemerging.</p> <p>The new plan (DMCP), recognised the increasing complexity of mastitis management. Due in part to: increasing herd sizes, changing nature of pathogen responsible from contagious to environmental and the changes in public perceptions surrounding animal welfare, antibiotic use and known economic benefits for improvement.</p> |
| <p><u>Australia</u> Countdown 1998 CountdownMax 2008</p> | <h3 style="color: blue;">3-phases were evident in the development of Countdown</h3> <p>1999-2001 The development of "tech-notes", farm guidelines and course for farmers and advisors</p> <p>2001-2004 Updates of the tech-notes, provision of certification for performance testing of machines and building industry capacity to improve and control mastitis through cell-check programmes</p> <p>2005-2009 Introduction of mastitis risk management service called "Countdown MAX driven in part by research that indicated a need for further education and collaboration between stakeholders within the dairy industry, (Nettle, Hope et al. 2006, Penry 2011).</p> <p>Countdown MAX was a collaborative development between the project team and a working group of experienced practitioners to ensure the resulting service model was a good fit with the mode of operation of businesses: a necessary first step for it to be embraced by the private sector. This represented a major shift in the design approach for Countdown Downunder as it was the first time the project team had not guided associates along a planned route, the nature of the end product being totally unformed at the beginning of the working group discussions.</p> |

Adapted from: <http://www.mastitiscontrolplan.co.uk/history> and <http://www.dairyaustralia.com.au/Animal-management/Mastitis/Countdown-resources-and-tools-2.aspx>

A.6 A screen shot of SmartSamm information on the DairyNZ site:(Retrieved: June 8, 2013 from: <http://www.smartsamm.co.nz/>)

SmartSamm 
 Powered by DairyNZ 

Search 

Home Farmers Fix my Problem Tools Resources Training Advisors


Welcome to SmartSamm

SmartSamm helps dairy farmers, their farm team and advisors, to improve udder health and milk quality, resulting in:

- Time savings at milking
- Healthier cows and happier people
- More production and profit


SmartSamm's [Healthy Udder](#), [Gap Calculator](#) and [Guidelines](#) will help you achieve your goals for mastitis and milk somatic cell counts.

SmartSamm for Farmers




[Learn more](#) [Guidelines](#)

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Fix my Problem



Need help now?

- [High BMBCC](#)
- [Too Many Clinicals](#)
- [Finding Clinicals](#)
- [Test Spraying](#)
- [Test Damage](#)

Healthy Udder

Quick tips to:

- [prevent](#) mastitis
- [find](#) mastitis and
- [treat](#) mastitis.

[Learn more](#)

Mastitis Focus Report

Keep track of udder health in your herd and detect emerging problems.

- Download [Mastitis Focus Info sheets](#)

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Healthy udders produce quality milk.

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A.7 Copy of Letter sent to key informant interviewees

Information for interviewees of Robyn Cox

Postgraduate student - Lincoln University 2012.

Thesis for partial submission for M.Appl.Sci.

Somatic cells and bacteria in raw milk: why should we care, and how have they been managed? -The New Zealand perspective 1987-2012.

Significant parts of the research for this thesis will a synthesis of information provided by key informants.

- All face-face interviews will be transcribed and recorded using a voice recorder unless an interviewee specifically asks for the voice recorder not to be used, whereby all final transcribed notes will be taken from using written notes during the interview.
- Any written matter whereby an interviewee is quoted, or their opinion is inferred, will be provided for review by the interviewee prior to submission. Any material that the interviewee would like to be amended or removed will be done so if the interviewee asks for this; either verbally or in writing to Robyn Cox.

I would like to take this opportunity to thank you for your cooperation in attaining this information.

Kind regards,

Robyn Cox

Robyn.Cox@lincolnuni.ac.New Zealand

Thesis supervisor: keith.woodford@lincoln.ac.New Zealand

A.8 On Farm interview

Number of cows milked in total _____

Number of milking sheds _____

Number of staff involved in milking _____

What are the milk quality issues that you perceive to be most significant for the NZ Dairy Industry at present?

With regards to your own farm – what are the milk quality issues that are most significant to you?

Have you received any formal training in milk quality management? Yes / No

If so can you describe what you have done below

Year training occurred _____

Length of time training took _____

Provider of training _____

Qualifications that resulted from training _____

Are you planning any further training Yes / No / Undecided

Comments

Questions

If the rules suddenly changed for dairy trading where the acceptable limits for bacterial contamination need to be less than 10,000 cells/ml or SCC levels below 150,000 cells/ml how quickly do you think the New Zealand Dairy Industry could respond to this?

1. Why do you say this?
2. What are likely to be the greatest obstacles to overcome?
3. Are these the obstacles your farm would have to overcome, or is this a general belief about the industry?

DairyNZ set an aimed target of BTSCC to be less than 150,000 cells/ml in 1990.

4. What are your feelings about this target?

The NZ Dairy industry has had fluctuating results in their SCC levels over the past 25 years.

5. What would be the main factors that would be preventing the achievement of a continued lowering of the BTSCC levels in NZ?

6. What do you believe to be the key driving or success factors that would result in BTSCC improving?

| | No barrier | | | | | Significant |
|---|-------------------|---|---|---|---|--------------------|
| High On-farm-Debt | 0 | 1 | 2 | 3 | 4 | 5 |
| Time management | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff relationships | 0 | 1 | 2 | 3 | 4 | 5 |
| Family relationships | 0 | 1 | 2 | 3 | 4 | 5 |
| Weather | 0 | 1 | 2 | 3 | 4 | 5 |
| Yard design | 0 | 1 | 2 | 3 | 4 | 5 |
| Lack of leisure time | 0 | 1 | 2 | 3 | 4 | 5 |
| Milk pay-out fluctuations | 0 | 1 | 2 | 3 | 4 | 5 |
| The farm layout | 0 | 1 | 2 | 3 | 4 | 5 |
| Pressure from shareholders or employers | 0 | 1 | 2 | 3 | 4 | 5 |
| Housing | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff skill | 0 | 1 | 2 | 3 | 4 | 5 |
| Plant and Machinery | 0 | 1 | 2 | 3 | 4 | 5 |
| Yard design | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor genetics of herd | 0 | 1 | 2 | 3 | 4 | 5 |
| Building up the herd numbers | 0 | 1 | 2 | 3 | 4 | 5 |
| Quality of tracks, feed pads | 0 | 1 | 2 | 3 | 4 | 5 |
| Repetition of tasks | 0 | 1 | 2 | 3 | 4 | 5 |
| Meeting personal targets | 0 | 1 | 2 | 3 | 4 | 5 |
| Lack of good advice | 0 | 1 | 2 | 3 | 4 | 5 |

7. Rank each of the factors below in terms of **negative restraining** factors for reducing **SCC levels** in raw milk on New Zealand Farms?

| | <u>Not relevant</u> | | | <u>Most relevant</u> | | |
|---------------------------------------|---------------------|---|---|----------------------|---|---|
| Poor genetics | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor laneways | 0 | 1 | 2 | 3 | 4 | 5 |
| Old/worn teat liners | 0 | 1 | 2 | 3 | 4 | 5 |
| Incorrect Cup Pressure settings | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff skill | 0 | 1 | 2 | 3 | 4 | 5 |
| Plant and Machinery age | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor yard design | 0 | 1 | 2 | 3 | 4 | 5 |
| Calving | 0 | 1 | 2 | 3 | 4 | 5 |
| Trying to build up herd numbers | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor weather | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor staff training | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor staff attitudes and care | 0 | 1 | 2 | 3 | 4 | 5 |
| Can't afford to cull cows | 0 | 1 | 2 | 3 | 4 | 5 |
| Can't afford losses in production | 0 | 1 | 2 | 3 | 4 | 5 |
| It isn't the priority on farm | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor detection of mastitis cows | 0 | 1 | 2 | 3 | 4 | 5 |
| Not using dry-cow therapy effectively | 0 | 1 | 2 | 3 | 4 | 5 |
| Not using RMT paddles effectively | 0 | 1 | 2 | 3 | 4 | 5 |
| Not cleaning teats effectively | 0 | 1 | 2 | 3 | 4 | 5 |
| Time pressures | 0 | 1 | 2 | 3 | 4 | 5 |

8. Using the same ranking- Rank each of the factors below which do you think are the negative restraining factors for reducing Bacterial raw-milk contamination levels on New Zealand Farms?

| | <u>Not relevant</u> | | | | | <u>Most relevant</u> |
|-----------------------------------|---------------------|---|---|---|---|----------------------|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor genetics | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor laneways | 0 | 1 | 2 | 3 | 4 | 5 |
| Teat liners | 0 | 1 | 2 | 3 | 4 | 5 |
| Incorrect up Pressure settings | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff skill | 0 | 1 | 2 | 3 | 4 | 5 |
| Plant and Machinery age/condition | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor yard design | 0 | 1 | 2 | 3 | 4 | 5 |
| Trying to build up herd numbers | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor weather | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor staff training | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor staff attitudes and care | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor detection of problems | 0 | 1 | 2 | 3 | 4 | 5 |
| Cups falling/kicked off | 0 | 1 | 2 | 3 | 4 | 5 |
| Power cuts | 0 | 1 | 2 | 3 | 4 | 5 |
| Milk tanker arrives too early | 0 | 1 | 2 | 3 | 4 | 5 |
| Milk tanker arrives too late | 0 | 1 | 2 | 3 | 4 | 5 |
| Time pressure | 0 | 1 | 2 | 3 | 4 | 5 |
| Ineffective chemical usage | 0 | 1 | 2 | 3 | 4 | 5 |
| Poor routines in the shed | 0 | 1 | 2 | 3 | 4 | 5 |
| Unknown accidental causes | 0 | 1 | 2 | 3 | 4 | 5 |

9. Rank each of the factors below which do you think are the **positive driving factors** that would help reduce **SCC levels** in raw milk on New Zealand Farms

| | <u>Not relevant</u> | | | <u>Most relevant</u> | | |
|---|---------------------|---|---|----------------------|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| Good genetics | 0 | 1 | 2 | 3 | 4 | 5 |
| Good weather | 0 | 1 | 2 | 3 | 4 | 5 |
| Lower on-farm debt | 0 | 1 | 2 | 3 | 4 | 5 |
| Good organisational skills | 0 | 1 | 2 | 3 | 4 | 5 |
| Skilled workforce | 0 | 1 | 2 | 3 | 4 | 5 |
| Positive relationships with staff | 0 | 1 | 2 | 3 | 4 | 5 |
| Good relationship with vet | 0 | 1 | 2 | 3 | 4 | 5 |
| Opportunities to share info with other famers | 0 | 1 | 2 | 3 | 4 | 5 |
| Cheaper drugs for treatment | 0 | 1 | 2 | 3 | 4 | 5 |
| Access to on-line help services | 0 | 1 | 2 | 3 | 4 | 5 |
| Positive relationships at home | 0 | 1 | 2 | 3 | 4 | 5 |
| Culling infected animals | 0 | 1 | 2 | 3 | 4 | 5 |
| Good visual detection of animals | 0 | 1 | 2 | 3 | 4 | 5 |
| Education programmes in prevention | 0 | 1 | 2 | 3 | 4 | 5 |
| Fear of penalty from Milk Company | 0 | 1 | 2 | 3 | 4 | 5 |
| Desire to have healthy/happy cows | 0 | 1 | 2 | 3 | 4 | 5 |
| Pride in achieving targets | 0 | 1 | 2 | 3 | 4 | 5 |
| Financial Incentives to supply low SCC milk | 0 | 1 | 2 | 3 | 4 | 5 |
| Concern about export market access | 0 | 1 | 2 | 3 | 4 | 5 |
| _____? | 0 | 1 | 2 | 3 | 4 | 5 |

10. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement

| | <u>Strongly Disagree</u> | | | | | <u>Strongly Agree</u> |
|--|--------------------------|---|---|---|---|-----------------------|
| SCC levels are a serious problem for the NZ Dairy Industry | 0 | 1 | 2 | 3 | 4 | 5 |
| SCC levels are easily managed if the dairy staff are skilled and dedicated | 0 | 1 | 2 | 3 | 4 | 5 |
| SCCs are not as big a problem as people think as the NZ milk supplied is well below the international penalty limits | 0 | 1 | 2 | 3 | 4 | 5 |
| SCCs are a bigger problem than many people think, because not enough emphasis is given to the hidden costs | 0 | 1 | 2 | 3 | 4 | 5 |
| SCCs are just a seasonal problem that farmers accept and act on when appropriate | 0 | 1 | 2 | 3 | 4 | 5 |
| SCCs levels could harm our export markets in our future if we don't continuously improve the BTSCC levels in NZ | 0 | 1 | 2 | 3 | 4 | 5 |

Rank the following 6 statements (1-6)

Ranking choose between 1-6 (1 being most important)

The reasons a farmer should reduce SCCs are:

- The cow may be in pain
- It could affect production levels
- It is a big hassle to manage
- There is a risk of penalties
- Staff morale could get low
- It could damage our export markets

| |
|--------------------------|
| <input type="checkbox"/> |
| <input type="checkbox"/> |
| <input type="checkbox"/> |
| <input type="checkbox"/> |
| <input type="checkbox"/> |
| <input type="checkbox"/> |

11. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement

The best thing about low SCC levels:

Strongly Disagree

Strongly Agree

| | | | | | | |
|--|---|---|---|---|---|---|
| It feels good to have healthy cows | 0 | 1 | 2 | 3 | 4 | 5 |
| I can concentrate on increasing production | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff morale is higher | 0 | 1 | 2 | 3 | 4 | 5 |
| I will have more leisure time | 0 | 1 | 2 | 3 | 4 | 5 |
| I will save money on treatment | 0 | 1 | 2 | 3 | 4 | 5 |
| I will avoid penalty payments | 0 | 1 | 2 | 3 | 4 | 5 |
| I will be happier at home | 0 | 1 | 2 | 3 | 4 | 5 |

Rank the following 12 statements (1-12)

Ranking: choose 6 statements below and rank between 1-6 (1 being most important)

The best way to reduce SCCs:

- More severe penalties for breaches
- Give incentive payments for low levels
- Cheaper and effective antibiotics
- Subsidised consultancy services
- More staff education programmes
- Better research and genetics
- Regular communication with other farmers
- Use 'Dry- cow therapy'
- Use teat sealants between seasons
- Using ID tools such as RMT paddle
- More promotion of its importance to farmers
- Disinfect teats each milking

12. **Agree – Disagree** Beside each sentence write whether you agree/ disagree with the statement

Strongly Disagree _____ **Strongly Agree**

High Bacterial thoughts:

| | | | | | | |
|--|---|---|---|---|---|---|
| Bacterial problems are all about hygiene | 0 | 1 | 2 | 3 | 4 | 5 |
| Staff skill is the most important thing | 0 | 1 | 2 | 3 | 4 | 5 |
| Cups falling off/getting dirty is the key cause | 0 | 1 | 2 | 3 | 4 | 5 |
| Being rushed is the key cause | 0 | 1 | 2 | 3 | 4 | 5 |
| Lack of routine is the key cause | 0 | 1 | 2 | 3 | 4 | 5 |
| Penalty payments are the main incentive to keep them low | 0 | 1 | 2 | 3 | 4 | 5 |

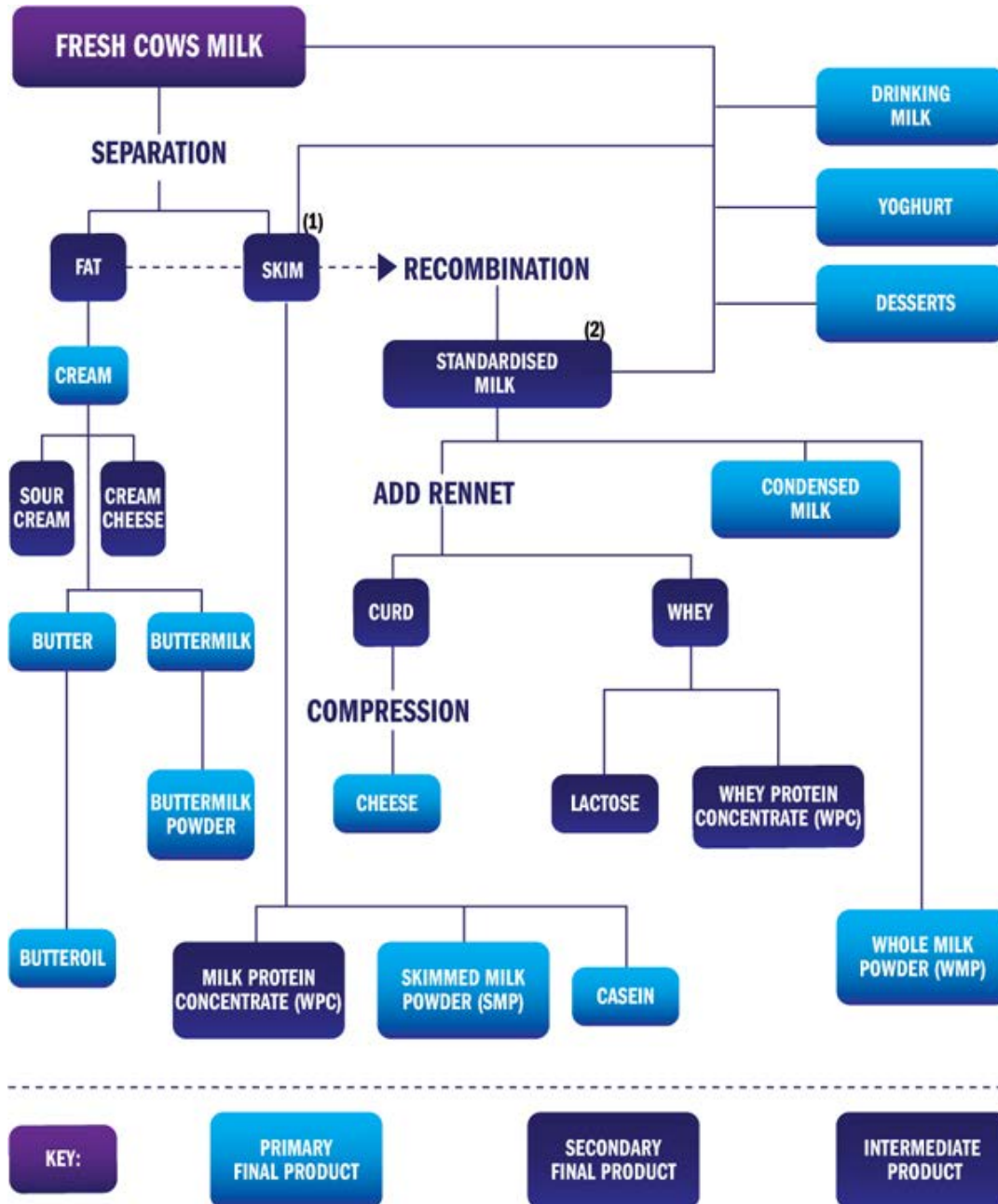
Rank the following 6 statements (1-10)

Ranking: choose 6 statements below and rank between 1-6 (1 being most important)

The best way to reduce should reduce bacteria:

- Decrease the allowable thresholds
- Give incentive payments for low levels
- Upgrade plant and machinery
- Subsidised consultancy services
- More staff education programmes
- Faster cooling in vat
- Reduce time pressures
- Clean races and yards
- Established routines
- Bigger penalty fines

A.9 Table summarising the conversion of milk, by a range of processes, into a variety of dairy products and food ingredients.



Source: (More, 2009)

A.10 Example of newspaper article depicting the reaction to antibiotics and dairying the United Kingdom (2012).

Yikes! MRSA Found in U.K. Milk: DNews Nugget

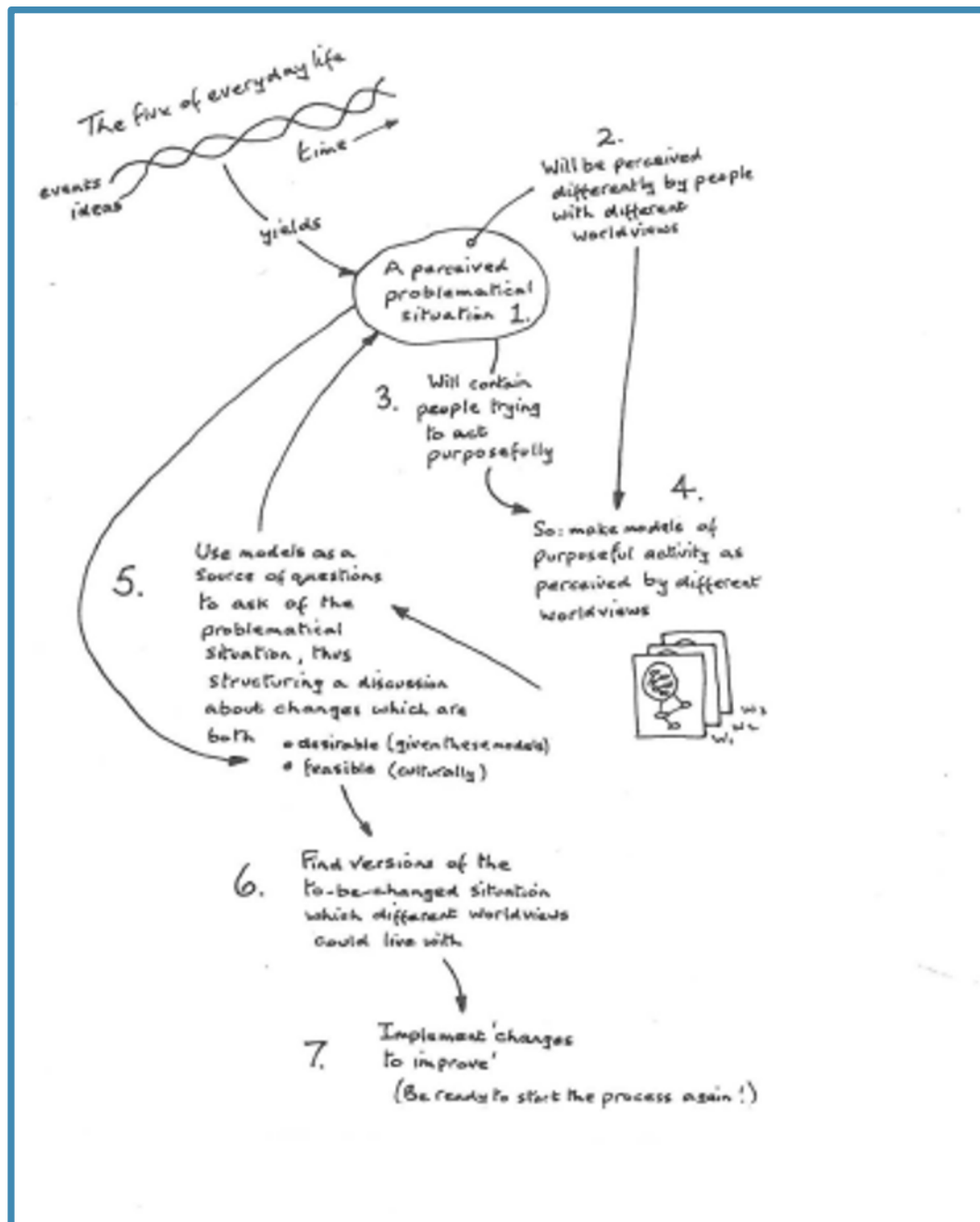
Dec 27, 2012 01:31 PM ET // by Lori Cuthbert

Yikes! MRSA Found in U.K.

“Milk: A new strain of dangerous antibiotic-resistant organism MRSA has been found in milk from five different farms in England, reports The Independent. Tests of 1,500 milk samples turned up seven that were tainted with the new MRSA, a so-called super bug that causes severe infections in humans. It's thought that the widespread use of antibiotics in dairy herds to prevent udder infections is behind the new MRSA strain, MRSA ST398, the paper says. U.K. farmers are pressured by supermarket chains to produce milk, resulting in overcrowded farms, where a sickness can sweep through an entire herd,” (Cuthbert 2012)

Retrieved July 12, 2013 from: www.seeker.com/yikes-mrsa-found-in-uk-milk-dnews-nugget-1766326559.html

A.11 Checkland's SSM's cycle of learning for action



From: SSM's cycle of learning for action: From Checkland, P. B., Poulter, J. (2006, pg. 14).

Learning for action: a short definitive account of soft systems methodology and its use for practitioner, teachers and students.

A.12 Personal Communication: Research Interview dates and locations summary.

Researchers and Consultants

Note: the researchers and consultants were interviewed together, as they had dual roles.

However, when asked what their key role was presently in the New Zealand dairy industry they chose to be identified as either researchers (R) or consultants (C)

1. Cameron, K. (2013). Professor of Soil Science, Head of Centre for Soil and Environmental Research R. Cox. Lincoln University.
2. Malcolm, D. (2012). Interview at DairyNZ, Ruakura. R. Cox. Personal communication, May 2,, 2012, Hamilton
3. Eden, M. (2012). Interview at DairyNZ, Ruakura. R. Cox. Personal communication, May 2, 2012, Hamilton
4. Lacy-Hulbert, J. (2012). Interview at DairyNZ, Ruakura. R. Cox. Hamilton Personal communication, May 2, 2012, Hamilton
5. Hillerton, J. E. (2012). Interview at DairyNZ, Ruakura. R. Cox. Personal communication, May 2, 2012, Hamilton.
6. R1 (2012). Interview at DairyNZ, Ruakura. R. Cox. Hamilton. Personal communication, May 2, 2012, Hamilton
7. R1 (2012). Second Interview at Dairy NZ Hamilton. Personal communication, November 27, 2012, Hamilton
8. R2 (2012). Interview at DairyNZ, Ruakura. R. Cox. Hamilton. Personal communication, May 2, 2012, Hamilton.
9. R3 (2012). Interview at DairyNZ, Ruakura. R. Cox. Hamilton. Personal communication, November 27, 2012, Hamilton.

Consultants

1. C1 (2012). Interview at DairyNZ, Ruakura. R. Cox. Personal communication, May 2, 2012, Hamilton.
2. C2 (2012). Interview at DairyNZ, Ruakura. R. Cox. Personal communication, May 2, 2012, Hamilton
3. C1 (2012). Second Interview at Dairy NZ, Ruakura. R. Cox. Personal communication, November 27, 2012, Hamilton
4. C2 (2012). Second Interview at Dairy NZ Ruakura. R. Cox. Personal communication, November 27, 2012, Hamilton
5. C3 Personal communication, June 7, 2012, Amuri
6. C4 Interview, R. Cox.. Personal communication, June 19, 2012, Hamilton
7. Franks, R. (2012). Interview at Milk Quality Conference. R. Cox. Hamilton. Personal communication, June 19, 2012, Hamilton

Farmers

1. F1 (2012). Farmer 1. R. Cox. Personal communication, May 15, 2012, Dunsandel.
2. F2 (2012). Farmer 2. R. Cox. Personal communication, May 15, 2012, Dunsandel
3. F3 (2012). Farmer 3. R. Cox. Personal communication, June 7, 2012, Amuri
4. F4 (2012). Farmer 4. R. Cox. Personal communication, June 7, 2012, Amuri
5. F5 (2012). Farmer 5. R. Cox. Personal communication, July 17, 2012, Southbridge
6. F6 (2012). Farmer 6. R. Cox. Personal communication, July 17, 2012, Darfield
7. F7 (2012). Farmer 7. R. Cox. Personal communication, July 24, 2012, Lincoln

Government Officials and Testing Agents

1. Jamieson, P. (2012). Senior technical Officer, MilkTestNZ. R. Cox. Hamilton Personal communication, May 3, 2012, Hamilton.
2. G1 (2012). First Interview at MilkTest NZ R. Cox. R. Cox. Hamilton Personal communication, May 3, 2012, Hamilton.

3. G1 (2012). Second Interview at MilkTest NZ R. Cox. Personal communication, November 28, 2012, Hamilton
4. Barnao, C. (2012). Re: Approach at Milk Quality Conference". R. Cox. Personal communication, June 19, 2012. . Hamilton
5. G2 (2012). Re: Interview: What events and ideas have influenced the perceptions surrounding emerging issues in milk quality for the New Zealand Dairy Industry? R. Cox. Personal communication, June 19, 2012. . Hamilton
6. G2 (2012). Interview at Milk Quality Conference. R. Cox. Hamilton, NZ. Personal communication, June 19, 2012, Hamilton

Milk Supply Managers

1. Williams, D. (2012). Supply Manager, Synlait Milk Ltd. R. Cox. Dunsandel. Williams, D. (2012). First Interview. R. Cox. Personal communication March 12, 2012. Canterbury, New Zealand
2. P1 (2012). Second Interview with Milk Quality officer. R. Cox. Personal communication, August 7, 2012. Canterbury, New Zealand
3. Williams, D. (2012). Second interview. R. Cox August 24, 2012. Canterbury, New Zealand
4. P2 (2012). Re: Approach at Milk Quality Conference. R. Cox. Personal communication, June 19, 2012. . Hamilton

A.13 Summary table of Questionnaire to draw conclusions for Lewin's force field models: Advisors.

| Views shared by advisors | Key barriers for NZ to effectively manage milk quality generally | Negative restraining forces for the reduction of bacteria | Negative restraining forces for the reduction of SCC | Positive driving forces for the reduction of SCC |
|--|---|---|--|--|
| Large factors | The human factor such as staff/ employee/family relationships Staff skill Building up herd numbers Lack of good advice | Staff skill levels and poor attitudes and care from staff Poor detection of problems Poor routine in the shed | Poor attitudes in staff Poor detection of mastitis on-farm such as not using tools such as RMT paddles effectively | Good organisation skills Relationships: both with vets, at home and between staff The opportunity to share best practice with others Skilled workforce- e.g. ability to detect mastitis Pride in reaching targets The fear of penalty from the milk company |
| Medium factors | Milk pay-out fluctuations The farm layout Quality of tracks, feed pads | Ineffective chemical usage Poor weather Condition of laneways | Build-up of herd numbers Poor staff training It isn't a priority on-farm Incorrect cup pressure systems | The desire to have happy healthy cows Financial incentives to lower SCC levels Providing good education programmes for milkers |
| Other interesting comments not necessarily shared by all advisors | Complacency due to repetition of tasks Note using DCT (dry cow therapy) effectively High on-farm debt in NZ | Time pressure Calving Poor weather Old worn teat liners | Cups falling off Accidental causes that are not identified Not changing teat liners Power cuts | Change of mind set Culling infected animals Concern about market access Lower on-farm debt Access to on-line help service |

A.14 Summary table of Questionnaire to draw conclusions for Lewin's force field models: Farmers

| Views shared by farmers | Key barriers for NZ to effectively manage milk quality generally | Negative restraining forces for the reduction of bacteria | Negative restraining forces for the reduction of SCC | Positive driving forces for the reduction of SCC |
|---|---|--|---|--|
| Large factors | Staff relationships Staff skill Building up herd numbers | Poor detection of problems Staff skill levels Plant machinery age and condition | It isn't a farm priority Staff skills Poor attitudes in staff Poor detection of mastitis Poor staff training Can't afford to cull cows | Positive relationships with staff Skilled workforce- e.g. ability to detect mastitis Good organisation skills The fear of penalty from the milk company Financial incentives to lower SCC levels Culling infected animals |
| Medium factors | Time management Weather Repetition of tasks Meeting personal targets Lack of leisure time | Poor attitudes from staff Poor routines in shed Poor weather Ineffective chemical usage Time pressures | Trying to build up herd numbers Incorrect cup pressure systems Time pressures Can't afford losses in production | Pride in reaching targets Providing good education programmes for milkers Good weather |
| Other comments not shared by all farmers | | | | The desire to have happy healthy cows Sharing information with others |

A.15 Comparison between advisors and farmers' drivers and restraints for OFMQ – part I

| Identification of factors | Views shared by advisors | Views shared by farmers | Views shared by advisors | Views shared by farmers |
|---|--|---|---|---|
| | <i>Key barriers for NZ to effectively manage milk quality generally</i> | <i>Key barriers for NZ to effectively manage milk quality generally</i> | <i>Negative restraining forces for the reduction of bacteria</i> | <i>Negative restraining forces for the reduction of bacteria</i> |
| Large factors | <p>The human factor such as staff/ vets/ employees/family relationships</p> <p>Staff skill</p> <p>Building up herd numbers</p> | <p>Staff relationships</p> <p>Staff skill</p> <p>Building up herd numbers</p> | <p>Staff skill levels</p> <p>Poor detection of problems</p> <p>Poor attitudes and care from staff</p> <p>Poor routine in the shed</p> | <p>Poor detection of problems</p> <p>Staff skill levels</p> <p>Plant machinery age and condition</p> |
| Medium factors | <p>Milk pay-out fluctuations</p> <p>The farm layout</p> <p>Quality of tracks, feed pads</p> | <p>Time management</p> <p>Weather</p> <p>Repetition of tasks</p> <p>Trying to meet personal targets</p> <p>Lack of leisure time</p> | <p>Poor weather creating poor condition of laneways</p> <p>Ineffective chemical usage</p> | <p>Poor weather</p> <p>Ineffective chemical usage</p> <p>Time pressures</p> <p>Poor attitudes from staff</p> <p>Poor routines in shed</p> |
| Other interesting comments not shared by all advisors or farmers | <p>Complacency due to repetition of tasks</p> <p>Not using DCT (dry cow therapy) effectively</p> | <p>Farmers considered that relationship with staff were the only significant relationship barriers and vets and family did not score highly as a barrier.</p> | <p>Cups falling off</p> <p>Accidental causes that are not identified</p> <p>Not changing teat liners</p> <p>Power cuts</p> | <p>The factors to the left were shared by around half the farmers to be of some importance</p> |

A.16 Comparison between advisors and farmers' drivers and restraints for OFMQ – part II

| | Views shared by advisors | Views shared by farmers | Views shared by advisors | Views shared by farmers |
|----------------------------------|---|--|---|--|
| Identification of factors | Negative restraining forces for the reduction of SCC | Negative restraining forces for the reduction of SCC | Positive driving forces for the reduction of SCC | Positive driving forces for the reduction of SCC |
| Large factors | <p>Poor attitudes in staff</p> <p>Poor detection of mastitis on-farm</p> <p>such as not using tools such as RMT paddles effectively</p> <p>High on-farm debt in NZ</p> <p>Lack of good advice</p> | <p>It isn't a farm priority</p> <p>Staff skills</p> <p>Poor attitudes in staff</p> <p>Poor detection of mastitis on-farm</p> <p>Poor staff training</p> <p>Can't afford to cull cows</p> | <p>Good organisation skills</p> <p>Relationships: both with vets, at home and between staff</p> <p>The opportunity to share best practice with other</p> <p>Skilled workforce- including the ability to accurately visually detect mastitis</p> <p>The fear of penalty from the milk company</p> <p>Pride in reaching targets</p> | <p>Positive relationships with staff</p> <p>Skilled workforce- including the ability to accurately visually detect mastitis</p> <p>Good organisation skills</p> <p>The fear of penalty from the milk company</p> <p>Financial incentives to lower SCC levels</p> <p>Culling infected animals</p> |

| | Views shared by advisors | Views shared by farmers | Views shared by advisors | Views shared by farmers |
|---|--|---|--|--|
| Medium factors | <p>Trying to build up herd numbers</p> <p>Incorrect cup pressure systems</p> <p>Poor staff training</p> <p>It isn't a priority on-farm</p> | <p>Trying to build up herd numbers</p> <p>Incorrect cup pressure systems</p> <p>Time pressures</p> <p>Can't afford losses in production</p> | <p>Providing good education programmes for milkers</p> <p>The desire to have happy healthy cows</p> <p>Financial incentives to lower SCC levels</p> | <p>Providing good education programmes for milkers</p> <p>Good weather</p> <p>Pride in reaching targets</p> |
| Other interesting comments not necessarily shared by all | <p>Time pressures</p> <p>Calving</p> <p>Poor weather</p> <p>Old worn teat liners</p> | <p>The lack of farm priority was the key factor for farmers.</p> <p>Interestingly "access to advice" did not score highly by farmers and was considered adequate already, and lower on the radar than advisors may realise</p> <p>Staff training a large factor for farmers</p> | <p>Change of mind set</p> <p>Culling infected animals only agreed by some advisors</p> <p>Concern about market access</p> <p>Lower on-farm debt</p> <p>Access to on-line help service</p> <p>Debt did not score as such- but possibly a factor considered when "personal targets" was chosen</p> | <p>The desire to have happy healthy cows</p> <p>Culling a very high factor for most farmers</p> <p>Both scored lower with farmers than advisors</p> <p>On-line help did not feature neither did debt</p> |

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