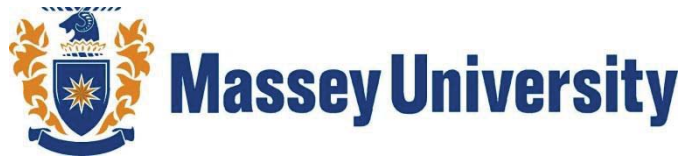


Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**Agricultural software – A case study of feed and animal
information systems in the New Zealand dairy industry**

**A thesis presented in partial fulfilment of the requirements of a
Masters of AgriCommerce
at Massey University, Palmerston North, New Zealand**



Palmerston North, New Zealand

Hamish Hammond

2017

Abstract

Every farmer utilises agricultural software, either directly or indirectly, as part of feed and animal information systems (IS) used for decision making and compliance on New Zealand (NZ) dairy farms. With continued development and availability of advanced information and communication technologies (ICT), more farmers are using software in their IS. This study investigates: how NZ dairy farmers use agricultural software in their feed and animal IS; the software attributes that influence the use and impact of these software; and, the drivers and inhibitors of software use and impact. A case study research approach was used to investigate these questions. Evidence was collected using semi-structured interviews with six NZ dairy farmers with farms of different scale and ownership structure, and with five commercial agricultural software providers. Results show that feed and animal IS are particularly useful for farmer decision making and compliance at the operational and tactical management levels, but also produce data and information critical for strategic management. The number of software products used and the degree of data and information collation in animal IS compared to feed IS are considerably different. Animal IS were streamlined, with data and information collected and collated together in a limited number of software with only one or two 'focal' software as the centrepiece of the IS. In contrast, feed IS were less streamlined, with data and information flowing into a number of different software. Six important software attributes that influence use and impact of software were identified by farmers and providers, with 'simplicity' and, 'integration with software and hardware', the most highly recognised attributes. The delivery of software with these attributes was achieved by providers in a number of instances, however, other software failed to fully meet farmer needs. Organisational and people drivers/inhibitors had a greater effect on software use and impact than technological drivers/inhibitors indicating that these IS dimensions should be the focus of future improvements.

TITLE: *Agricultural software – A case study of feed and animal information systems in the New Zealand dairy industry*

DEGREE: *Masters of AgriCommerce*

NAME: *Hamish Hammond*

YEAR: *2017*

KEYWORDS: *Farm management, information systems, dairy farming, decision making, compliance, information and communication technology, agricultural software*

Acknowledgements

Sincere thanks and my gratitude must go out to the interviewees representing the six farms and five software providers who participated in this study. Without their contribution this thesis would not exist, so thank you for your time and willingness to answer all of my questions.

To my supervisors, Nicola Shadbolt, Liz Dooley and Callum Eastwood, thank you for your guidance and time. You challenge my thinking in different ways and in doing so I have grown as a student, researcher and person.

Financial assistance was gratefully received by the Centre of Excellence in Farm Business Management (AgriOne) and, LIC and the Aspin family. Thank you for the assistance, without it I would not have been able to complete this study.

Thank you to my Massey friends. This was a great year for the 'Fortress of Knowledge' (the postgraduate office). Shaf, Win and I completed our Masters, and, Ling, Rithy and Betty were all working hard toward completing their studies. The comradery experienced in the Fortress was immeasurably beneficial to all of our work. Other friends at Massey: DJ, Javier, Felipe, Federico, Eva, Joe, Sam, Will, Emma and Matt, thank you for your friendship.

Lastly, to my family and Rachel, your unrelenting support and encouragement make the challenges of postgraduate studies bearable. I hope that I can apply what I have learnt to the 'real-world', and I look forward to starting a new chapter with you at the farm.

Table of Contents

Abstract.....	i
Acknowledgements.....	ii
Table of Contents.....	iii
Table of Figures.....	vi
Table of Tables	viii
List of Abbreviations	ix
Key definitions	ix
Chapter 1 Introduction	1
1.1 Context.....	1
1.2 Problem Statement.....	5
1.3 Research Questions	5
1.4 Research Objectives.....	5
1.5 Thesis Outline.....	6
Chapter 2 Literature review.....	7
2.1 Introduction	7
2.1.1 Farm management and decision making.....	7
2.1.2 Areas of management.....	9
2.2 Information systems introduction	18
2.3 Information systems in agriculture.....	26
2.4 On-farm use of information and communication technology in information systems	33
2.5 Gauging the impact of ICT on agricultural information systems.....	55
2.6 Summary of literature.....	62
Chapter 3 Method.....	63
3.1 Introduction	63
3.2 Selection of research strategy	63
3.3 Case selection	67
3.4 Participants	68

3.5 Data collection	70
3.6 Data analysis	72
3.7 Ethical considerations	73
3.8 Summary	74
Chapter 4 Results	75
4.1 Introduction	75
4.2 Description of the farmers.....	75
4.3 Case 1 and Case 2 Feed and animal information systems.....	79
4.4 Software attributes that influence the use and impact of feed and/or animal management software - farmers.....	86
4.5 Desirable improvements categorised by attribute.....	91
4.6 Drivers and inhibitors of software use and impact - farmers.....	94
4.7 The impact of feed and animal software - farmers	100
4.8 Software provider interviewees	103
4.9 Case 1 Feed management.....	104
4.10 Case 2 Animal management	105
4.11 Software attributes that influence the use and impact of feed and/or animal management software - software providers.....	107
4.12 Drivers and inhibitors of software use and impact – software providers.....	118
4.13 The impact of feed and animal software - software providers	126
Chapter 5 Discussion.....	129
5.1 Introduction	129
5.2 Feed and animal information systems in brief	129
5.3 The primary impact of software	130
5.4 Major software attributes that influence use and impact of feed and/or animal management software.....	132
5.5 Drivers and inhibitors of software use and impact	144

Chapter 6 Conclusion	151
6.1 Introduction	151
6.2 Major conclusions	151
6.3 Implications of the research	153
6.4 Specific recommendations.....	153
6.5 Assessment of the method	155
6.6 Further research	156
7.0 References	157
8.0 Appendices.....	164
Appendix 1.0: Method supporting documentation (pre-selection checklist, guiding questions and definition), participation form and consent sheet.....	164
Appendix 2.0: Farmer feed and animal software use and impact overview.....	181
Appendix 3.0: Diagrams of feed information systems according to farmers.....	189
Appendix 4.0: Diagrams of animal information systems according to farmers	201

Table of Figures

Figure 1 The distinction between the levels of farm management.	10
Figure 2 The strategic management process.....	11
Figure 3 Types of strategy.....	12
Figure 4 Tactical planning process.....	13
Figure 5 Fields of management	15
Figure 6 Farm management cube	16
Figure 7 The tactical management process	17
Figure 8 Knowledge-creation process and areas of learning.	21
Figure 9 Functions of an information system	22
Figure 10 Dimensions and relationship within a modern information system.....	24
Figure 11 Concept of management information systems	27
Figure 12 Example MIS, showing the activities and data/information flows.....	29
Figure 13 Example representation of the annual grazing management cycle, with seasonal phases, critical success factors and, tools and information used identified.	31
Figure 14 Potential attributes and features of grazing decision support systems for dairy farmers.....	32
Figure 15 Internal (a) and external (b) processes for planning and decision making. OR = Organisational research, DSS = decision support system/s.....	44
Figure 16 Factors motivating future users of grazing decision-support systems.....	54
Figure 17 Framework to compare sustainability tools.	56
Figure 18 Computerised system adoption model	58
Figure 19 Degree of influence of users versus Level of Impact.....	60
Figure 20 Research strategy versus research characteristics	65
Figure 21 Five phases of analysis and their interactions	72
Figure 22 Feed information system – Feed allocation sub-system.	82
Figure 23 Animal information system - Breeding sub-system.....	85
Figure 24 Schematic overview of how and where animal management software operates in the NZ dairy industry.	106
Figure 25 Software attributes that influence use and impact of animal and/or feed management software.....	132

Figure 26 The drivers and inhibitors of software use and impact as identified by farmers and software providers, categorised by the dimensions of information systems144

Table of Tables

Table 1 List of the main attributes that influence agricultural software use – Users’ perspective.....	46
Table 2 List of the main attributes that influence agricultural software provision - Providers perspective.....	47
Table 3 Drivers and inhibitors of ICT use for agriculture.....	50
Table 4 Fundamental difference between quantitative and qualitative research.....	63
Table 5 Farmer interviewee overview.....	75
Table 6 Farmer software use.....	77
Table 7 Software use (and options) in the feed allocation sub-system.....	80
Table 8 Software use (and options) in the breeding, culling, drying off and animal movement sub-system.....	84
Table 9 Attributes of software and software provision that influence the use and impact of software – farmers.....	86
Table 10 Drivers and inhibitors of software use and impact – farmers.....	94
Table 11 Software Providers.....	103
Table 12 Attributes of software and software provision that influence the use and impact of software – software providers.....	107
Table 13 Summary of Provider's cloud and smartphone app features.....	110
Table 14 Integration of software by Software Providers.....	114
Table 15 Summary of Software Provider support and training.....	115
Table 16 Summary of software provider feedback and development functions.....	116
Table 17 Drivers and inhibitors of software use and impact – software providers.....	118
Table 18, Farm 1 software use, impact and cost.....	182
Table 19, Farm 2 software use, impact and cost.....	183
Table 20, Farm 3 software use, impact and cost.....	184
Table 21, Farm 4 Software use, impact and cost.....	185
Table 22, Farm 5 software use, impact and cost.....	186
Table 23, Farm 6 software use, impact and cost.....	187

List of Abbreviations

Abbreviation	Meaning
DSS	Decision-support systems
ERP	Enterprise resource planning
GIS	Geographical information systems
ICT	Information and communication technologies
IoT	Internet of Things
IS	Information systems
MIS	Management information systems
MS	Milksolids
NAIT	National Animal Identification and Tracing
NZ	New Zealand
PA	Precision agriculture
SME	Small to medium sized enterprises

Key definitions

Information systems - A system that uses formal and informal components (and procedures) to provide farm management at all levels, in all functions, with appropriate information, based on data from both internal (inside the farm) and external (outside the farm) sources. IS enable timely and effective decision making for planning, implementing and controlling the farming activities.

Agricultural software (also called 'software') - Computer or smartphone based programs, or applications, that are used for the management of agricultural business. It includes both computer-based software packages and smartphone applications as core components of individual solutions, and will consider other ICT (precision agriculture and ICT infrastructure) as part of a farmer's information systems.