Factors Affecting Canterbury, New Zealand Farmers' Adoption and Use of Computerised Information Systems

Jorge Alvarez and Peter Nuthall

Research Report 06/2001
July 2001

Farm and Horticultural Management Group
Lincoln University

ISSN 1174-8796

Farm and Horticultural Management Group

The Farm and Horticultural Management Group comprises staff of the Applied Management and Computing Division at Lincoln University whose research and teaching interests are in applied and theoretical management and systems analysis in primary production.

The group teaches subjects leading to agricultural/horticultural commerce and science degrees, though the courses offered also contribute to other degrees.

The group is strongly involved in postgraduate teaching leading to honours, masters and PhD degrees. Research interests are in systems modelling, analysis and simulation, decision theory, agribusiness and industry analysis, business strategies, employment relations and labour management, financial management, information and decision systems, rural development and also risk perceptions and management.

Research Reports

Every paper appearing in this series has undergone editorial review within the group. The editorial panel is selected by an editor who is appointed by the Chair of the Applied Management and Computing Division Research Committee.

The views expressed in this paper are not necessarily the same as those held by members of the editorial panel, nor of the Group, Division or University. The accuracy of the information presented in this paper is the sole responsibility of the authors.

Copyright

Correspondence

This paper represents work to date and may not necessarily form the basis for the authors' final conclusions relating to this topic. It is likely, however, that the paper will appear in some form in a journal or in conference proceedings in the future. The authors would be pleased to receive correspondence in connection with any of the issues raised in this paper. Please contact the authors either by email or by writing to the address below.

Any correspondence concerning the series should be sent to:

The Editor
Farm and Horticultural Management Group
Applied Management and Computing Division
PO Box 84
Lincoln University
Canterbury
NEW ZEALAND

Email: postgrad@lincoln.ac.nz

Abstract

Between July and August of 2000, 39 Canterbury dairy farmers were interviewed to identify which factors operated as adoption barriers to information innovations (computerised systems) in Canterbury (New Zealand) dairy farming. Interview results provide strong evidence to support the set of important factors hypothesised. These factors are the farmer's computer technology alienation feelings ("knowledge gap"), information management skills, and the economic benefit perception of software use. Also related are farmer characteristics such as education, age, personality, farming (sub)culture, advisory and farm circumstances. It was also found that fifty percent of the perceived benefit derived from software use was explained by user perceptions of the software work environment, its user-friendliness, and whether the software matched the farmer's decision framework.

Content

Tables

Figures

1 Introduction

The aim of this study is to identify which factors have operated as adoption barriers to information innovations (computerised systems) in Canterbury (New Zealand) dairy farming. This study is an attempt to link the farm management information system development process with the characteristics that may affect farmer information innovation adoption, and their successful use. Firstly, the research problem is briefly presented, then, two sets of hypotheses are stated, and the research method is described. Secondly, the results are presented and discussed, and finally some conclusions are presented.

2 The research problem

Each farm team has their own information system which supports the different aspects of the management process. The system has usually developed in an unplanned manner, reflecting local information resources and the personal characteristics of the management team. In improving the system farmers have shown a slow rate of information innovation adoption. This situation contrasts with farmer innovative behaviour related to other technological areas. However, many Canterbury dairy farmers have adopted information innovations in the form of computer systems. This research will focus on these adoption processes.

3 The research hypotheses

Given that information innovation adoption is not due to either government or similar edict (e.g. from a bank lender), nor due to technological necessity, the research hypothesis is that information innovation adoption depends on the concurrent presence of three factors. These are listed below and diagrammatically demonstrated in figure 3.1.

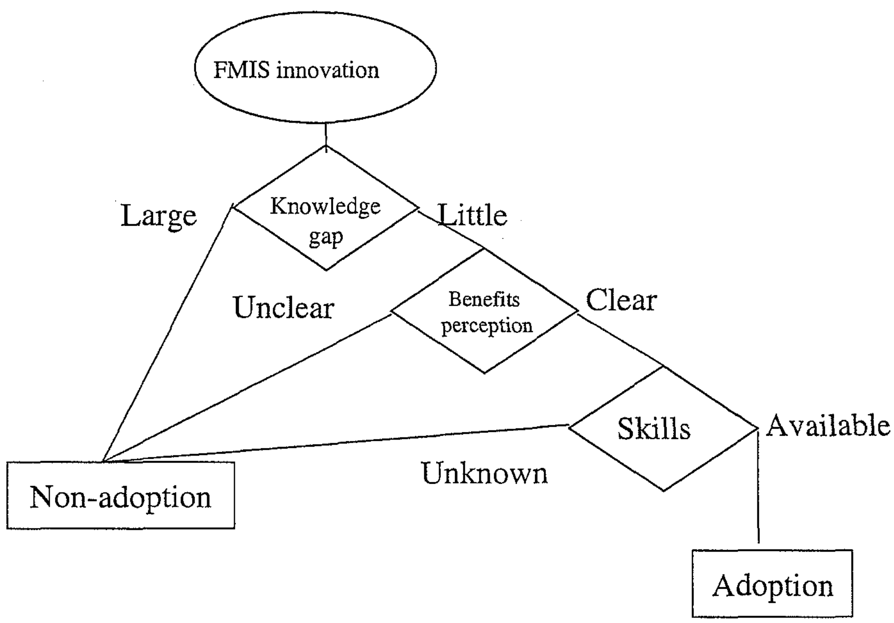
- The first is the knowledge gap between the software developer and user. This gap involves the knowledge and information that each farmer possesses and uses for operating and managing her/his dairy farm relative to the software developers' concepts. A large gap may result in different viewpoints of the decision problem and its solution. If this knowledge gap is small, adoption will be facilitated, otherwise adoption will not occur. Often the developers' knowledge relies on scientific, economic and management research in contrast to practical considerations. Higher levels of acceptance may exist for applications developed by analysts who also have a farming background.
- The second factor is the extent of a farmer's perception of the economic benefits and ease of management derived from the adoption of an information innovation. A clearly perceived benefit will reinforce adoption behaviour, otherwise adoption will not occur. The first and second factors are related.

- The third factor concerns the skills needed to manage the information innovation. Adoption will be accelerated if farmers have the skills, otherwise adoption will be slowed down.

Adoption is not sufficient to guarantee the successful use by farmers (See Figure 3.2). The second general hypothesis is that successful use depends on the following three factors:

- The extent to which the information innovation operation fits with the farmer's existing work environment. The better this fit (i.e. no unusual system requirements such as data inputs or time), the greater the use. This "fit" might well depend on the extent of farmer involvement in system development.

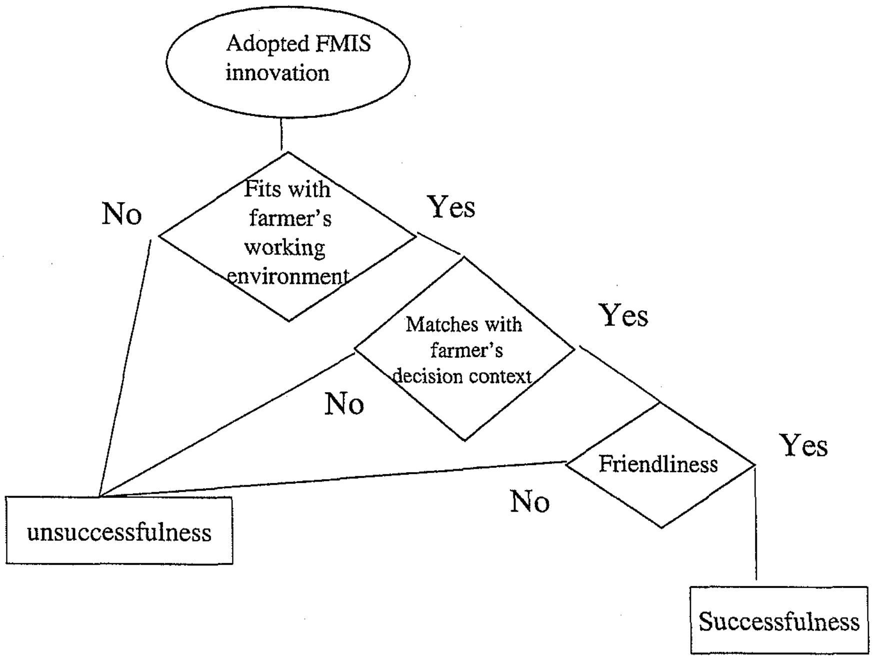
Figure 3.1: Information innovation adoption framework



Note: FMIS means "farm management information system".

- The matching of the information innovation capability with the farmer's decision context. The more flexible the system to accommodate the farmer's requirements, the more successful the system will be.
- Suitable system facilities such as the introduction of inputs, interface design, output type and design, and integration with other applications. These aspects define the level of application friendliness. The greater the friendliness, the more likely will the application be successful.

Figure 3.2: A framework for the successfulness of an innovation



4 The research method

Since the focus of this research is on the information innovation adoption process, the farmers are grouped into two main categories according to whether they use on-farm applications: users and non-users of computerised information systems. "Users" are farmers who have adopted one or more information innovations as part of their existing FMIS. These systems may be bought, co-developed or self-developed. The second group represents farmers who have never adopted information innovations, or have discontinued their use, either because they still use traditional information procedures (i.e. manual), or because they use off-farm information services.

Between July and August of 2000, 39 Canterbury dairy farmers were interviewed to collect the data required to asses the research hypotheses. These interviewed farmers were selected randomly from a group of 191 farmers who agreed to be interviewed from a total of 290 farmers whose data was previously gathered through a mail questionnaire sent to all Canterbury dairy farmers.

5 Results

5.1 Introduction

Of the 39 farmers interviewed, 19 had been using computerised systems for one or more years, 6 started in 2000, and 14 were not users when the interviews took place. Within this last group, one farmer was using a consulting service that included information management. Although the farmer was not using a computer by himself, his information management was very similar to those using computerised systems. The 13 remaining farmers were split into two categories -those who were thinking of using computerised systems, and those who were not. The groups had 7 and 6 farmers respectively.

Relative to the farmers not interviewed, the interviewees had, on average, smaller farms and herds, they involved accountants more in their decision making and a larger percentage of them owned computers. A larger percentage were also using computerised systems to manage livestock information (Alvarez and Nuthall, 2001c).

5.2 Adoption of computerised systems

Of the interviewed sample, 15.4% were new users and 35.9% non-users. These two groups provide data to directly access the first set of three hypotheses related to computerised systems adoption.

5.2.1 The knowledge gap

The farmer's "knowledge gap" was measured using two approaches. The first refers to the level of formal education received by the farmer as formal education is one of the main developers of knowledge, and effectively reduces people's relative "knowledge gap". However, computer information technology only started to become a common part of school environments by the nineties, whereas in universities this was in the second half of the eighties. It is possible to have a well educated farmer who finished her/his formal education at the beginning of the eighties without having any exposure to computer technology. However, due to the small number of records (Alvarez and Nuthall, 2001c), the data on formal education levels did not provide a statistically significant difference.

The second approach uses farmer opinions about considering the use of computers and software as an information management tool. Farmers thinking of using a computer certainly reflect a positive attitude to this technology as an alternative to improve their information systems. Thus, the "knowledge gap" may not be the cause of non-use. On the other hand, some of the farmers who are not considering this possibility may think their information management does not need the use of computer technology, while others may have other reasons that explain their refusal to use computerised systems.

Non-users were split in two subgroups according to their willingness to use software in the future. Five cases of the six of farmers who were not considering software utilisation can be placed into the group of people who think information management can not be helped with computer technology (a large "knowledge gap" relative to software developers who clearly believe a computer system will be useful). These farmers think that computer technology will not solve their farm management problems.

The following quotes illustrate these cases. One farmer said "*my strength is not in computers so I'd rather use somebody else who is good at computers rather than me spending a couple of hours a night bashing away at the keyboard and not achieving a helluva lot. I feel my strength is more on the farm looking after the stock and the grass, that sort of thing*". Another farmer stated "*we've got a computer and my wife and children use it. When they have used it I've seen so many problems and so much frustration... I have seen just so much time lost trying to work out how it all works and then the frustration it causes when it doesn't work or works wrongly. I guess that's probably what puts me off*". The same farmer added "*it's not going to change a lot of things. It's not going to make today warmer and make the grass grow faster and a lot of those things. Or make it rain a bit more in the summer when we need it. There's a lot of those things that no amount of technology can actually change*". A third farmer noted that he decided not to use a computer as "*probably because I haven't been brought up with computers. I know that's not a very good excuse. I prefer to be out on the farm working. That's the thing that I enjoy. I like doing the practical stuff and there are some things I'm sure you can gain out of it but I don't think it would make me any happier. That's probably the main reason – I'm happier out on the farm than at the computer*".

The remaining farmer of this subgroup justified his unwillingness to use computerised systems due to his age. He considered himself too old to learn the required skills. He had tried twice unsuccessfully.

In the other subgroup, eight farmers who were considering using a computer, only one is not viewing computer technology as a way to improve the farm information system. In this case the farmer is delegating to his spouse everything that could be related to on-farm computer use.

5.2.2 Perception of economic benefits

Farmers' perception of the economic benefits of using computerised systems was discussed at the interviews. Both groups of farmers, users and non-users, were asked to explain the reasons behind their decisions. Users were asked to describe what were the advantages and disadvantages of a specific piece of software which had been previously identified. Non-users, after asking them if they had information about farm computerised systems, were asked to explain why they were not using the technology. After the respondents had given two or three arguments, if the economic issue had not been mentioned, directly or indirectly, an explicit question addressing this matter was brought up. The respondent was invited to make a hypothetical comparison between the costs (computer and software purchasing, training and time cost) and the benefits (whatever the farmer considered might be possible) of using the computer technology.

All non-users who were not considering the possibility of using a computer expressed their uncertainty about the economic rewards from the use of software. One of these farmers said "*I'm a wee bit dubious about it* (using computerised systems) *being more profitable – maybe*". Another farmer stated "*I don't see that it will* (pay) *because a lot of it has to be written down manually first. You have to take a note of a lot of things first. So you have that anyway, and then it's not going to change a lot of things*". A third farmer said (in answering whether there were positive benefits) "*that could very well be true. I don't doubt that, it's just a matter of going and doing a course and learning how to use it. The trouble with computers, I think, is that they seem to be obsolete so quickly. I'm nearly 58, I wasn't brought up with them like children these days. They're just not my thing, I'm not all that interested in them. But I don't doubt they can be good. As far as the LIC* (Livestock Improvement Corporation) *and the information there and the accountant, they can probably do it in half the time it would take me to do it and at less cost*". A fourth farmer stated (answering whether there were net benefits) "*long-term, yes. Immediate, possibly. Definitely long term because everything is going that way... But in the short term it would take me longer to figure the computer out than the way I'm doing it at the moment*".

The perceptions of non-users who were currently considering the use of a computer were less uncertain and more positive. Only one in eight farmers was doubtful. This farmer stated (in answering whether he thought he would recover the money for buying a computer and the software, and using it on the farm) "*I'm not sure, I suppose you would in the end*"; (do you have a concrete idea?) "*No, not really*". The remaining farmers gave positive and clear answers on this issue. One farmer said "*I think* (I would get a net benefit), *no I'm sure you would. If things are more at your control, at your fingertips, and you have more information available it seems to me you'd be able to make better decisions".* Another farmer stated" *I don't' know whether it should repay itself. It should be seen as a* *management tool, the same way as I have to go out and buy a cash book every so often to enter information. So the computer is an extra expensive cash book - it's a tool. By using it, it should repay itself, but in the meantime it has information stored in there that come the time I need to go back and get that information, rather than go back through my filing cabinet or paper references, I can access the information more quickly with a computer. I can see that it would repay itself, but I wouldn't go back and spend x amount of dollars just for the sake of recouping the investment. It would be strictly bought as a management tool*'.

All new and experienced users have a positive perception of the economic benefits. Some perceptions were extremely concrete, others were more vague, usually associated with the possibility of saving working time. The next two farmer's quotes illustrate this variety. One farmer said "*I'm perhaps spending more time on it (using the software) now. But my accountant had slightly more control over it before so I feel I'm more on top of our financial situation when I'm doing it on the financial software myself. I understand it better and I'm saving a little bit of money as well because I'm not paying the accountant to do it (GST return)…I probably would have recovered my expenses (software cost) within eight months by doing it myself so that's not too bad*'. Another farmer stated " *the financial software in itself does not improve the profit - by going to discussion groups, advisory and information* (people*) give you the best practise; they tell you how to improve the profit. The financial software allows you* ***to measure the profit****. So, what I am saying is the ideas and the tools do not come from the financial software – the software is only a management tool, the ideas to make the profit have to come from somewhere else. By using advisory, written articles, discussion groups - they give you ideas, you bring the figures home, introduce them to your farm, and the software basically is just the means to measure that profit. In itself it does not make the profit."* A third farmer said "*the benefits we gain from it (software and computer use) are quite phenomenal. Not just for the farm, but I've always had thoughts about what may be outside the farm. Everything I have is in the farm, and maybe we should just take something outside the farm. We could find out what that would entail but I've no doubts that it's going to be far, far more important as time goes on. There's new information coming through all the time and we have to keep moving forward, but bearing in mind - this is the one thing that concerns me is the time spent on there - you still have to spend quality time on the farm making decisions. I know that if I'm in here and not out there keeping an eye on things we will drop a bit of production, not a lot, but that's something that I've got to bear in the back of my mind. If I'm in here too much someone still has to do the donkey work, the hard work, out on the farm. We haven't done away with someone to milk the cows, look at the pasture, feed the supplement, all those things. Work still needs doing out on the farm. We don't want to get too carried away with the computing side".*

5.2.3 Skill levels

The computer skill hypothesis can be split in two parts. Firstly, utilising those skills required to operate a computer, such as keyboard skill, some operational system factors (use of windows, mouse, and file management), and the skills of fundamental software application. These types of skills will be called "operational skills". Secondly, those skills related to information management, such as problem recognition abilities, problem definition strengths and data management capacities. These types of skills will be called "information management skills". Each class of information skill is analysed separately.

Only two of the fourteen farmers who were non-users of computerised systems stated that they had computer operational skills. One of them used a computer in an off-farm business, the other was the farmer who had contracted an advisory service to manage his whole farm information. The remaining non-user farmers stated that they had no operational skills. Taking into account that 75% of these farmers owned farm computers, this lack of operational skills may be considered one of the main barriers preventing these farmers using computerised information systems.

Farmer information management skills were evaluated through a specific question. Before the interviewees were asked about software advantages or disadvantages, or reasons for not using software to manage their farm information, everyone was asked to identify five main areas that they controlled very closely as they believed these were essential for the success of the whole operation.

The farmers were asked to state how frequently they updated information, how they processed the information, how they usually recognised a problem in this area, and how they dealt with such a problem. The form used to record the answers is given below.

The 3-5 things (or issues) that you keep track of continuously	Updating frequency	Qualitative or quantitative	Any processing activity?	How you recognise that a "problem" is arriving?	How you deal with that "problem"?
Issue 1					
Issue 2					
Issue 3					
Issue 4					
Issue 5					

The answers were analysed using three aspects: how a problem is defined and a solution isolated within the context of a particular control area, how data is collected and processed, and how a problem situation is recognised.

Table 5.1 Farmer's information management skill scale

Problem definition and solution search		Data collection/processing		Problem recognition-control system	
Intuition. Mental model (automatism). "Gut feelings".	**1**	Relevant data is collected and processed following a non-formalised (mind) model. "In my mind".	**1**	Based on human senses and mental standards ("something wrong is happening").	**1**
Rules of thumb or well established routines (experience).	**2**	Data is recorded and processed informally, such as notes in loose papers, or calendars.	**2**	Based on industry standards	**2**
		Data is recorded and processed formally. A manual or electronic system may be used.	**3**	Based on advisory recommendations	**3**
				Based on planned goals	**4**
Expert advise	**3**				
Analytical approach (partial and total budgeting, "what if" analysis, optimisation)	**4**				

Farmers may use different approaches to find usable solutions. For each farmer the most effective approach is one that produced a feasible solution, given farmer capabilities and farm circumstances. There is not a standard best approach. However, some approaches could be more compatible with computerised system use than others. Table 5.1 presents a farmer's information management skill scale.

Farmers who usually rely on their "gut feelings" (intuition) to define problems and search solutions, who mainly use their mind to collect data and process information, and who generally recognise problems based on their human senses and mental standards, are unlikely to see computerised information systems as an useful and valuable tool for managing farm information. They have their "own computers", inside their minds, which does not need additional software to perform information management tasks. On the other hand, farmers who usually use an analytical approach in dealing with problems, who generally have their "own computers", inside their minds, which does not need additional software to perform information management tasks. On the other hand, farmers who usually use an analytical approach in dealing with problems, who generally use formalised procedures to record and process data, and who mainly rely on "off-mind" control systems based on industry standards, advisory recommendations, and/or planned goals are more likely to see software and information technology as a useful and valuable alternative for managing information.

Using the above farmer's information management skill scale each control area answer was processed and each interviewed farmer given an information management skill score for problem definition and solution search, data collection and processing, and problem recognition.

Table 5.2 Group average values for information management skills

	Problem definition and solution search	Data collection and processing	Problem recognition-control system
Non users (not thinking of using)	2.29	1.78	1.56
Non users (thinking of using)	2.56	2.25	1.77
New users	2.63	2.28a	2.14a
Experienced users	2.84a	2.54b	2.67bc

Notes: Problem definition and solution search: a) statistically significant difference between non-users (not thinking of using) and experienced users, t-test= -2.281, p=3.2%; Data collection and processing: a) statistically significant difference between non-users (not thinking of using) and new users, t-test= -1.769, p=11.7%, b) statistically significant difference between non-users (not thinking of using) and experienced users, t-test= -3.771, p=0.1%; Problem recognition: a) statistically significant difference between non-users (not thinking of using) and new users, t-test= -1.592, p=14.2%, b) statistically significant difference between non-users (not thinking of using) and experienced users, t-test= -2.575, p=1.7%, c) statistically significant difference between non-users (thinking of using) and experienced users, t-test= -2.236, p=3.5%

On average experienced users had the largest scores in the three information management skills measured, followed by new users, and then non-users who were thinking of using software. Non-users who were not thinking of using computerised systems showed the smallest values. Differences were statistically significant between experienced users and non-users who were not thinking of using computerised systems in all information management abilities. These differences may be due to the use of computerised systems. However, new users, and even non-users who were thinking of using software also showed higher information management skill values (some of these differences are not statistically significant). This may mean that information management skills, particularly problem definition and solution search, and data collection and processing are related to more permanent farmer's characteristics such as personality and farming culture.

5.3 Usefulness of computerised systems

The second set of three hypotheses, related to the usefulness of computerised systems, was assessed using data collected from experienced users. From a total of 19 interviews, 11 of them focussed on financial packages, 6 on livestock packages and 2 on software packages for managing feed and pasture information. Each farmer was asked to rank the software using a five point scale of 1-not successful through to 5-highly successful.

Six farmers gave the highest score (4 to financial packages, 1 to a livestock package, and 1 to a feed and pasture package); 9 farmers assigned a 4 score (6 to financial packages, and 3 to livestock packages), and 4 farmers gave a 3 score (1 to a financial package, 2 to livestock packages, and 1 to a feed and pasture package). These results were related to the factor scores discussed below, with the correlation being presented for an intersection.

5.3.1 Fitting the farmer's work environment

Data related to this hypothesis was collected using the following scale

the FMIS innovation fits well with former work environment	Minor changes were necessary	Intermediate situation	Significant changes were necessary	the farmer adapted her/his way of working in a mayor way to make utilisation of the new tool possible
5	4	3	2	1

Farmers were asked to state whether the new procedure (computerised system) had changed their work routine or work environment.

5.3.2 Matching the farmer's current decision approach

Data related to this hypothesis was also collected using the following scale

the FMIS innovation "thinks" the decision problem just like I used too	Minor changes in thinking required	Intermediate situation	Significant changes in thinking required	The farmer has adapted her/his view or understanding of the decision problems in a mayor way to make possible the utilisation of the new tool
5	4	3	2	1

Again farmers were asked to state whether the new procedure (computerised system) had changed their views or thoughts about the decision problem(s), for which the information is produced.

5.3.3 Software user-friendliness

Data related to this hypothesis was collected by asking users about software advantages and disadvantages. The responses were then processed using the scale shown below.

The software is easy to use	Minor details are difficult	Intermediate situation	Significant components are difficult	The software is unfriendly
5	4	3	2	1

5.3.4 Results

Table 5.3 summarises farmer opinions about factors affecting software successfulness. Factor scores were averaged for each successful value.

Table 5.3 Average values of software factors with respect to different "success" levels

Successfulness level	Fitting with farmer work environment	Matching with farmer's decision system	Software user-friendliness
3	3.25	4.5	2.25
4	4.11	3.78	4.25a
5	4.33	3.33a	4.83b

Notes: Matching with farmer's decision system: a) statistically significant difference between score "3" and score "5", Mann-Whitney-test: -1.592, p=11.1%; Software user-friendliness: a) statistically significant difference between score "3" and score "4", Mann-Whitney-test: -2.106, p=3.5%, b) statistically significant difference between score "3" and score "5", Mann-Whitney-test: -2.634, p=1.0%.

While there is a positive relationship between software success and the work environment and user-friendliness, the other factor considered shows a negative relationship. Given the quantitative nature of these variables, a regression analysis was carried out. This is presented in table 5.4.

Table 5.4 Regression analysis of factors affecting software successfulness

Variable	Coefficient	t-test	Statistical significance
Constant	3.734964	5.621054	6.31E-05
Fitting with farmer work environment	0.115513	0.726237	0.47966
Matching with farmer's decision system	-0.27229	-1.97919	0.067808
Software user-friendliness	0.237292	2.036562	0.061067

R2= 0.506315, F= 4.786063, p= 0.016907.

As was expected, the software matching with the farmer's decision system and user-friendliness show statistically significant coefficients. This regression explains half of the variation in the software successfulness level score. This at least shows that farmers are consistent in their views of software.

6 Discussion

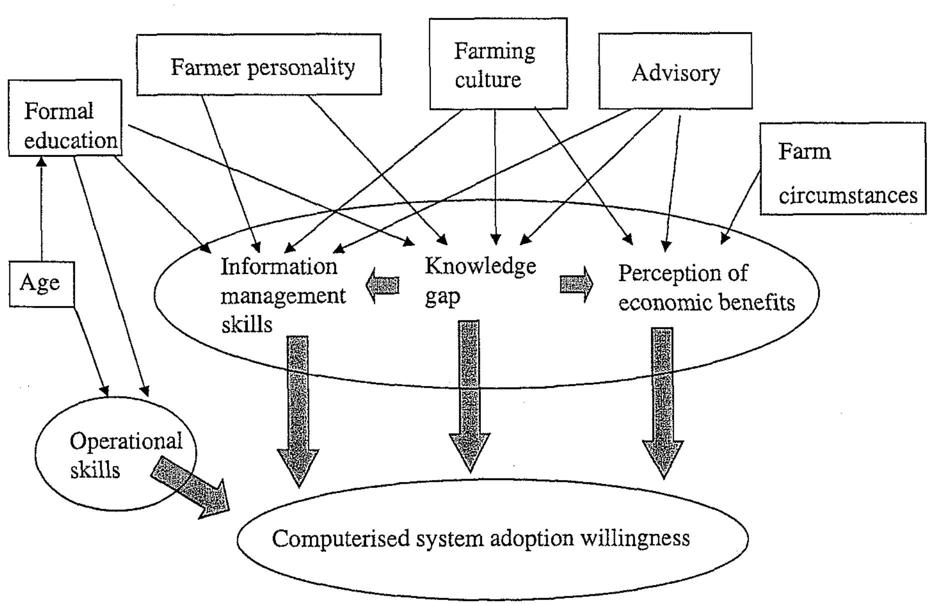
6.1 Factors affecting computerised system adoption

Interview results provide strong evidence to support the set of hypotheses proposed to explain farmer adoption willingness of computerised systems. Non-user farmers, who were not considering using computerised systems, saw them as useless for their particular situations, and therefore expressed their unwillingness to adopt such systems. These farmers saw themselves far away from computer technology (knowledge gap), expressed their scepticism of potential economic benefits, and they had neither the operational skills to operate a computer system, nor the information management skills compatible with this kind of technology. In contrast, non-user farmers who were thinking of using this technology (they did not feel alienated by computer technology) had a positive perception of potential economic benefits, and showed information management skills more compatible with computerised system use.

Both groups of farmers shared a lack of operational skills required for using computerised systems. This lack of operational skills may delay computerised system adoption, but it could be more easily removed than the other barriers. Conversely, the other three barriers, the knowledge gap, perception of economic benefit, and information management skills, seem to be more permanent factors that may interact with each other.

Mail questionnaire data showed statistically significant relationships between some farmer characters and computerised system use (Alvarez and Nuthall, 2001a and Alvarez and Nuthall, 2001b). Some of these farmer characteristics can be related to those included in the hypotheses as shown in figure 6.1.

Figure 6.1 A model of computerised system adoption



The model presented introduces the farmers' age, formal education, personality, farming (sub)culture, advisory and farm circumstances (area, herd). The possible interactions between these factors and those included in the hypotheses are briefly discussed.

Formal education, as was noted earlier, is one of the main developers of knowledge so it is a direct contributor in reducing the farmers' "knowledge gap". Results from the mail questionnaire showed a positive relationship between education and computerised system use. This relationship was quantified using a logistic regression (Alvarez and Nuthall, 2001b). At the same time, formal education also builds students' information management skills by providing problem solving frameworks and information searching strategies. Finally, formal education offers training opportunities for computer operational skills. However, this is only relevant for farmers who finished their tertiary education towards the end of the eighties and beyond, and those who have finished their secondary education by the second half of the nineties and beyond. This is one of the reasons why farmer age is related to (computer) operational skills. Additionally, a negative relationship was found between age and education (Alvarez and Nuthall, 2001a); the younger the farmer, the more educated.

Given a small "knowledge gap", some farmers may think about a problem and its solution somewhat differently relative to other farmers. This has been described as "an attitude toward change", a factor, which may be used to distinguish early adopters from laggards (Rogers, 1983). Similarly, personality features may be related to information management skills. For instance, Kolb (1984) developed a classification scheme according to a person's predominant learning style and method of dealing with problems.

Similar to formal education, farming (sub)culture is another main developer of farmer knowledge. Farming (sub)culture involves values, ideas, and principles that are shared by the farming community where farmers were children and developed their thinking. Farmers usually belong to complex networks that involve family members, friends, neighbours, and colleagues. Part of this knowledge involves the usual procedures to deal with and solve problems. In this context, information management skills usually exist as validated "rules of thumb". In this way other farmer opinions and experiences may become key components in a particular farmer's perception of economic benefits of using computer technology.

Results from the mail questionnaire have also shown a positive relationship between the level of advisor involvement in decision making and the use of computerised systems. This relationship was also quantified using a logistic regression (Alvarez and Nuthall, 2001b). Interview results found a positive relationship between the frequency of adviser visits and computerised system use (Alvarez and Nuthall, 2001c). While not being as important as formal education and farming (sub)culture, the farmer-advisor relationship does, however, contribute to the build up of farmer knowledge, information management skills, and to provide ideas for formulating the economic perception of technological changes.

Other factors can potentially impact on the view of the economic benefit. The size of the herd is one factor. A positive relationship was in fact found between herd size and computerised system use in the mail questionnaire data. This relationship was also quantified through a logistic regression (Alvarez and Nuthall, 2001b). Another factor is the stage of development. This determines the priorities on work time, and how much time is left to perform decision making activities. A third factor is the level of "time scarcity". Like the development stage, this factor determines priorities, and may impact on the opportunity cost at learning time, thus affecting a farmer's perception of economic benefit particularly when some training is required. Finally, the availability of family members (partner, son, or daughter) with the required operational skills and a positive attitude to computerised systems may also affect the economic benefit perception.

The model presented in figure 6.1 also suggests three of the factors interact each other. Information management skills can be considered as part of a farmer's knowledge. On the other hand, when an economic benefit perception is developed, key "knowledge" is required to estimate the expected values of possible costs and benefits. According to the interview data, these factors do not seem to act sequentially, as originally suggested in figure 3.1. In contrast, they seem to be highly integrated, perhaps because they are different aspects of an unique major factor. Clearly, operational skill represents a different factor, which is related sequentially with the first one, preventing adoption.

6.2 Factors affecting software value

The proposed factors explained half of the variation in the "successfulness" ranking assigned by farmers to their software packages. Software "successfulness" has positive relationships with whether it fits the work environment, and its user-friendliness, though only the last relationship shows statistical significance. On the other hand, the relationship between software success and "decision system matching" is negative and statistically significant.

The lack of statistical significance between "software success" and the software's compliance with the work environment may be explained because 11 of the 19 users were using similar procedures before they started using the current software packages. These similar procedures included older software versions, and services that managed the information similarly.

The statistically significant positive relationship between software success and user-friendliness was expected. Farmers, like other computerised system user groups, prefer procedures that keep "things as simple as possible".

Instead, the statistically significant negative relationship between software success and "decision context" matching was not expected. This means that users who have changed their view, or thought of a decision making problem in order to use the information provided by the software, have given a high success score to these computerised systems. While certain users were using computerised systems only to replace a manual or service procedure (there were no significant changes in their information management), other users have changed their information procedures due to some of the computing technology advantages such as quicker data processing and information retrieval, higher data storage capacity, and more complex calculations. Results show that the opinions from these last users have been predominant.

7 Conclusion

Unwillingness to use computerised systems can be explained according to three related factors. These are the farmer's computer technology alienation feelings ("knowledge gap"), incompatible information management skills, and poor economic benefit perceptions. Conversely, the lack of (computer) operational skills can delay software adoption, but can be removed through training if the above factors support a positive attitude toward computerised system use.

Formal education, personality, farming (sub)culture and attitude to the use of advisory services are major contributors to the farmer's "knowledge gap", information management skills, and economic benefit perceptions. This last is also affected by farm size.

If feasible, actions promoting information technology change should focus on building farmer information management skills, and in making available knowledge relevant to developing positive economic benefit perceptions, assuming they exist. Advisors can play a significant role, even though non-user farmers tend to have less contact with farm consultants.

An additional strategy, particularly where non-users not considering the use of computerised systems represent important segments in the farming community, is the development of information management tools more compatible with these farmers' current information systems.

Fifty percent of the reported software "success" was explained by the users' perceptions of the software fitting the environment, its user-friendliness, and whether it matched the farmers' decision system. While the first two factors show the expected positive relationships, the last one shows an unexpected negative relationship. This last negative relationship may mean that users expect to develop a learning curve through software use that may change their existing problem solving and information management approaches.

8 References

Alvarez, J. and Nuthall, P. (2001a) Computer use and attitudes for a sample of Canterbury, New Zealand, dairy farmers, Farm and Horticultural Management Group, Lincoln University, Canterbury.

Alvarez, J. and Nuthall, P. (2001b) Computers and Information Management in Canterbury Dairy Farming, Farm and Horticultural Management Group, Lincoln University, Canterbury.

Alvarez, J. and Nuthall, P. (2001c) Canterbury dairy farmer's opinions about using computerised farm information systems, Farm and Horticultural Management Group, Lincoln University, Canterbury.

Kolb, D. A. (1984) Organizational Psychology (fourth ed.) Prentice-Hall, INC., New Jersey.

Rogers, E. (1983). Diffusion of innovations (Third ed.). New York: The free press.