Intelligent support systems in agriculture: A study of their adoption and use

Abstract

Australian agriculture is one area in which a number of intelligent support systems have been developed. It appears, however, that comparatively few of these systems are widely used or have the impact the developers might have wished. In this study a possible explanation for this state of affairs was investigated. The development process for 66 systems was examined. Particular attention was paid to the nature of user involvement, if any, during development and the relationship to system success.

The issue is not only whether there was user involvement but rather the nature of the involvement, that is, the degree of influence users had during development. The patterns identified in the analysis suggest user influence is an important contributor to the success of a system. These results have theoretical significance in that they add to knowledge of the role of the user in the development of intelligent support systems. The study has drawn together work from three areas: Rogers' diffusion theory, the technology acceptance model, and theories relating to user involvement in the development of information systems. Most prior research in the information systems area has investigated one or two of the above three areas in any one study. The study synthesizes this knowledge through applying it to the field of intelligent support systems in Australian agriculture. The results have considerable practical significance, as apparently developers of intelligent support systems in Australian agriculture do not recognize the importance of user participation, and continue to develop systems with less than optimum impact.

Intelligent support systems in agriculture: A study of their adoption and use

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A special mention to all the participants who gave their time so graciously to take part in this study.

I dedicate this thesis to my two daughters, Emily and Callista, and to my parents, Len and Bette Ryan. Through them I have learnt so much.

Declaration

I declare that this thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, and that, to the best of my knowledge and belief it contains no material previously published or written by another person except where due acknowledgment is made in the text of the thesis.

Teresa Lynch

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Chapter 1

1 Introduction

And what is good, Phaedrus,
And what is not good
Need we ask anyone to tell us these things?
(Pirsig, 1976)

1.1 Background to the research

Information systems success continues to be an elusive target. A study by the OASIG (Organisational Aspects Special Interest Group) (1996) in the United Kingdom found that around 40% of information technology system developments failed or were abandoned. The systems failed, the report suggests, because, amongst other reasons, most investments were technology led and users did not usually have any major influence on system development.

Certain approaches to information systems development allow for users to be more involved in development. Supporters of development approaches that involve users argue that if users are involved in the development of information systems then the systems are more likely to be successful (Checkland & Scholes, 1990; Mumford, 1996). Approaches involving users are participatory, tend to have an adopter focus rather than a developer focus (Surry & Farquhar, 1997) and incorporate ideas from 'softer' systems methodologies (Checkland, 1981; Checkland & Scholes, 1990). That is, the developers focus on the needs and expectations of the users – the adopters of the technology.

While a number of studies have examined the relationship between user involvement and system success (Barki & Hartwick, 1991, 1994; Baroudi *et al.*, 1986; Cavaye, 1995; Doll & Torkzadeh, 1989; Hartwick & Barki, 1994; Hunton & Beeler, 1997; Hwang & Thorn, 1999; Lin & Shao, 2000; Lu & Wang, 1997; McKeen &

Guimaraes, 1997; McKeen *et al.*, 1994; Robey *et al.*, 1989; Saleem, 1996) the exact nature of this relationship is still unclear with findings from different studies producing contradictory results. Clearly, there is a need for further work in the area of user involvement in information systems development.

With this in mind, the focus of this study is on the involvement of users in the development of a certain type of software system, intelligent support systems, in Australian agriculture and the outcome of these systems (Figure 1-1).

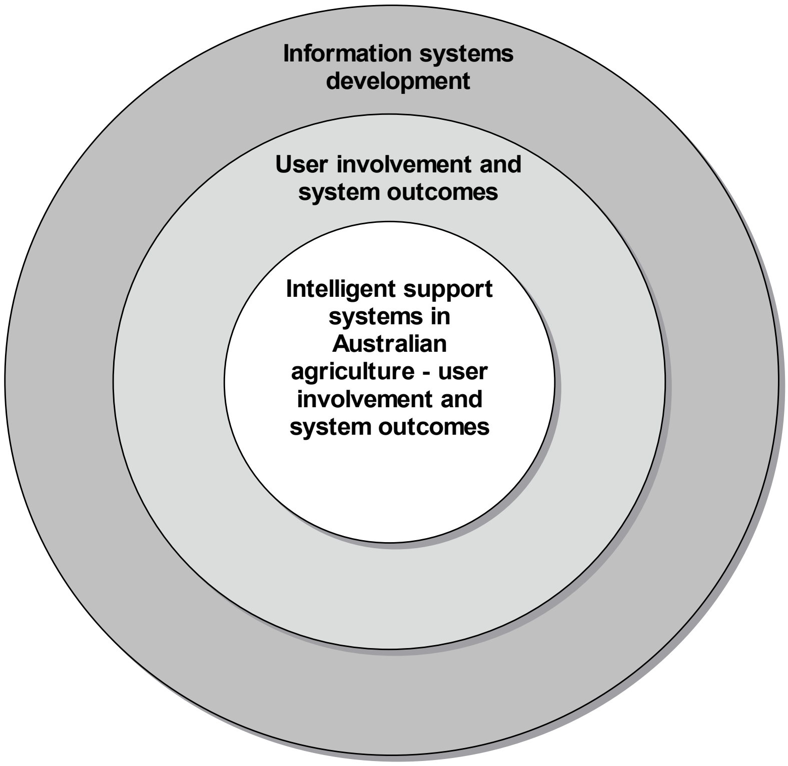

Figure 1-1 Focus of research project

Whilst there has been considerable effort and money spent in the development of intelligent support systems for use by farmers there is a body of literature indicating very limited adoption of intelligent support systems by farmers (Brown *et al.*, 1990; Cox, 1996; Foale *et al.*, 1997; Glyde & Vanclay, 1996; Greer *et al.*, 1994; Hamilton *et al.*, 1990; Hilhorst & Manders, 1995; Wilde, 1994). The issues surrounding the limited adoption of this type of system are of interest. In this study, the term 'intelligent support systems' includes expert systems and decision support systems - computer systems that can be used to assist in problem solving and decision-making.

In summary, within the information systems literature the relationship between user involvement and system outcome is not clear in that there have been contradictory results from studies that have looked at the issue of user involvement and system success. This study explores this relationship further using the development of intelligent support systems in Australian agriculture as the application for investigation. The results of this study are, therefore, relevant to practitioners developing intelligent support systems for Australian agriculture in that it provides an understanding of scenarios that are more likely to lead to adoption and success.

1.2 Research framework and objectives

1.2.1 Research framework

In this study the development and use of intelligent support systems in agriculture is examined in terms of the theory of diffusion of innovations (Rogers, 1962, 1983, 1995; Rogers & Shoemaker, 1971), the technology acceptance model (Davis, 1993; Davis *et al.*, 1989), and theories relating to user involvement in the development of information systems (Alavi & Joachimsthaler, 1992; Barki & Hartwick, 1991, 1994; Cavaye, 1995; DeLone & McLean, 1992, 2002; Hunton & Beeler, 1997; Hwang & Thorn, 1999; Ives & Olson, 1984; Lin & Shao, 2000; McKeen & Guimaraes, 1997; McKeen *et al.*, 1994; Yoon *et al.*, 1995). The process of development, adoption, and success or failure of intelligent support systems in agriculture is explained in terms of these theories.

Many studies investigating the adoption, use, failure, and success of information systems focus on the use of information systems within organisations. In many of these studies the use of the technology is mandatory – not optional. Rogers' diffusion theory (Rogers, 1995) provides a good understanding of the issues of adoption within organisational settings. More importantly, for this study, it provides a theoretical base for understanding the issues affecting the adoption of technologies by individuals and where use is not mandatory. For this reason, it provides part of the theoretical basis for this study. The technology acceptance model (Davis *et al.*, 1989) has been applied to the information systems area and looks at the impact of perceived usefulness and perceived ease of use on system usage. The technology acceptance model draws on some aspects of Rogers' diffusion theory in terms of system characteristics. From Rogers' diffusion theory (Rogers, 1995) and the technology acceptance model (Davis *et al.*, 1989), it appears that systems are more likely to be adopted and be successful if they are useful and are easy to use (Adams *et al.*, 1992; Agarwal & Prasad, 1999; Davis, 1993; Karahanna & Straub, 1999; Keil *et al.*, 1995; Szajna, 1994, 1996).

The importance of involving users in the development of intelligent support systems compared with other types of information systems application has been discussed in the literature. Ives and Olson (1984) argue that user involvement is more critical for certain types of systems, such as decision support systems (DSS), than for more conventional transaction type systems. They suggest that DSS require involvement because the system designer cannot produce an effective DSS without knowledge provided by the user and because acceptance is critical due to the mostly voluntary nature of DSS use (p.589).

The point at which users become involved in the development process is also important. If users are involved late in the development process then the system may not be as useful to the users. Ives and Olson (1984, p.601) suggested that researchers, when looking at user involvement and information system success, should look at the 'characteristics of the involvement process itself such as the degree and type of interaction'. This study looks at the ‘characteristics of the involvement process itself’ but also takes into consideration more recent work (Barki & Hartwick, 1991, 1994; Baroudi *et al.*, 1986; Cavaye, 1995; Doll & Torkzadeh, 1989; Hartwick & Barki, 1994; Hunton & Beeler, 1997; Hwang & Thorn, 1999; Lin & Shao, 2000; Lu & Wang, 1997; McKeen & Guimaraes, 1997; McKeen *et al.*, 1994; Robey *et al.*, 1989; Saleem, 1996) that has arisen from the seminal work of Ives and Olson (1984).

This current research is significant in that it brings together three areas, Rogers’ diffusion theory, the technology acceptance model, and theories relating to user involvement, into one theoretical model.

Rogers’ diffusion theory is concerned with many aspects of adoption, amongst which are communication about the innovation, characteristics of the innovation, and the setting into which the innovation is being introduced. However, Rogers’ diffusion theory does not consider user involvement in the development of the innovation. The technology acceptance model draws on some aspects of Rogers’ diffusion theory and is concerned with the relationship between two system characteristics in particular, usefulness and ease of use, and system outcome. The technology acceptance model does not focus on how to ensure that systems have the characteristics that improve adoption levels. Work in the area of user involvement and system outcomes has not generally investigated whether user involvement has impacted on the usefulness and ease of use of the software (Cavaye, 1995; Ives & Olson, 1984) and how this may impact on system outcomes.

1.2.2 Research objectives

The objectives of this study were to:

- explore the reasons behind the development of intelligent support systems in Australian agriculture,
- investigate the approaches used in the development of intelligent support systems in Australian agriculture in terms of user involvement,
- investigate the level of adoption of intelligent support systems in Australian agriculture.

Through investigation of a specific application, that is, intelligent support systems in Australian agriculture, the broader objectives of this study were to:

- develop and investigate a theoretical model that links user involvement, specific characteristics of the system, the uptake of the system in terms of adoption, and the context in which the system was developed,
- increase the understanding of the nature and role of user involvement in the development of information systems software.

1.3 Justification for the research

The original intention of the researcher was to develop an intelligent support system to encourage farmers to adopt a particular type of farming method that was seen, by researchers and extension officers, to be more sustainable. However, it became apparent during the early stage of this research project that these types of systems were not being adopted by farmers – and were often not widely used by extension staff or agricultural advisers. Despite this state of affairs, systems were still being developed or modified and there appeared to be conflicting evidence concerning the benefit of these systems to farmers and their advisers (Cox, 1996; Plant, 1993; Stapper, 1992). Whilst there was discussion in the literature about the reasons for the limited benefits and low adoption of intelligent support systems in Australian agriculture, no study had been undertaken to investigate the actual levels of adoption and the reasons behind the adoption rates. There was no information on why these systems were developed, how the systems were developed especially in relation to the level of user involvement, and the perceived success of these systems in the eyes of the developers. That is, what were the expectations of the developers when they developed these systems? Were they anticipating wide adoption of their system or did they have some other reason for developing the system?

How the farmers regarded these systems was also of interest. Given the suggested low adoption rate of these systems, the farmers' perspective of these systems and why they use or do not use them is more difficult to ascertain. Farmers may not use intelligent support systems for a number of reasons: they do not have a computer, they prefer to make their decisions on prior experience, or they are very happy with their current agricultural consultant. These types of reasons for not using an intelligent support system give an understanding of why the adoption rate is low but does little to inform practitioners on how to determine if the system they are hoping to build would be used by farmers. This study attempts to address these issues and provide a theoretical basis for scenarios that are more likely to lead to adoption of such intelligent systems by farmers.

The high failure rate of information systems is of concern to managers and/or funding bodies because these systems require significant inputs of money and resources for their development. If the uptake of intelligent support systems within

Australian agriculture is as low as that indicated by some researchers then it is important for funding bodies to be aware of this fact.

The study is significant in that it addresses not only the approach taken in the development of these systems, including the unresolved issue of user involvement, but also the issue of the interaction of technical systems and the social context into which these systems are introduced

1.4 Methodology

Prior to this study, there was limited knowledge of the development and outcomes of many of the existing intelligent support systems in Australia.

For the main study, information about intelligent support systems in Australian agriculture was obtained from a number of sources including farming publications, the web, and research papers. Data was collected on 66 of these systems via telephone interviews. This sample represents all identified intelligent support systems developed for agricultural applications in Australia where up to date contact details were available and the systems had passed beyond the prototype phase or were not research only type systems. The interviews were open-ended in nature and were conducted, in the main, with a developer or manager of each of the systems. This in-depth survey approach combines elements of both case study methodology and survey methodology.

Following data collection from individuals involved in the development of the systems, the data were examined for the main emerging issues and coded accordingly. The data were analysed from a qualitative and quantitative perspective and using descriptive statistics.

In a second stage in the research, two of the intelligent support systems studied in the first stage of this study were examined in greater depth. The data gathered from users of the systems were examined and coded according to the research theme. These findings show the users' views of the systems in terms of usefulness and ease of use, and their perceptions of the level of involvement they had in the development of the system.

1.5 Thesis outline

This current chapter has provided a brief outline of the thesis and has set the scene for the following chapters.

Chapter 2 provides a review of the literature. It outlines in more detail the research problem, the research model, and the propositions arising from the body of knowledge.

Chapter 3 discusses the methodology used in the collection of the data. It describes in detail how the data were collected and why the chosen methodologies were used. It discusses the issues surrounding the methodology chosen for this study.

Chapter 4 details the results and analysis of the survey of developers of intelligent support systems.

Chapter 5 details the results and analysis of the in-depth studies of users of two systems.

Chapter 6 synthesizes the results from the survey and in-depth studies and discusses the conclusions that can be drawn from the outcomes of this research.

1.6 Definitions

Definitions of key terms used in this thesis are now defined.

Impact of system: A rating given to a system in terms of level of impact. Systems were coded as high, medium, or low impact systems. Impact was determined by examining *level of adoption*, *market share*, and the *technical outcome* for a system.

Intelligent support systems: These systems includes expert systems and decision support systems – computer systems that can assist in problem solving.

Level of adoption: An adoption outcome for a given system – usually determined in terms of units sold or distributed.

Market share: Percentage of known market share that the system had achieved in terms of sales or distribution.

Technical outcome: The impact that development of a system had on understanding issues surrounding the original problem.

User influence: The degree of influence users had over system design. User influence was determined by examining the type of involvement and the degree of involvement.

User involvement – degree of: Involvement ranged from none to extensive and is composed of three different aspects of involvement – involvement in testing, involvement in development, and whether user feedback was incorporated into the system.

User involvement – type of: Type of user involvement ranged from no involvement, consultative involvement, representative involvement, through to consensus involvement.

1.7 Limitations and key assumptions

Every effort was made to ensure a rigorous approach to the collection and analysis of data for this research. As in any study, however, the approach adopted has limitations.

1.7.1 Limitations

- This study focuses on the development of intelligent support systems in Australian agriculture. Some aspects of this study will only be relevant to Australian developers and funding bodies within this field of study.
- For the systems investigated in phase one of the study only one person was interviewed for each system. Thus, only one viewpoint of each system was gained.
- The collection of data on each of the systems relied on the interviewee's recollection of events. However, interviewees were principally individuals who were involved in the development of the system and so had a good personal understanding of the issues involved in the development of the system.
- The method of identifying which users to interview in the second phase of the study is a limitation as the selection of users was not random.
- As with any qualitative analysis, there is a certain amount of subjectivity in assigning values to some attributes, and in categorizing responses.

1.7.2 Key assumptions

- It is assumed that the use of intelligent support systems in agriculture has the potential to assist farmers and their advisers in their decision-making.

1.8 Conclusions

This chapter has laid the foundations for this report. It has introduced the research framework and the research objectives. The importance of this research was discussed and a brief outline of the methodology was given. The limitations of this research were discussed. The following chapters will expand on the topics outlined in this chapter.

<u>Chapter 2</u>

2 Conceptual background

Applications in search of users or users in search of applications?
(Stapper, 1992)

2.1 Introduction

Chapter 1 briefly outlined issues surrounding the disappointing outcomes for many information systems software applications. In particular, the limited adoption and use of intelligent support systems in Australian agriculture was discussed.

This chapter provides a conceptual framework for understanding the issues surrounding intelligent system adoption and explains how this conceptual framework is derived from aspects of the theory of diffusion of innovations, the technology acceptance model, and user involvement in information system development. Later chapters in the thesis show how elements of this framework were investigated empirically.

The chapter proceeds as follows. This section outlines the structure of the chapter. The second section, 2.2, gives an overview of the current status of the adoption and use of intelligent support systems in agriculture to illustrate the background and importance of the study. The third section, 2.3, gives an overview of the conceptual framework proposed and outlines its origins in relevant theory

Subsequent sections explain in greater detail how the conceptual framework is based in theory. The fourth section, 2.4, discusses the adoption of a technology in terms of diffusion theory. The fifth section, 2.5, discusses the relationships between perceived usefulness, perceived ease of use, and adoption outcomes with particular reference to the technology acceptance model. The sixth section, 2.6, discusses the importance of involving users in software development. Following this, section seven, 2.7, discusses the outcomes of intelligent support system software targeted at the agriculture sector. The eighth section, 2.8, revisits the conceptual framework. In the ninth section, 2.9, the research propositions for this study are outlined. The concluding section, 2.10, reviews and demonstrates the importance of the conceptual framework.

2.2 Adoption of intelligent support systems in agriculture

Farming decisions are becoming more complex due to a variety of factors that include the internationalisation of farming and the need for farmers to adopt sustainable farming practices. Intelligent support systems have the potential to be important tools in the decision-making process for farmers and their advisers (Ritchie, 1995). These systems might allow farmers to evaluate available information and take into account constraints placed upon them by local governments, authorities, and the environment. The system developers obviously perceive potential benefits to farmers from the use of these systems. However, there is a considerable body of literature indicating limited adoption of intelligent support systems by farmers (Brown *et al.*, 1990; Cox, 1996; Foale *et al.*, 1997; Glyde & Vanclay, 1996; Greer *et al.*, 1994; Hamilton *et al.*, 1990; Hilhorst & Manders, 1995; Rickert, ; Wilde, 1994). Whilst considerable money has been spent in the development of these systems, few appear to be adopted for regular use.

Intelligent support systems include expert systems (ES) and decision support systems (DSS) - computer systems that can be used to assist in problem solving. An expert system solves problems at a level generally recognised as equivalent to that of a human expert or specialist in the field. The system is highly domain specific, that is, it knows a great deal about a narrow range of knowledge rather than something about everything (Firebaugh, 1988, p.336). While DSS are similar to expert systems in that they can aid in the decision-making process, they differ in that they tend to employ quantitative rather than qualitative reasoning and place more responsibility for problem solving on the user (Luconi *et al.*, 1993). Power (1997) defines DSS as computer-based systems intended to help managers make decisions. A spreadsheet can be used as a decision support system. A further difference is that expert systems can usually give an explanation of the reasoning processes of the system.

An example of a widely known agricultural intelligent support system is SIRATAC. This system was developed for cotton farmers and is often cited in the literature on expert systems (Hamilton *et al.*, 1990; Macadam *et al.*, 1990; Plant, 1993; Wilde, 1994). SIRATAC is an example of an intelligent support system that had some acceptance at first but eventually was terminated (Cox, 1996; Hearn & Brook, 1989; Macadam *et al.*, 1990).

SIRATAC is not atypical. Researchers at Swinburne University maintained a database of 34 agricultural based expert systems (Wilde, 1994) in Australia. Only 5 of these systems were in use at that time. That is, 85% of the systems registered in the database were not in use. Some of the systems that were identified as not in use were still being developed. Reasons for non-use of a particular system were not identified.

Edwards-Jones and McGregor (1992) undertook a literature survey of journal and conference publications between 1982 and 1990 on the trends in the development of expert systems in agriculture. They reported over 280 publications during that period although they do not state whether some publications were reporting on the same software product. They were unable to gauge the success of expert system implementation from their review because many of the papers failed to report on whether the systems under discussion were fully developed, in the prototype phase, or whether they were being used at all. As the authors point out, this meant that it was not possible to undertake an analysis of systems that were in regular use. Such an analysis might have been beneficial in identifying successful systems and their characteristics. While their report outlining their study was brief, they did comment on the fact that while a considerable amount has been written about expert systems and their application in agriculture, their widespread use does not appear to have eventuated. Brown *et al.* (1990) raised similar concerns in their study of expert systems and an assessment of their outcomes. They also examined articles in the literature and found that only occasionally was an evaluation of the system under discussion included. They commented that the articles rarely specified the reasons for developing the system.

A researcher's career may be judged by software outcomes. Given this fact, researchers may tend to report on the positive aspects of software implementation such as technical features or how well the system matched advice given by an expert rather than on adoption levels and impact levels – especially if these levels are low. There is, therefore, a problem in determining, from the literature, the extent of adoption and use of these types of systems, although as previously outlined there is some evidence that adoption levels are low.

In order for intelligent support systems to reach their full potential, as perceived by their developers, it is necessary to determine a more accurate indication of the adoption and use of these systems and to start to gather information on why farmers accept or reject such systems. Some researchers (Cox, 1996; Stapper, 1992) suggest that the potential of intelligent support systems in agriculture is limited and that the potential perceived by the developers of these systems is not a realistic appraisal.

Cox (1998) argues that:

> Decision support systems … have been proposed as a way of transferring information from researchers to farmers. I have questioned whether this is justified as a general strategy because routine decisions are often clear, and difficult decisions are only difficult because they are marginal – it does not matter a jot which way you jump, either because there are no differences between the outcomes associated with alternative decisions or the background is so noisy that these cannot be distinguished (p.627).

Guerin and Guerin (1994) have comprehensively reviewed the issue of the adoption of innovations in general by farmers in Australia. Whilst there are suggestions within the literature about factors affecting the use of intelligent systems by farmers, no studies have been undertaken to collect information on the impact of these systems in terms of their adoption. The focus of this thesis is specifically on the adoption, in Australia, of intelligent support systems by farmers.

The current status of intelligent support systems is now discussed.

2.3 Conceptual framework

This thesis proposes that the development and use of intelligent support systems in agriculture be examined in terms of the theory of diffusion of innovations (Rogers, 1962, 1983, 1995; Rogers & Shoemaker, 1971), the technology acceptance model (Davis, 1993; Davis *et al.*, 1989), and theories relating to user involvement in the development of information systems (DeLone & McLean, 1992; Ives & Olson, 1984). Drawing from these theories, it is proposed that the process of development, adoption, and success or failure of intelligent support systems in agriculture is best understood in terms of a dynamic, conceptual framework. A conceptual framework explains, visually, the key factors and constructs and the presumed relationship amongst them (Miles & Huberman, 1994, p.18).

A conceptual framework was developed for this study (Figure 2-1). The conceptual framework proposed for the understanding of intelligent system adoption draws on innovation diffusion literature as well as information systems literature – the latter principally from the areas of the technology acceptance literature and user involvement in information system development. This framework emphasises the importance, for development of a successful product, of the interrelationships between software developers, the potential adopters of the product, and the context in which the software is developed and used.

The framework proposes that characteristics of an operational software system depend in part on the development methods used to produce the system (L1 link in Figure 2-1). The degree of adoption of the system then, in turn, depends on a number of characteristics of the operational system (L2 link). In addition, aspects of the software development methods, such as user involvement and the communication processes, can affect the degree of adoption directly (L3 links). The broader social and organisational context in which systems are developed can influence the nature of involvement, the characteristics of systems that are developed, and the degree of adoption (L4 links). Finally, different types of systems and different stages of system development may require different degrees and types of involvement (L5 link). Each of these proposed relationships is based on underlying theory.

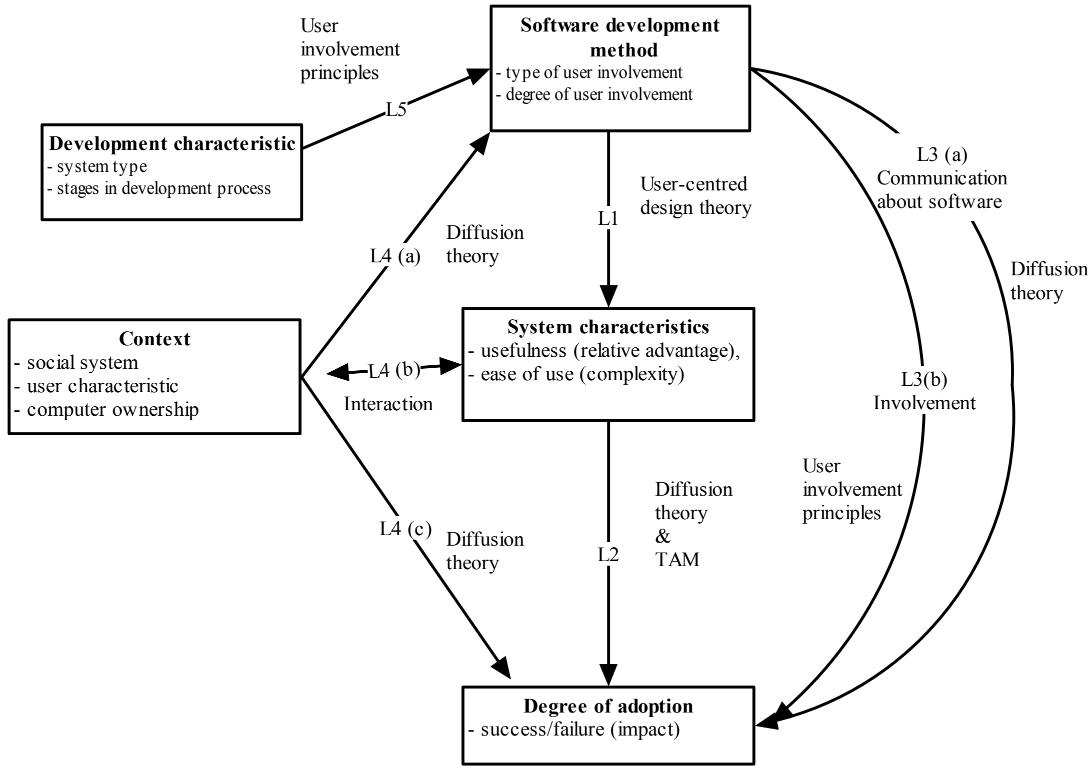

Figure 2-1 Context-involvement-outcome model

The first relationship (L1) arises from theory in the information systems field that discusses the importance of capturing the needs of users through user involvement in system development. In particular, approaches stressing user involvement are expected to lead to systems that better meet the needs of users, for example, in terms of usefulness and ease of use. Ives and Olson (1984, p.601) suggested that researchers, when looking at user involvement and information system success, should look at the 'characteristics of the involvement process itself such as the degree and type of interaction'. That is, link L1 proposes there can be different degrees and types of involvement in software development and that the degree and type of involvement may influence the usefulness and ease of use of the software that is developed. Different types of systems may require different degrees and types of involvement. These issues are captured in link L5.

The second relationship (L2) is based on theory of diffusion of innovations and the related technology acceptance model (TAM), which provide for links between characteristics of an innovation (a software product) and its degree of adoption. TAM proposes that systems that users perceive as useful and easy to use are more likely to be adopted than systems that are not perceived as useful and easy to use. These two characteristics are closely related to the characteristics of relative advantage and complexity – two characteristics that form part of diffusion theory.

In addition, diffusion theory provides insights into how communication channels amongst information providers and potential adopters can influence adoption levels (L3 links). Furthermore, diffusion theory contributes to our understanding of how the wider social systems into which innovations are introduced play a role in adoption outcomes (L4 links). For this current study, where the focus is on individual farmers adopting an innovation, as opposed to adoption within a medium to large organisation, diffusion theory provides a useful framework to begin understanding issues affecting software adoption. In fact, it gives rise to an understanding of why farmers may have failed to embrace intelligent support systems (Lynch *et al.*, 2000). Diffusion theory indicates that communication is an important aspect of innovation adoption.

Not all links developed in the framework will be examined in this current study. The links that are the main focus of this study are L1, L2, and L3b. That is, this study will focus on the outcomes of involving or not involving users in software development in terms of system characteristics and system uptake. The reasons behind why a system was developed in the first instance and a given system outcome will be explored. Furthermore, users' views of systems in which they have been involved will be sought. The focus of this part of the study will be in terms of perceived usefulness and perceived ease of use.

2.4 Diffusion of innovations

2.4.1 Diffusion theory

Rogers' theory of diffusion of innovations provides underlying support for the characteristics of the product developed, the eventual adoption or otherwise of the product, and the context in which the innovation is developed (Links L2, L3, L4 in Figure 2-1). This theory argues that there are four main elements that play a part in the diffusion of an innovation (Rogers, 1995):

- the features or characteristics of the innovation
- how information about the innovation is communicated
- time, and
- the nature of the social system into which the innovation is being introduced.

The elements that are discussed here are the characteristics of the innovation, how information about the product is communicated, and the nature of the social system (the context). Each of these elements is explained in more detail in following sections. Time is not discussed, as the time taken to adopt a product is not a focus of this research. Diffusion theory discusses many other aspects of the adoption of an innovation, for example, the decision process of whether to adopt the innovation or not and the innovativeness of individuals and their adoption decisions. Clearly, these factors influence adoption outcomes but are not the focus of this current study.

2.4.1.1 Characteristics of the innovation

Rogers (1995) identified five general attributes of innovations that influence whether the innovation will be adopted. The emphasis for the following characteristics of the innovation relates to how an individual *perceives* that innovation. Two individuals could perceive the characteristics of the innovation differently.

The characteristics of the innovation as perceived by an individual (Rogers, 1995, p.15) are:

- **Relative advantage** - the degree to which an innovation is perceived as better than the idea or practice it supersedes.
- **Compatibility** - the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
- **Complexity** - the degree to which an innovation is perceived as difficult to understand and use.
- **Trialability** - the degree to which an innovation may be experimented with on a limited basis.
- **Observability** - the degree to which the results of an innovation are visible to others.

It is not the perceptions of the innovation itself that are of interest but rather the perceptions of using the innovation (Moore & Benbasat, 1991).

2.4.1.2 How information about the innovation is communicated

Information about an innovation must be communicated to an individual. Through the process of information sharing, individuals acquire information about an innovation that allows them to evaluate that innovation:

> .. the innovation-decision process is an information-seeking and information-processing activity in which an individual obtains information in order to decrease uncertainty about the innovation (Rogers, 1995, p20).

This communication can be via the mass media or via personal communication. Whilst the mass media can reach more people, one-on-one communication is often more effective in changing attitudes towards an innovation. Most people evaluate an innovation by looking at the impact of the innovation on individuals who have already adopted the innovation.

2.4.1.3 Nature of the social system into which the innovation is being introduced

The social or communication structure affects the diffusion and adoption of innovations in a system. The diffusion of an innovation through a social system, such as an organisation or a group of farmers, will be affected by the norms of the group. The opinion of the leaders within that social system will affect adoption. Innovations can be adopted or rejected by individuals or by an entire social system. An example of adoption by individuals would be the adoption of an intelligent support system by an individual farmer whilst an example of adoption by an entire social system would be the adoption of a particular software system by an organisation.

There are consequences associated with the adoption or rejection of an innovation (Rogers, 1995). There may be desirable and undesirable consequences, direct and indirect consequences, anticipated and unanticipated consequences. These consequences are communicated to other individuals within the social system. What actually eventuates as a result of the adoption of an innovation will influence the long-term adoption of that innovation. That is, individuals may change their attitude towards an innovation if the consequences of adoption or rejection of that innovation have different consequences than that initially envisaged.

2.4.2 Issues surrounding diffusion theory

Rogers' acknowledges that there has been criticism of diffusion theory (Abrahamson, 1991) because of its pro-innovation bias (Rogers, 1995, p.100). There was an underlying assumption that an innovation should be adopted and if an individual did not adopt an innovation this was because of some inadequacy within the individual and not because of some inadequacy with the innovation. Rogers has put forward strategies for overcoming this pro-innovation bias (Rogers, 1995, p.106). Seligman (2000) provides a different focus to the pro-innovation focus with his adopter-centred process model of information technology adoption. In addition, Newell *et al.* (1993) suggest a user-focus model that views an innovation as socially constructed – with different users perceiving and constructing technologies, that are basically the same, in different ways. More recently, Newell *et al.* (2000) place the emphasis on a knowledge-focus perspective model to explain diffusion. They use this model to explain the apparent contradictions between the limited success rate of business process re-engineering and its widespread diffusion amongst western firms.

However, given the nature of the target group for this study, Rogers' diffusion theory provides a useful starting point for understanding the issues involved. Much of Rogers' work was with individuals adopting an innovation, as opposed to organisations or individuals within organisations adopting an innovation. Rural communities, both in the first and third worlds, are included in diffusion theory discussion. The intended target audiences for many intelligent support systems that are under investigation in this study are farmers. Farmers' experiences are similar to those explored in Rogers' diffusion theory. The issues surrounding adoption of innovations by farmers are different to the issues surrounding adoption within organisations. For example, the adoption of the innovation is optional as opposed to the mandatory adoption that is often required within an organisation. Rogers' diffusion theory is more appropriate for this study than other approaches that focus more on adoption within organisation and the impact of organisational culture (Abrahamson, 1991; Slappendel, 1996; Wolfe, 1994).

Other information systems researchers have used Roger's diffusion theory to examine non-mandatory adoption of an innovation by individuals. In their study of individuals using Internet banking, Tan and Teo (2000) used Rogers' diffusion theory and the theory of planned behaviour (Ajzen, 1985) to identify the attitudinal, social, and perceived behavioural control factors influencing Internet banking.

A meta-analysis was undertaken by Tornatzky and Klein (1982) on innovation characteristics and their relationship to innovation adoption and implementation. A meta-analysis is a set of procedures that allows the analysis of statistics across many studies without access to the original data set. The authors were critical of much of the studies undertaken in the area of adoption of technologies. Their findings indicate that the study of innovation characteristics is 'typified by poor conceptualisation and research methodology' (p.39). However, despite these shortcomings three innovation characteristics showed some consistency across the studies in relation to adoption of a technology. These characteristics were: relative advantage, complexity, and compatibility.

The above section outlined the theoretical aspects of diffusion theory relevant to the conceptual framework and criticisms of diffusion theory and diffusion research were acknowledged. The following section focuses on the adoption of a particular innovation, intelligent support systems, in terms of the theoretical aspects of diffusion theory.

2.4.3 The adoption of intelligent support systems in terms of diffusion theory

Diffusion theory predicts that the adoption levels of a technology, such as an intelligent support system, would be related to characteristics of the system – relative advantage, compatibility, complexity, trialability and observability. This is represented, in part, as Link L2 in the conceptual framework. In addition, diffusion theory highlights the importance of the nature of the social context into which the innovation is introduced (L4), for example a farming community, and the communication processes used to disseminate information concerning the innovation (L3a). The situation in relation to intelligent support systems in agriculture is now examined with respect to each of these concepts. This examination shows that a number of factors militate against the successful adoption of intelligent support systems by farmers, and offers an explanation of the apparent low usage of intelligent support systems in agriculture.

2.4.3.1 Characteristics of intelligent support systems innovations in agriculture

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes.

It is important to understand that not all innovations have advantages. Some innovations do not appear to afford the user <u>any</u> advantage. As Rogers states:

> Simply to regard adoption of the innovation as rational (defined as use of the most effective means to reach a given end) and to classify rejection as wrong or stupid is to fail to understand that individual innovation-decisions are idiosyncratic and particularistic. They are based on the individual's perceptions of the innovation. Whether considered as right or wrong by a scientific expert who seeks to evaluate an innovation objectively, an adoption/rejection is always right in the eyes of the individual who made the innovation-decision (at least at the time of decision is made) (Rogers, 1995, p.111).

'The degree of relative advantage is often expressed as economic profitability, social prestige, or other benefits' (Rogers, 1995, p.212). In regard to intelligent support systems, some systems may simply not provide any relative advantage in terms of economic advantage. While for other systems, it may be hard for the farmer to see the economic benefits in the short term. While changing to a new crop variety may produce improved yields within the next season, the economic benefits of intelligent support systems may be less clear.

Social prestige is an aspect of relative advantage that influences adoption rates. Often, however, there is no clear social prestige associated with using intelligent support systems. They are not a *visible* adoption technology. Adopting other farming practices, such as farm layout, is more visible and may bring social prestige. Using computers, and the associated software, is not visible to neighbouring farmers and so does not have the same social prestige factor.

There may not be any obvious advantages for farmers to purchase and use many of the intelligent support systems that are on the market. The farmer would often prefer to seek advice from an agricultural consultant or spend time chatting with a neighbour about management decisions than to spend time interacting with a software product (Kelleher *et al.*, 1992). The farmer may not believe that the outcomes of using a decision aid will yield sufficient advantage to justify its use. A comprehensive study by Kaine *et al.* (1994) was undertaken to 'explore the relationship between planning, performance and the use of decision aids in farming' (p.3). While virtually all farmers believed that they could influence production outcomes, many farmers believed that the performance of the farm business in other areas was subject to the influence of factors such as commodity prices, input costs, and interest rates which were beyond their control. The results suggested that the use of planning aids depended on the degree to which farmers perceived they could exert control over the performance of their farming operations. The majority of farmers in their sample were of the opinion that they did not have sufficient control over the financial performance of their businesses to warrant the use of decision aids. That is, the planning aids were perceived as not providing any relative advantage.

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters. For farmers to adopt intelligent support systems they need to be users of computers and be familiar with similar types of software. The use of intelligent support systems would then be more compatible with their experiences.

In Australia, farmers have historically had limited experience in the use of computers. A comprehensive survey undertaken by Worsley (1994) in 1990 indicated that, amongst farmers in the wheat belt of New South Wales, computer ownership was around 6.7%. They estimated that, at that time, $7 million was spent annually, in Australia, developing agriculture related software for use by farmers and agricultural consultants. The study was undertaken following the Australian Bureau of Statistics report (1991) that computer usage for farmers was below 10%. There was clearly a mismatch between the large amounts of software being developed for farmers compared to the low level of computer ownership amongst farmers.

Information collected in the mid-1990s indicated that computer ownership across agriculture industries in Australia was around 31%, being highest amongst wheat and other crop producers at 44% (ABARE, 1996). More recently, computer ownership across agriculture industries in Australia was estimated at 49%, being highest amongst cotton growers and plant nurseries (76% and 71% respectively). Beef cattle farms had the lowest proportion of computer use estimated at 38% (Australian Bureau of Statistics, 2000).

The issue, though, is not just about computer ownership amongst farmers but how farmers view computers as management tools and their purpose in using the computers. There is evidence that these attitudes are not favourable. Stubbs *et al.* (1998) studied farmers across five states, including both users and non-users of personal computers, investigating their views, attitudes, and perceptions of computers in their decision-making. Important findings were:

- for many farmers, computers were seen to be time wasters
- the majority of farmers are of a non-computer generation and many see no reason to change their current habits of book-keeping and farm management
- for many farmers with smaller holdings they could not justify the costs - in terms of money and time. Many failed to see any benefits. They saw farming as a 'way of life' as opposed to a small business
- determining which type of computer to buy and what software to use was a major obstacle for many farmers.

It appears that intelligent support systems are not particularly compatible with the current computing practices of farmers. The reality for many farmers may be that they believe they are better off spending time in their paddocks making their decisions rather than interacting with a computer.

A study into the adoption of farm management information systems by Lewis (1998) suggested that the success of adoption of a computer-supported farm management information system depended on the prior use of a similar manual system. That is, farmers are more likely to use a computerised management information system if they have previously used a manual type system. To expect farmers to adopt computerised management information systems when they have not even used a manual management system is unrealistic. Lewis suggested that there is an increasing level of sophistication from using no management information system, to using a manual management information system to using a computerised management information system, to using the Internet for farm management. This continuum of moving through levels of management sophistication would also be true for adoption of intelligent support systems. Farmers who use ‘gut-feeling’ as their approach to farm management are less likely to use an intelligent support system as an aid in their decision making than farmers who regularly use software packages as part of their farm management practices. That is, the innovation must be compatible with the existing values, needs, and past experiences of potential adopters.

Complexity is the degree to which an innovation is perceived as being difficult to use. For many farmers, computers are seen as a relatively complicated technology to use. Furthermore, many of today's intelligent support systems are complex and require technical support before they can be used effectively. Intelligent support systems are generally more complex to use than other types of software, hence farmers perceive the technology as being difficult to use.

Cox (1996) believed that the expectation that farmers would adopt intelligent support systems to improve farming practice was ‘seriously flawed’. The reasons Cox gave included the complexity and heavy demand for technical support that intelligent support systems require, the unreasonable amount of data input from the farmer, and the need for farmers to be competent computer users. As another drawback, intelligent support systems often provide information only for exceptional situations and so by this very fact, their use is limited and ‘the potential gain from using the technology is marginalised’ (p.356).

Furthermore, a commonly reported problem with such software applications is that they may require the farmer to provide data that they do not typically collect (Glyde & Vanclay, 1996; Stubbs *et al.*, 1998) or to enter the same data into two different software packages (Stapper, 1992). This adds a further layer of complexity to an already complex system.

Thus, the complexity of many intelligent support systems militates against their adoption.

Observability is the degree to which the results of an innovation are observable. Software dominant innovations have 'less observability, and usually have a relatively slower rate of adoption' than hardware innovations (Rogers, 1995, p.244). It appears that the more the potential adopters can see the results of an innovation, the more likely they are to adopt it. The impact of a decision made through interaction with an intelligent support system may not be readily attributed to the use of that software. Therefore, intelligent support systems would be adopted more slowly than an innovation where the results could be more directly attributed to the adoption of that innovation, such as changing crop layout or tillage practice. In fact, use of an intelligent support system does not necessarily mean that a farmer will change their farming practice. This complicates even further the observability of the innovation.

Additionally, farmers must put trust in the output of the software. If the software suggests a farming strategy that is in conflict with farmers' current farming strategy then farmers must make a choice between their years of experience and the output from a software product. Generally they have no knowledge as to how the software reached its decision. Farmers like to see proof that the outputs predicted by the software match those in their paddocks under the environmental conditions on their properties. Work by Hamilton (1996) suggested that farmers must understand how the software program works before they will trust the output. Farmers did not trust the output of a DSS, *How Wet*, until the nature of the program's reasoning was explained using pen and paper worked examples. Once the farmers understood the process they were willing to use the software.

Trialability is the degree to which an innovation may be experimented with before adoption. Currently many intelligent support systems can be trialed via demonstration versions before being purchased. Often, however, the software requires extensive data entry as well as a time commitment to become familiar with the system. The farmer may perceive this as a large investment without any guarantee of improved farming outputs, and 'pass up' the software.

The above discussion has looked at the characteristics of an innovation that affect adoption levels. This is represented, in part, by link L2 in the conceptual framework. Apart from the characteristics of the innovation considered above, two other aspects of diffusion theory appear particularly relevant to the adoption and use of intelligent support systems. These aspects concern communication processes and the nature of the social system into which the innovation is introduced.

2.4.3.2 How information about intelligent support systems is communicated

The task of achieving change in agricultural communities has typically been approached in many farming communities throughout the world using a *transfer of technology approach* (Ison & Ampt, 1992). In this approach a linear model of technology development is used - the extension officer transfers the information generated by scientists to farmers. The approach requires extension officers to visit farming groups and inform farmers of recent research findings and indicate how these findings could be implemented. The approach, in the past, did not normally first determine whether, in fact, the information might be of importance to the farmer. The extension officer reported to the farmers the results of research with the belief that once the farmers learnt about the research they would change their farming practices.

The transfer of technology approach assumed that the areas of interest for researchers were also the areas of concern for farmers. It also assumed that farmers were interested in what the researchers had to say. While this approach is relatively simple, the low adoption rate of much of the information provided led to a critical appraisal of the methodology as a mechanism for imparting information to farmers, particularly on complex farming issues (Bawden *et al.*, 1985; Blacket, 1996; Clark, 1996; Doll & Francis, 1992; Gerber, 1992; Guerin & Guerin, 1994; Hamilton, 1996; Ison & Ampt, 1992; Lanyon, 1994; Okali *et al.*, 1994; Scoones & Thompson, 1994).

Under the transfer of technology approach the farmers are the receivers of information. According to Chambers and Jiggins (1987), the transfer of technology model involves research priorities that are determined by scientists with a focus on experiments that are conducted under controlled conditions examining only a few variables. This model is output oriented, and not client focused, and hence is not focused on feedback from farmers. It also assumes that scientists' knowledge is superior to farmers' knowledge and scientists know more than farmers.

The transfer of technology approach has been used in the development and delivery of intelligent support systems (Cox, 1996; Stapper, 1992). The transfer of technology approach is efficient but ineffective when coping with complex issues such as sustainable agriculture (Blacket, 1996) and, it would seem, the complex issue of adoption and use of intelligent support systems.

Researchers and extension officers perceive areas where computer applications will aid farmers in their decision making process. They proceed to develop an application assuming that once the system is demonstrated to farmers then the farmers will clearly see the benefit of the system and adopt it. Possibly, the prevalence of this approach has contributed to the low adoption of intelligent support systems in agriculture (Cox, 1996; Stapper, 1992).

The communication process used for information sharing about an innovation impacts on the adoption of that innovation. This is represented as link L3a in the conceptual framework. If a technology transfer approach has been used to disseminate information about intelligent support systems, then this communication method would not have been the most effective in terms of allowing individuals to acquire information about an innovation in order for them to evaluate that innovation.

When looking for reasons why farmers have failed to adopt intelligent support systems, it is important to look also at the nature of the social systems or social context within which farmers operate as discussed in the next section. Extension officers need to consider that for many farmers the resistance or reluctance to change may have some logical basis (Vanclay & Lawrence, 1994).

2.4.3.3 Nature of the social systems into which intelligent support systems are introduced

A study by Mesiti and Vanclay (1996) considered the issue of farming styles and decision-making. They argued that farmers have different ways of managing and operating their farms not based entirely on technical needs, but on a combination of social and cultural factors. They suggested that farm management is not a technical activity that is based on rational decision-making, but a socio-cultural activity that needs to be understood in terms of farming subcultures.

The issue on non-adoption of technologies in general was raised by Blacket (1996). He cautioned:

> .. research on barriers to adoption assume the technology is relevant in the first place and that the problem is that of the client. How often are these assumptions proved wrong? (Blacket, 1996, p.2).

Blacket determined that for many farmers it was the rural lifestyle that was the main reason for farming. This has important implications in the adoption of new technologies as decisions may not be based on economic rationale. He suggested that technology providers must have a clearer understanding of the impact of the technology on not only farm production but also on economic, marketing, and lifestyle factors. If a clear picture of these factors was not established, he suggested, there would be a failure to understand why certain innovations are taken up and others are not.

Software developers must have an understanding of how farmers are making their decisions and what information is important to them in order to make these decisions. Husband and wife teams manage many farms jointly. The women tend to be more involved in the collecting and recording of information and yet it is often the husbands who make many of the management decisions. They often make their decisions without consulting with their wives despite the women's good feel for the state of the business gained from regularly doing the books (Daniels & Woods, 1997).

The context into which an innovation is introduced impacts on adoption levels of that innovation. This is represented as link L4c, in the conceptual framework. As well, the context should influence the nature of the innovation, L4b, and the manner in which the innovation is developed, L4a.

2.4.4 Summary of issues

It can be seen that diffusion theory allows an understanding to emerge of why technologies fail to be adopted. In particular, drawing from the available literature, links L2, L3a, L4a, L4b and L4c from the conceptual framework have been discussed.

Link L2 highlights the relationship between the perceived characteristics of an innovation and the adoption outcome. Link L3a examines the impact of communication on adoption. Links L4a, L4b and L4c are the links associated with the context in which an innovation is introduced. That is, these links represent the impact that the social system, the user characteristics, and the level of computer ownership could have on user involvement in software development and also on uptake of a software innovation. Link L4b is the two-way relationship between the context into which the system is introduced and the type of innovation that is being introduced. It suggests that when systems with certain characteristics are introduced into the social system they influence factors within that social system. That is, if systems are developed that farmers find easy to use then this will influence farmers' use of these types of systems and this in turn will change the user characteristics. However, the direction of the arrow is bi-directional indicating that the social context, user characteristics, and computer ownership should influence the type of systems that are developed.

The conceptual framework proposes that social context, user characteristics, and computer ownership should be taken into consideration when designing software. Because of the nature of the technology under consideration and the social system into which it is being introduced, communication and interaction between developers and/or researchers and the end-users appears to be important to ensure that developers produce a product that meets the needs of users and also to ensure that users are aware of the technology.

As indicated earlier, diffusion theory suggests, amongst other factors, that the characteristics of an innovation will affect adoption of that innovation. The idea that characteristics of the innovation will affect adoption has been explored and expanded upon in the information systems literature. Moore and Benbasat (1991) developed an instrument to measure the various perceptions that an individual may have in regard to adopting an information technology innovation. The perceptions used in the instrument were mainly drawn from Rogers' five characteristics of innovations. There has been interest by information systems researchers in two characteristics in particular - perceived usefulness and perceived ease of use. These two constructs arose from Davis' technology acceptance model (TAM) (1989) and are closely related to Rogers' perceived relative advantage and perceived complexity. TAM examines the relationship between perceived usefulness and perceived ease of use and the impact they have on system usage. This relationship is represented by link L2 in the conceptual framework.

The following section looks firstly at TAM and the constructs perceived usefulness and perceived ease of use. The implications surrounding the importance of these two constructs on system usage are discussed.

2.5 Technology acceptance model

The issue of understanding why some systems are successful and others fail has been the focus of much information systems research (Davis *et al.*, 1989; Lyytinen, 1999). Davis *et al*. point out that previous studies in the area of systems adoption looked at many issues. Amongst these issues were: the impact of users' internal beliefs and attitudes on system usage, what factors influenced these internal beliefs and attitudes, the impact of system design characteristics on usage, the impact of user involvement on system usage, and the role of differing development methods. Many of these studies produced mixed findings. TAM was developed specifically to explain computer usage behaviour – that is, why users adopt some systems but fail to adopt others.

> Practitioners and researchers require a better understanding of why people resist using computers in order to devise practical methods for evaluating systems, predicting how users will respond to them, and improving user acceptance by altering the nature of systems and the processes by which they are implemented (Davis *et al.*, 1989, p.982).

TAM was formulated to 'provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions' (Davis *et al.*, 1989, p.985) using a small number of fundamental variables suggested by previous research. TAM (Davis *et al.*, 1989) was adapted from the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980). Both models were developed to explain and predict behaviour. The revised TAM (Davis, 1993, p.476) (Figure 2-2) proposes that system usage is determined by the attitude that an individual has towards using the innovation. This attitude towards the innovation is influenced by the perceived usefulness and perceived ease of use of the innovation.

Perceived ease of use is proposed to have a causal effect on perceived usefulness. System design characteristics influence the formation of perceptions about the software. Factor analysis by Davis (1989) indicates that perceived usefulness and perceived ease of use are statistically distinct constructs.

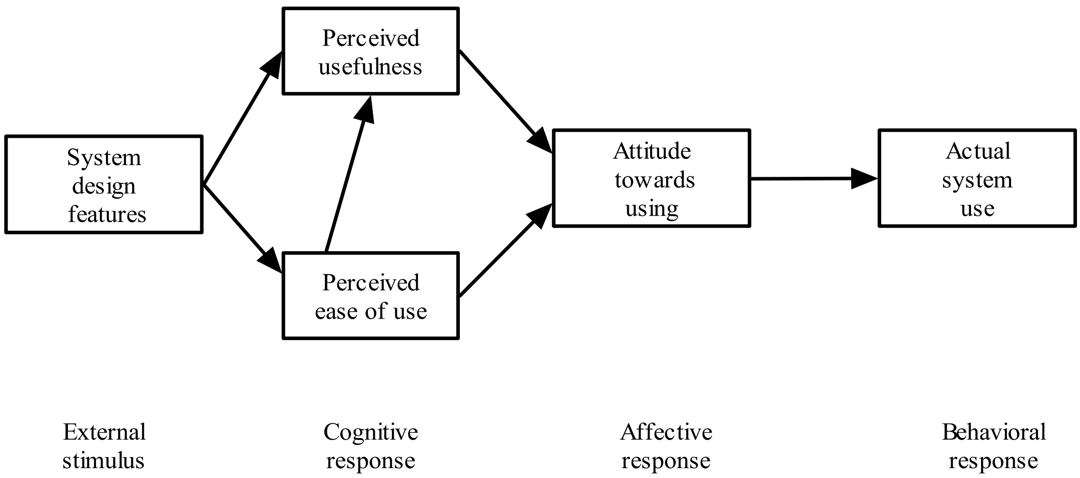

Figure 2-2 Technology acceptance model – revised version
(Davis, 1993, p.476)

2.5.1 Perceived usefulness and perceived ease of use

Perceived usefulness can be viewed as 'the degree to which an individual believes that using a particular system would enhance his or her job performance' (Davis, 1993, p.477). That is, it would take less time to perform a certain task or the output would be of a higher quality. This construct is very similar to the concept of Rogers' perceived relative advantage (Moore & Benbasat, 1991).

Perceived ease of use can be viewed as 'the degree to which an individual believes that using a particular system would be free of physical and mental effort' (Davis, 1993, p.477). This construct is viewed as the opposite or inverse of Rogers' characteristic of perceived complexity. That is, an innovation that is perceived as complex is not likely to be perceived as easy to use.

Using an instrument (Davis, 1989) that he had developed and tested to measure the constructs of perceived usefulness and perceived ease of use, Davis (1993, p.484) found that perceived usefulness of an innovation was 50% more influential than ease of use in determining usage:

> Many designers believe that the key barrier to user acceptance is the lack of user friendliness of current systems, and that adding user interfaces that increase usability is the key to success. Yet the present results indicate that, although ease of use is clearly important, the usefulness of the system is even more important and should not be overlooked (Davis, 1993, p.484).

And,

> .. the prominence of perceived usefulness makes sense conceptually: users are driven to adopt an application primarily because of the functions it performs for them, and secondarily for how easy or hard it is to get the system to perform those functions. No amount of ease of use can compensate for a system that does not perform a useful function (Davis, 1993, p.333).

The constructs of perceived usefulness and perceived ease of use and TAM have been further investigated by a number of researchers (Adams *et al.*, 1992; Agarwal & Prasad, 1998b, 1999; Igbaria *et al.*, 1997; Karahanna & Straub, 1999; Keil *et al.*, 1995; Szajna, 1994, 1996; Taylor & Todd, 1995a; Taylor & Todd, 1995b; Xia & Lee, 2000).

The importance of the relationship between the two constructs, perceived usefulness and ease of use, and system usage has been confirmed (Adams *et al.*, 1992; Agarwal & Prasad, 1999; Karahanna & Straub, 1999; Keil *et al.*, 1995; Szajna, 1994, 1996). The exact nature of each relationship and the importance each construct plays in system usage varies between different studies. There has also been discussion concerning the factors that influence the development of the perceptions of the usefulness and ease of use of software (Agarwal & Prasad, 1998a, 1999; Karahanna & Straub, 1999; Xia & Lee, 2000). That is, how do the potential adopters of software form their perceptions about the usefulness and ease of use of the software and what factors influence these perceptions? Adams *et al.* (1992) and Agarwal and Prasad (1998b) proposed that there appeared to be moderating influences on the relationship between perceptions and adoption decisions. Adams *et al.* (1992) found that there was not a simple relationship between ease of use and usage and suggested that there may be other factors that influence usage - such as a user's experience.

In a series of studies, Agarwal and Prasad (1998a; 1998b; 1999) investigated factors that could influence how perceptions of usefulness and ease of use are formed. Factors that they investigated were personnel innovativeness, communication channels through which awareness of an innovation is obtained, and individual difference factors, including level of education, prior or similar experiences, and involvement in training. They also looked at personal innovativeness in terms of the effect it has on moderating the relationship between the perceptions of an innovation and the decision to adopt.

Their studies confirmed the importance of usefulness and ease of use in determining system usage. They put forward the argument that individuals may hold identical beliefs about an innovation but make different decisions about adopting that innovation depending on their individual differences, such as personal innovativeness (Agarwal & Prasad, 1998a). They found that personal innovativeness had a significant moderating effect on the relationship between perceptions of compatibility and usage intentions. It did not, however, have a moderating effect on perceptions of usefulness and ease of use and the usage intentions. That is, if a system is perceived as useful and easy to use, the personal innovativeness of the users will not impact on usage intentions. In relation to communication channels, they found that personal channels were less effective than mass media channels for enhancing awareness of an innovation. However, in general, personal channels are more important in influencing perceptions. Involvement in prior training influenced perceptions of usefulness. Perceptions of ease of use were influenced by an individual's role in relation to the technology, their level of education, and any prior or similar experiences.

There has been criticism of research in this area as many of the studies on TAM have focused on the determinants of intention to use an information system and have not validated their models in respect to prediction of actual behaviour (Rawstorne *et al.*, 2000). That is, few studies have looked at adoption decisions over time to determine if intention to adopt is a good predictor of the actual adoption decision. An underlying assumption of TAM is that given sufficient time and knowledge about a given technology or activity, 'an individual's stated preference to perform the activity (usually declared in the form of an intention) will, in fact, closely resemble the way they do behave' (Rawstorne *et al.*, 2000, p.35). Nonetheless, in his longitudinal study within a hospital setting, Rawstorne did find that TAM did predict some behaviour, but not all, and that intention to use did predict actual use.

Much of the more recent research in the area of TAM has been investigating factors that could influence how perceptions of usefulness and ease of use are formed in the belief that if an individual forms a perception that a particular software is useful or easy to use then this will lead to adoption of that software. A study by Xia and Lee (2000) looked at the importance of persuasion, amongst other factors, on influencing perceptions and attitudes in relation to the intention to adopt. However, the author of this thesis would argue that if the software was not truly useful and easy to use then once the user began to use the software on a regular basis they would experience dissonance if their experience in using the software was different to what they were persuaded to believe.

In their study of information technology adoption across time Karahanna, Straub, and Chervany (1999) found that pre-adoption attitude is based on perceptions of usefulness, ease of use, result demonstrability, visibility, and trialability. Post-adoption attitude, however, is only based on instrumentality beliefs of usefulness and perceptions of image enhancements. This study highlights the importance of usefulness in terms of initial adoption and long-term use.

Despite the criticisms of some studies investigating aspects of TAM, the importance of the relationship between perceived usefulness and perceived ease of use and intention to use a software application is well established. Whilst researchers have suggested adaptations to TAM, throughout all the studies the relationship between perceived usefulness and perceived ease of use and intention to use a system has not been disputed. The TAM proposed by Davis *et al*. (1989) allowed the importance of the perceived usefulness and perceived ease of use on system usage to be clearly demonstrated. However, of interest to software developers is the issue of how to ensure that the systems they developed are useful and easy to use. TAM does not address this issue. In fact, this author is of the opinion that while investigation of factors that could influence how perceptions of usefulness and ease of use are formed is interesting, of greater importance is developing software that is truly useful and easy to use.

The focus of this current research is, therefore, neither on the statistical significance of each of the constructs upon the other, nor on exactly how the perceptions are formed. Rather, given the importance of usefulness and ease of use in predicting intentions of system usage, the focus of this study is investigating if user involvement in software development leads to systems that are useful and easy to use. That is, systems that are developed with user involvement should better meet the needs of users. The conceptual framework around which this study is built proposes that the manner in which systems are developed impacts on the usefulness and ease of use of the software. Before looking at general issues surrounding the development of software, the importance of usefulness in software applications is illustrated in two separate studies undertaken by Keil *et al.* (1995) and Agarwal and Prasad (1998b) on an expert system application.

2.5.2 The adoption of an expert system - a focus on usefulness and ease of use

Two separate research studies were independently undertaken on the impact of perceived usefulness and perceived ease of use of a particular software system identified in one study as CONFIG (Keil *et al.*, 1995) and in the other study as CONFIGURATOR (Agarwal & Prasad, 1998b). Because the software system was an expert system application the outcomes of the two studies are of particular interest to this current study.

Keil *et al.* (1995) raise the interesting issue as to why systems that have been developed with a strong emphasis on ease of use are still perceived by users as cumbersome to use. Using a field study approach they looked at the issues surrounding the expert system, CONFIG. The system was designed to assist the company's sales representatives configure the various computer hardware and software that they sold. However, only 25 percent of staff were using the system. The developers of CONFIG were certain that the one of the main reasons that more users were not using the system was because it was difficult to use. With this in mind, the developers set out to improve CONFIG and make it more user friendly. The developers spent considerable time and effort in changing the user interface without changing the functions that the software performed.

This change to the user interface, without any changes to the functionality of the system, provided a good opportunity to gather data on usefulness and ease of use of the software before and after the changes were implemented. Using the usefulness and ease of use measures developed by Davis (1989) and refined by Moore and Benbasat (1991) they studied users' reactions to the new interface.

Despite the efforts expended by the developers, there was no significant change in users' perceptions of the ease of use of the new version of the software. What did emerge was the fact that users had rated CONFIG relatively low in usefulness and ease of use prior to the changes. It appears that making changes to the interface and not to the functionality of the system was not the correct tactic. In effect, the developers had turned a not very useful, not very easy to use system into a not very useful, easier to use system. The developers had placed too much emphasis on ease of use and overlooked usefulness. Keil *et al.* (1995) suggest that the aim for developers should be to develop software that rates high in ease of use and high in usefulness.

Why did the users of CONFIG perceive the software as not useful? The researchers gathered information through interviews and observations to help them answer this question. It became apparent that the developers of CONFIG had a misunderstanding of the processes that a sales person used when configuring systems. The sales process was more complex than the developers' model. The software system that was developed did not match the task – it matched the developers' perception of the task. Users did not perceive the newer version of CONFIG as easy to use, despite the improved user interface, because it did not help them do their tasks any more effectively than the older version of CONFIG.

From their study, Keil *et al.* (1995) suggest that designing for ease of use 'must begin with some type of task analysis that goes beyond the typical considerations of ergonomics and user interface' (p.88). They suggested that the qualitative data collected in their study offered some “weak signals” for the hypothesis that perceived ease of use is influenced by task/tool fit. That is, users’ perception of how easy a software system is to use is not only influenced by interface issues but also by how easy it is to perform the tasks that they wish to do.

The paper by Agarwal and Prasad (1998a, p.26) was written after the Keil *et al.* paper (1995) but makes no reference to this previous work. While the two research groups have given different names to their systems it would seem that the papers are discussing the same software system.

The research approach taken by Agarwal and Prasad is different to that of Keil *et al.* They made the following, apparently incorrect, assumption:

> .. not only does the innovation possess some intrinsic, positive value for potential adopters, but the implementors *also* believe in the existence of this positive value (Agarwal & Prasad, 1998a, p.20).

The authors justify this underlying assumption in that it is consistent with prior research in innovation. This pro-innovation approach has been discussed earlier. Given the work by Keil *et al.* (1995) it would appear that the implementors’ belief in the existence of positive values for the users was false. The innovation in its current form did **not** truly possess ‘some intrinsic, positive value for the potential adopters’. The system was not truly useful to the user. In relation to some aspects of their unexpected findings the authors commented that despite the fact that user friendliness and ease of use was an extremely important design requirement for the system the mean value for ease of use was towards the mid-point of the scale.

Despite their different approach to this study to that of Keil *et al.* they do suggest that:

> … our results underscore the crucial importance of the early stages of the systems development life cycle for less innovative individuals. It is critical that their work patterns and flows be thoroughly understood during the systems analysis stage so that systems may be designed to be compatible with preferred work flows. Hence, a socio-technical approach to systems design might be needed so that systems fit in with preferred workflows and behaviour patterns (Agarwal & Prasad, 1998a, p.26).

The importance of usefulness of software to users is clearly shown in the study of Keil *et al.* (1995). The study is of particular interest to this current study as it examines usefulness and ease of use in an expert system application.

Few studies examining intelligent support systems in agriculture and the relationships between usefulness and ease of use and system outcomes could be found. Glyde and Vanclay (1996) examined the development of the DSS, *AusVit*. The researchers concluded that it was not likely that *AusVit* would be widely adopted - not because farmers were not likely to be owners or users of computers - but because they were unlikely to be convinced that a DSS would provide information that they ought to consider above that of their own experiences (Glyde & Vanclay, 1996). Also, the management style of the farmers did not match the input requirements of the computer system. That is, farmers did not typically observe their crops at the level required in the software. It would seem then that the system was not meeting the needs of farmers – it was not truly useful to them.

Section 2.5 looked at TAM and the importance of the two constructs - perceived usefulness and perceived ease of use in predicting software usage. This is represented in the conceptual framework through link L2. From the work of Davis (1993) and Keil *et al.* (1995) it is clear that one important factor affecting the adoption of an innovation is its usefulness or relative advantage - that is, to be adopted a software system should meet some need of the potential users. While a focus on the needs of potential users is something that one would expect when software is developed, it appears that this is not always the case.

The following section looks at software development methods and the issue of involving users in the development process. This is represented in the framework through links L1 and L3b.

2.6 Information systems development methods

A recent OASIG (Organisational Aspects Special Interest Group) (1996) study in the United Kingdom found that around 40% of information technology systems developments failed or were abandoned. The problems appeared to lie, not with the technology, but rather with the lack of attention paid to the needs of people who used the technology. The systems failed, the report indicated, because, amongst other reasons, most investments were technology led and users did not usually have any major influence on system development.

The outcome for expert systems is even more disappointing. In his study investigating the fate of commercial expert systems built during the early and mid-1980s, Gill (1995) found that most of the systems had fallen into disuse or were abandoned. Only about a third of the systems were successful. Technical issues were not the reason for the poor adoption and short-lived use of systems. Rather lack of system acceptance by users, inability to keep developers, maintenance issues, and changes in organisational priorities were the most significant factors affecting long-term expert system adoption and use. Some systems were abandoned because they were not consistent with the organisation's goals. That is, they did not meet the needs of the organisation.

Software development methodologies have been developed to assist software developers build systems that meet their clients' needs. These methodologies are generally formalised procedures or protocols to guide development. It appears that there may be problems with software development methodologies considering so many systems fail. It has been suggested (Fitzgerald, 1998; Grudin, 1991; Russo & Stolterman, 1998) that many developers currently do not even follow software development methodologies when developing software systems.

Grudin (1991) raised the concern that many of the software development methodologies currently available were developed before interactive end user applications became important. Because of this they do not provide for an early and continual focus on users - quite the contrary. He suggested that the traditional structured analysis approach actually relegates the task of establishing a 'man-machine interface' to one sub-phase of system development. Not only are users not consulted but also 'The designers of countless failed products anticipated user populations that did not materialize' (Grudin, 1991, p.60). Intuition, he added, has become a less reliable guide to development. While contact with system users is required he also acknowledged that determining how direct or extensive this contact need be and actually achieving it has been surprisingly difficult. However, for today's interactive systems developer, the reliance on specification documents imposes a 'wall' between users and developers that may impede user-based iterative design. Furthermore, developers who are isolated in large engineering laboratories may neither empathise nor sympathise with users who are inexperienced, non-technical, or have different values and work styles. This view is in line with the work of Edstom (1977) who found that the more structured a task environment the harder it was for users to exert an influence over system design. Ineffective communication showed a significant negative association with success.

In his study determining the extent that developers currently use software development methodologies, Fitzgerald (1998) found that 60 percent of the respondents were not using a methodology. He commented that the general view was that methodologies are cumbersome and consume time and resources that were not always available. Like Grudin, he suggested that many current methodologies are derived from practices and concepts relevant to older organisational environments and there is a need to reconsider their role in today's environment. There is a need for more rapid system delivery than that which is currently being achieved.

Arguing along similar lines, Russo and Stolterman (1998) suggested that there is currently a 'misfit' between existing methodologies and the needs of developers. They believed that this is due to the changing nature of the types of systems developed. In the past, systems were more technical and were developed for a few specially trained users. Systems are now more user-focused and are developed for users who may have limited computer skills. The OASIG (1996) study also reported that the structured methods and tools appeared not to work, as they were too technically oriented. Many of the more conventional methodologies only allow for a relatively small degree of user involvement and pay little attention to social aspects (Hirschheim, 1985).

The older, more technological focused, development methods do not appear to be suitable for the current development environment. Many of the older, more established methodologies have a *developer-focus*. This approach assumes that a new product, either technical or non technical, will automatically replace inferior products or systems (Surry & Farquhar, 1997). Developers assume potential adopters will see the benefits just as they see them. The developer-based theories assume that there is no need to adapt the technology to the requirements of the people – rather everyone will adapt to the requirements of the technology. Davis *et al.* (1992) determined that this type of attitude, in part, lead to the failure of an un-demanding and elementary information system.

In contrast to the developer-focused approach, the *adopter-focused* approach focuses on the human, social, and interpersonal aspects of innovation diffusion (Surry & Farquhar, 1997). Developers are interested in the individual who will ultimately implement the innovation in a practical setting as the primary force for change. The adopter-based theories reject the assumption that superior products will automatically be attractive to potential adopters. They 'seek to understand the social context in which the innovation will be used and the social function the innovation will serve' (Surry & Farquhar, 1997, p.7). The adopter-focused approach emphasises the importance of user involvement in the design and development process. This approach changes the scope of the design from involving only technical matters to involving technical and social considerations (Hirschheim, 1985).

The call for a more participatory approach in software development is not new. As early as 1979 Mumford (1979) called for more user involvement in system design. However, it appears that developers of information systems applications have not taken this call seriously (OASIG, 1996) despite the fact that there are currently several development methodologies in the information systems field that have a participatory, adopter-focused approach. These adopter-focused methods aim to better capture the needs of the users and the role that the software will play in management decision-making.

Avison and Fitzgerald (1997) and Hirschheim *et al.* (1995) discuss aspects of these newer approaches. Amongst these are: Mumford's Effective Technical and Human Implementation of Computer-based Systems (ETHICS) (Mumford, 1996), Checkland's Soft Systems Methodology (SSM) (Checkland, 1981; Checkland & Scholes, 1990), and the Multiview approach (Avison & Wood-Harper, 1990) which is influenced by aspects of SSM, ETHICS and more traditional development methodologies. In his discussion on information systems failure rates, Lyytinen (1988) suggests the Soft Systems Methodology approach as being better able to 'tackle IS [Information Systems] failures' (p.74). Jackson's Critical Systems Thinking (CST) approach (Jackson, 1997) also focuses on the needs of the user. Checkland's Soft Systems Methodology acknowledges that problems are often not well defined and builds this fuzziness about the problem into the methodology. It takes into account the interaction between the social system and the technical system. The importance of involving users in system design and development is also discussed in the human computer interaction literature where a user-centred design approach is recommended.

A user-centred design aims to ensure that the system design focuses on people, their work, and their environment, and how the technology can best be used to support people (Preece *et al.*, 1994). One way of achieving a more user-centred design is through the use of prototyping. Prototyping allows a more rapid, iterative design process to occur. User-centred design is an adopter-focused approach to software development. Gould (1995) put forward the following four principles to help in the design of good systems: (1) early and continual focus on users, (2) early and continual user testing, (3) iterative design, and (4) integrated design. The job of the system designer is seen as designing a system that has the right functions so that people can do their work better. As part of this process Gould suggests ‘a first step in designing a system is to decide (a) who the users will be and (b) what they will be doing with the system’ (Gould, 1995, p.97).

The use of more participatory approaches in the development of DSS has been advocated by a number of researchers (Alavi & Napier, 1984; Koh & Heng, 1996; Kumari & Linecar, 1995; Yau & Sattar, 1994; Zhu & Dale, 2000). Kumari and Linecar (1995) proposed that by using a Soft Systems Methodology approach, knowledge acquisition would be thorough and would result in DSS that are more likely to be useful and usable by the decision maker. However, the author of this thesis suggests that while a system may have represented the knowledge correctly it may still not meet the needs of users.

Alavi and Napier (1984), whilst arguing for a more adaptive approach to decision support development, acknowledged that the high level of user involvement might not be applicable to situations in which the user is either unwilling or unable to participate in the design process. Koh and Heng (1996) suggest that users should not just be consulted in the design process, but rather they should be partners in the process. However, they also concede that there is the problem of users not understanding what is happening in the design process. It should also be noted that their use of the consultative development method did not appear to result in good user acceptance of the system. It appears that, despite their best intentions, they proceeded to build a system that the users did not want.

While the above discussion has argued that users should be involved in software development there is contradictory evidence concerning user involvement and system outcomes (Ives & Olson, 1984).

2.6.1 User involvement and system outcomes

Ives and Olson (1984) in their review of the impact of user involvement on information system success concluded that the benefits of user involvement had not been strongly demonstrated. Their study failed to find any strong evidence of a link between system success and user involvement. Of the 22 studies examined, eight (36%) claimed to demonstrate a positive relationship between user involvement and various measures of system success, seven others presented mixed results, and the results from the remaining seven studies were either negative or not significant.

This lack of clear evidence is due partly, they argued, to poor research design and data collection. Also, they suggested there was a need for the development of a validated standard measure for user involvement and information satisfaction. They suggested that the presence of intervening variables between user involvement and system outcome required further investigation.

They proposed the following descriptive model of user involvement in computer based information systems (Figure 2-3). The model is framed in terms of development of an application within an organisation with two classes of conditional variables affecting the appropriateness of user involvement. The first class represents the roles of the participants while the second class represents characteristics of the development process.

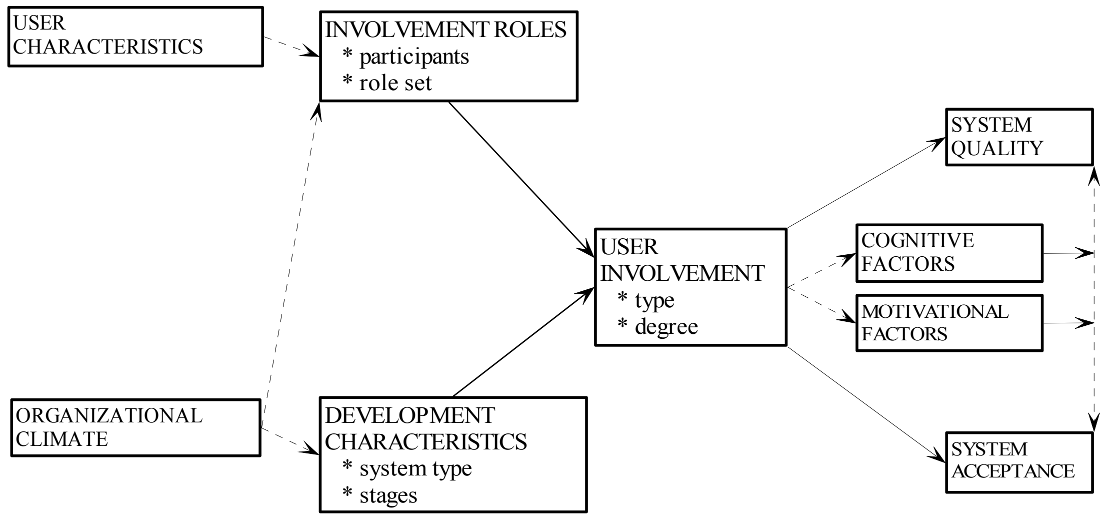

Figure 2-3 A descriptive model of user involvement
(Ives & Olson, 1984, p.588)

Involvement roles is concerned with who the participants should be and the role that these participants should take. Users that could be involved are primary users, managers, and secondary users. A secondary user would be someone who does not interact with the system directly but who is influenced by or influences the outputs or inputs to the system. Role set is concerned with selecting individuals to be involved and their predisposition to wanting to be involved. This may be influenced by incentives for being involved.

Development characteristics is concerned with the type of system being developed and the different stages of the development process. The stage in the development process refers to the fact that user involvement is more crucial at different stages in the development process.

In terms of system types, Ives and Olson (1984) argued that user involvement is more critical for certain types of systems than for others. In fact, they suggest that in some instances user involvement is inappropriate – for example, systems that require considerable technical expertise or systems that are unimportant to users. They go on to suggest that:

> User participation is advocated when acceptance is critical or when information required to design the system can only be obtained from users. Decision support systems (DSS), for example, require participation both because the system designer cannot produce an effective DSS without knowledge provided by the user, and because acceptance is critical due to the voluntary nature of DSS use (Ives & Olson, 1984, p.589).

The type of involvement can vary from direct, where all parties that will be affected by the system are involved, to indirect, where representatives serve on decision-making committees. Drawing from Mumford's (1979) work they list three types of involvement, from least to most direct:

- consultative – design decisions made by systems group but influenced by needs of users
- representative – all levels and functions of affected user groups are represented
- consensus – involvement of all users.

Examples of six different categories of involvement in increasing degrees of involvement are also provided:

- no involvement - unwilling or not invited to participate
- symbolic involvement - user input is requested but ignored
- involvement by advice - solicited through interviews
- involvement by weak control - sign off responsibilities
- involvement by doing - design team member
- involvement by strong control - user pays directly or user's organisational performance is dependent on the outcome.

As a result of their study on user involvement and system success Ives and Olson (1984) suggested that researchers, when looking at user involvement and information system success, should look at the 'characteristics of the involvement process itself such as the degree and type of interaction' (p.601).

In terms of system success, they found that determining how to measure system success varied in the many studies they examined. Several studies focused on system quality as an outcome variable, some studies looked at decision-making performance, while other studies considered changes in user behaviour or attitudes. System acceptance was more frequently measured and the most commonly used indicator of system acceptance was system usage.

The issue of system success is further complicated by the fact that different users can view the same system differently. According to the model proposed by Ives and Olson (1984), how a user views the quality of a system and the degree of acceptance of the system is influenced by cognitive and motivational factors. The cognitive factors that influence users perception of a system are: an improved understanding of the system, improved assessment of system needs, and improved evaluation of system features. Motivational factors include increased perceived ownership of the system by the user, decreasing resistance to change, and increasing commitment to the new system.

As a result of the findings of Ives and Olson (1984) there has been considerable discussion and investigation on the relationship between user involvement and system success (Barki & Hartwick, 1991, 1994; Baroudi *et al.*, 1986; Cavaye, 1995; Doll & Torkzadeh, 1989; Hartwick & Barki, 1994; Hunton & Beeler, 1997; Hwang & Thorn, 1999; Lin & Shao, 2000; Lu & Wang, 1997; McKeen & Guimaraes, 1997;

McKeen *et al.*, 1994; Robey *et al.*, 1989; Saleem, 1996). A brief discussion of findings relevant to this study follows.

Cavaye (1995) reviewed a further 19 empirical studies undertaken between 1982 and 1992. Only 7 (37%) of these studies found a positive relationship between user involvement and system success. The findings were similar to the review undertaken by Ives and Olson (1984) in that the findings were mixed and inconclusive. The percentage of findings indicating a positive relationship (37%) was remarkably similar to the results of Ives and Olson (1984) (36%).

A mail survey of 200 production managers (Baroudi *et al.*, 1986) found that user involvement lead to both enhanced user satisfaction and subsequent system usage. That is, the greater the user involvement the greater the system usage. The authors commented on the fact that a limitation of their study was that perceptual rather than objective measures of user involvement were collected. The measure of user involvement did not clearly differentiate the degree of actual user influence in the design process.

In a series of studies Barki and Hartwick (Barki & Hartwick, 1991, 1994; Hartwick & Barki, 1994) looked at the difference between user participation and user involvement. They defined participation as activities performed by users, while involvement was defined as the importance and personal relevance of the system to the user. Their research indicated that these two variables are different constructs. The authors suggested that the unclear results of the relationship between user participation and system success may be due to the fact that these terms are not measuring the same type of participation and in fact user participation impacts or influences user involvement. Their research indicated that user involvement, and not user participation, was strongly related to system usage (Barki & Hartwick, 1991).

In an attempt to explain the conflicting results regarding user participation and system success, McKeen, Guimaraes, and Wetherbe (1994) looked at the effect of four contingency factors on the relationship between user participation and user satisfaction. The four contingency factors they investigated were: task complexity, system complexity, user influence, and user developer communication. They gathered data on 151 independent system development projects in eight different organisations. Data were collected from two sources: the project leader in charge of development and the primary end user(s) of each system.

They found that user participation had a direct effect on user satisfaction and that this relationship was stronger when level of task complexity and system complexity was high. Their results indicated situations where user participation is most needed. In well-structured tasks where uncertainty and ambiguity are low, it may be preferable to have users participate minimally. Complex tasks, however, present situations where active user participation is essential and this participation leads to user satisfaction. They found that system complexity operated in a similar way to task complexity in that user involvement was more important when developing complex systems.

There are some situations when user involvement can be counterproductive (McKeen & Guimaraes, 1997). The authors cite an example where users behaved in a dysfunctional manner because of prior involvement in another system development and implementation process where their involvement was token and they had no influence in system design features. Furthermore, in the 151 projects investigated, users were involved in project definition in only 25 percent of the projects. That is, for 75% of the projects investigated, project definitions were completed without input from users. This suggests that for most systems, users were not involved in the conceptual aspect of project development. Research by Franz and Robey (1986) support the importance of involving users in the early stages of system development. Their study found that not only was there a significant relationship between user involvement and perceived usefulness but the relationship was stronger for the design phase than for the implementation phase.

In an attempt to bring together the many different studies in user involvement and system success, Hwang and Thorn (1999) conducted a meta-analysis of data from 25 studies. The results indicated that user involvement had a moderate positive correlation with four of the six success measures of DeLone and McLean (1992). The four measures were: system quality, use, user satisfaction, and organisational impact. User involvement correlated more strongly with system success than did user participation. The relationship appeared to be moderated by other variables such as system type and the stage of system development where users were involved. Of the six success measures (DeLone & McLean, 1992), user satisfaction was the most popular choice in measuring system success.

More recently, a survey of 154 organisations undertaken by Lin (2000) confirmed the positive contribution of user participation to successful system. The authors viewed user participation as a social process of interaction between users and designers through which both parties could learn about each other's expectations and requirements, and hence resolve their conflicts. This is similar to the communication process incorporated in the conceptual framework proposed in this current study.

The literature provides several explanations as to why involving users in the development process leads to increased acceptance of the system. Drawing from relevant studies, Ives and Olson (1984) listed the following explanations for why user involvement would lead to greater system acceptance: provide a more accurate assessment of information requirements, provide expertise about the organisation to the development team, avoid development of unacceptable or unimportant features, and improve user understanding of the system. Also drawing from relevant studies, Lin and Shao (2000) list, in addition to those listed by Ives and Olson, the following reasons: users have a more realistic expectation of the system, an opportunity for users and designers to resolve conflicts about design issues, increased ownership amongst users, decrease in resistance to possible change, and greater commitment from users.

While many studies have looked at user involvement and system outcome, there appear to be few studies that have looked specifically at the link between user involvement and the system characteristics of perceived usefulness and perceived ease of use. An exception is Franz and Robey's study (1986) in which they investigated organisational factors related to user involvement in information system development and perceived system usefulness. Their results showed that user involvement in design and implementation is related positively to users' perceptions of system usefulness. By involving users in the development process the systems that are developed may better meet the needs of users because they are useful.

The above discussion has been in terms of user involvement and system success for general software systems. The relationship between user involvement and system success for intelligent support systems, in particular, is now examined.

2.6.1.1 User involvement in intelligent support systems development

Several researchers have reported on a number of factors that appear to influence system success in relation to DSS (Alavi & Joachimsthaler, 1992; Barki & Huff, 1990; Liang, 1986; Mann & Watson, 1984) and expert systems development (Duchessi & O'Keefe, 1992; Finegan, 1993; Gill, 1995; Lewis *et al.*, 1998; Mak *et al.*, 1997; Rees, 1993; Will *et al.*, 1994; Yoon *et al.*, 1995).

Barki and Huff (1990) suggested that three factors – system flexibility, user participation in implementation, and user willingness to change – were found to have the strongest influence on both user satisfaction and system use.

In order to bring together the many studies on DSS implementation, a meta-analysis of the literature on DSS implementation issues was undertaken by Alavi and Joachimsthaler (1992). Their study examined the influence of four sets of user-related factors on DSS implementation success. These four factors were: cognitive style, personality, demographics, and user-situational variables. User-situational factors included training, experience, and user involvement. This analysis showed that user involvement, training, and user experience were the important variables in implementation success. They estimated that implementation success rate could be improved by up to 20 to 30 per cent through manipulation of these variables and that the strength of the relationships between user-situational variables and DSS implementation success highlighted the importance of user involvement and training in improving implementation success. They suggested that further studies were required that differentiated between the various degrees and types of user involvement.

Information collected from 69 project managers (Yoon *et al.*, 1995) found that expert system success is directly related to the quality of developers and the expert system shells used, end-user characteristics, and the degree of user involvement in expert system development.

Clearly, while many factors may influence intelligent support systems success, it is apparent from prior research that user involvement is an important factor - although the extent of the relationship between user involvement and system success varies between studies. This relationship is represented by links L1 and L3b in the conceptual framework.

Involving users in software development is not always easy and can present its own set of problems (Franz & Robey, 1984; Newman & Noble, 1990; Van Beek, 1995). Not all users are suited to the task of involvement (Van Beek, 1995). Often the ideas are too alien for the user to cope with, some users have too narrow an outlook, and there can be communication problems between developers and users. Good managers, clerks, salesmen, or farmers can make poor and unwilling systems analysts (Avison & Wood-Harper, 1991). The problem of involving users in the development of software was raised in the OASIG study (1996). The study identified limited understanding and skills on the part of users in relation to information technology problems. However, they concluded that while there was a cost of involving users, the cost of not involving them was greater.

In relation to involvement of farmers in research or software development activities, Gregor and Jones (1998) reported concerns from farmers that they believe they are being used as research tools for academics. They are tired of being surveyed and consulted when there is no clear evidence of any benefit to them for giving their time and information to the researcher.

In summary, user involvement is seen as a way of improving system success. By involving users in system development not only should the systems better meet the needs of users but users should have an improved understanding of the system and a greater sense of ownership and commitment towards the system. However, the exact nature of the relationship between user involvement and system outcome is unclear. The type of system that is being developed and degree of involvement, or influence, that users have during system development appear to affect the outcome of the system.

In terms of intelligent support systems targeted at the agriculture sector, few successful systems could be identified from the literature and thus there are limited data on which to make judgements concerning scenarios that are more likely to lead to successful outcomes. The following section discusses relevant studies that relate to this current study.

2.7 Relevant studies on intelligent support systems in agriculture

As early as 1989, Barrett *et al.* (1991) became concerned that farmers were not using the intelligent support software developed for them. They believed that there had been limited acceptance of such systems because of lack of understanding, by software developers, of the decision-making process of farmers, inadequate user involvement in their development, and improper problem definitions. Barrett *et al.* argued that there was a need to determine not only the critical success factors but also to define the logic used by expert farmers when they make decisions. The beneficiaries of intelligent support systems were, they suggested, primarily the scientists or the programmers.

A study by Hilhorst and Manders (1995) of the reasons behind the slow penetration of knowledge-based systems (KBS) at the farm level in the Netherlands identified the following causes:

- the very specific knowledge combined with the application target audience resulted in a relatively small market segment
- the intensive knowledge acquisition and testing resulted in high development costs of KBS; most systems were developed in a non-competitive environment
- pure commercial development would not be cost effective
- the low penetration of PCs at the farm level.

They suggested that there were pull and push factors at work. KBS development was more research driven and knowledge driven; many times it lacked a user pull. They cautioned that premature introduction of a research-type system may lead to very negative attitudes to KBS and information technology in general (Hilhorst & Manders, 1995). This concern is supported by Rogers (1995, p.227) who cautioned that 'a negative experience of one innovation can damn the adoption of future innovations'.

Problems with the development of these types of systems were outlined by Stapper (1992). He suggested that most of these products were developed on perceived needs and not as a result of market research. Moreover, he raised concerns over the development of applications in isolation from each other rather than through a coordinated approach. Individuals, he suggested, 'can receive internal or external funding to develop software applications with hardly any obligations to interact with others involved in similar programmes' (p.8). Cox (1996) also highlighted problems with the development of these types of systems. Few systems appear to be developed to satisfy a need articulated by farmers.

Wilde and Swatman (1997) believed that in the past many applications were developed because researchers were curious about certain farming problems. They reached this conclusion after tracking expert system software development in Australian agriculture. They suggested that decisions on funding were made more on whether the research would make a contribution to knowledge and less on whether the end product would be a commercial success or improve farming practice. They commented that the funding situation has recently changed and there is now a user pays attitude to the development of expert systems. They go on to argue that this new funding situation could limit the development of future applications of such systems and lead to a critical evaluation of the systems that are currently available and the effectiveness of those systems.

The development methodology of intelligent support systems in agriculture is rarely reported in the literature. In many cases the approach used in building a system is not explicitly mentioned in research reports. An exception is the system reported by Zhu and Dale (2000). They used a soft system methodology approach for identifying DSS opportunities for regional resource planning. This approach led to the development of a web-based DSS that ranges from information provision, knowledge-based support, and analytical modelling. The level of use of this facility is not known.

The ability to determine if a system is successful is confounded by the many dimensions to success. Expert systems, for example, are often evaluated as successful when they match the decisions made by recognised experts in the field.

The criteria for success is not whether the system is used or has aided farmers in their decision-making process. There have been few attempts to evaluate the success of expert systems in agriculture (Brown *et al.* 1990). For DSS, success is often measured in terms of the reliability of the underlying model.

Two reported instances where intelligent support systems have resulted in either improvement in economic returns or changing farming practices are GOSSYM/COMAX (Ladewig 1990; McKinion *et al.*1989) and the Penn State Apple Orchard Consultant (PSAOC) (Rajotte *et al.* 1992). GOSSYM/COMAX 'represents information of a team of 16 scientists, 17 years of research, 4 years of on-farm testing, and continual updating' (Ladewig 1990 p.1). The PSAOC development team involved 'experts from plant pathology, entomology, horticulture, agricultural engineering, agricultural meteorology, agricultural economics, and rural sociology' (Travis *et al.* 1992, p.545). The budget for support and maintenance only, to ensure adoption of the PSAOC Expert System, was $55,000 for the first year and $48,000 for the second year (McClure 1993). Neither of these systems appear to have used a participatory approach. The level of funding given to ensuring adoption for PSAOC and the extensive period of on farm testing for GOSSYM/COMAX may, but not definitely, have helped ensure the success of these two systems. The reasons for discussing these two systems is to highlight the fact that there are few reported examples of intelligent support systems changing farming practices or improving economic returns.

In relation to participatory development methods, researchers at the Agricultural Production Systems Research Unit (APSRU) located in Toowoomba, Queensland, have used a belated participatory approach to encourage farmers to interact with their highly complex decision support system APSIM (Agricultural Production Systems sIMulator) (McCown *et al.*, 1997; McCown *et al.*, 1996).

The APSIM system is a complex system that was never intended for direct use by farmers. The researchers were aware of the indifference that farmers had towards these types of systems (McCown *et al.*, 1997). To overcome this, the researchers used a 'co-operative learning' approach. Research staff met with farmer groups and allowed them to consider different farming scenarios, applicable to their farming situations, and then observe the output from the computer simulation and compare it to the output that they achieved in their farming situation in previous years. The researchers have taken this approach because they were aware of the limited acceptance of these systems by farmers and the complexity of their own system. The researchers admit that it is not generally feasible for researchers to be involved so intensively in providing a service using this approach. While the APSIM model was not developed using a participatory type approach, a participatory approach was taken when using the system with farmers. In this instance, involvement was used after the development of the system - not during the development of the system.

This researcher would argue that if the farmers had been involved earlier in the development of the APSIM product the software would have better met the needs of farmers and would have been easier for them to use.

2.8 Revisiting the conceptual framework

The conceptual framework (Figure 2-1) combines aspects of Rogers' diffusion theory (1995), the technology acceptance model (Davis, 1993; Davis *et al.*, 1989), and user involvement in information systems development (DeLone & McLean, 1992; Ives & Olson, 1984). For ease of reading the framework is presented again (Figure 2-4).

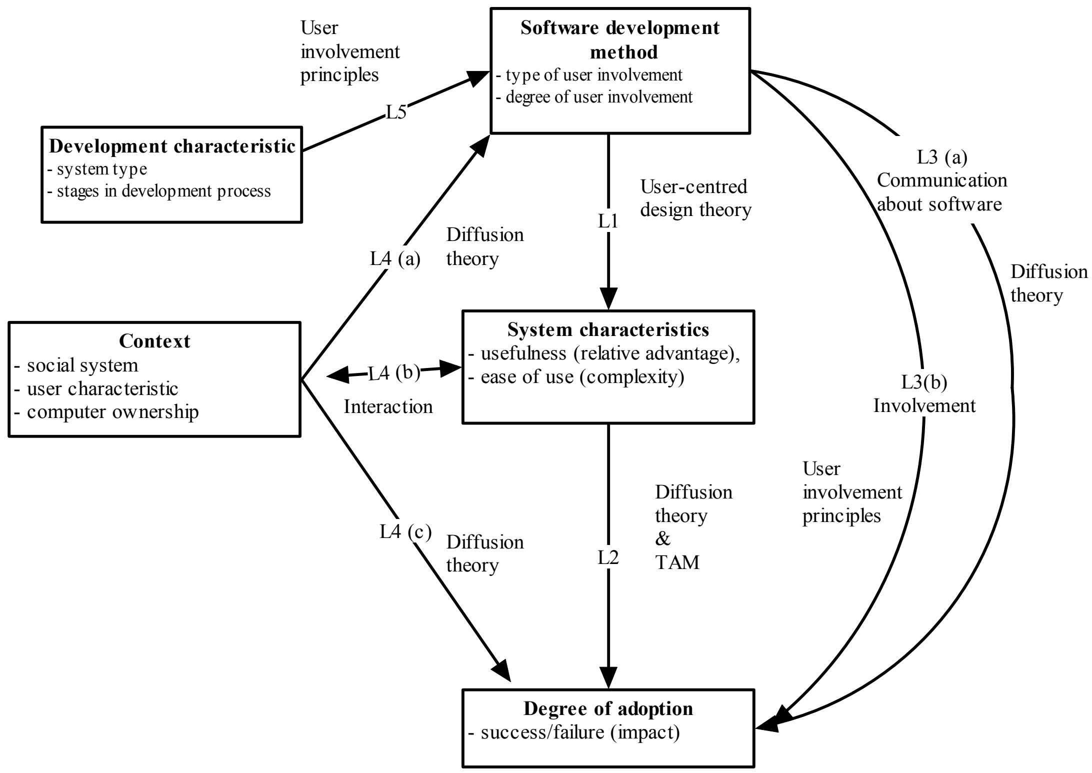

Figure 2-4 Context-involvement-outcome model

The framework proposes that the degree and type of user involvement will influence the usefulness and ease of use of the software (L1). This aspect of the framework is drawn from the information systems development literature in that there is some evidence that indicates that user involvement will lead to systems that better meet the needs of users. There are, however, few studies reporting on user involvement and the resulting impact on the specific system characteristics of usefulness and ease of use. The perceived usefulness and ease of use of the software influences the level of adoption (L2). This aspect of the framework comes from the technology acceptance model and Rogers' diffusion theory. Aspects of the software development methods, such as the communication processes (Link L3a) and user involvement (Link L3b) affect the degree of adoption directly. This aspect of the framework is based on

Rogers' diffusion theory and information systems development theory. Factors that affect the usefulness and ease of use of software are (1) the development methods used (L1) and (2) the context within which the system is developed (L4b). This aspect comes from information system development theories and Rogers' diffusion theory. The context in which the system is being developed will influence the degree and type of involvement (L4a). This aspect of the framework is from Rogers' diffusion theory and the work of Ives and Olson. The context in which the system is developed, for example, the level of computer ownership, skills of the users, and the level of experience will also impact on system adoption (L4c). The degree and type of user involvement may vary depending upon the type of system under development (L5). That is, if the system is a relatively straightforward system that either does not impact greatly on users, or is similar to other successful systems then the level of involvement required is less than that required for a more complex system. This aspect of the model is from the work of Ives and Olson (1984). It is proposed that user involvement is important in ensuring that systems developed are truly useful to users. However, as Ives and Olson indicated, the degree and type of user involvement required may not be the same for all types of systems (L5). This context-involvement-outcome framework is useful for understanding and exploring factors affecting adoption by individuals and adoption within organisations. The context may be a community of farmers or it may be a large multi-national organisation.

To sum up, the theory and prior work reviewed suggests that certain approaches to information systems development may lead to systems that better meet the needs of potential users. These approaches involve users - that is they are adopter-focused rather than developer-focused - and incorporate ideas from the 'softer' systems methodologies. From the technology acceptance model and diffusion theory, such systems are more likely to be adopted and be successful because of their perceived usefulness (relative advantage) and ease of use (non complexity). The involvement of users in the development process improves the communication about the software and so impacts on potential users view of the software. Different characteristics of the involvement process itself such as the degree and type of interaction are important factors to be considered when investigating user involvement in system success.

2.9 Research propositions

The theme of this current study is that for systems to be adopted they must be useful and easy to use. It is proposed that systems that are developed with user involvement are more likely to be useful and easy to use. The users' perspective (in this case, the farmers' perspective) can only be truly incorporated into the system by involving farmers very early in the development process. Systems developed without user involvement are more likely to be developed from the developers' perspective. Systems that are initiated from a researcher's or developer's perspective, with limited farmer involvement, are unlikely to be adopted by farmers. These systems are more likely to reflect the decision-making style of the researcher or developer and not meet the needs and decision-making requirements of the farmer. Researchers and developers structure their world in a way that helps them understand underlying mechanisms. This worldview is not necessarily compatible with the type of tools that could help farmers in their decision-making.

It follows that systems developed using an adopter-focused approach, through user involvement, would be more likely to be adopted than those developed using a developer-focused approach. Systems that are developed with user involvement would be more likely to be useful to the user. That is, the system would be fulfilling some need. As well, if users were involved in the development of the systems, then the systems would be expected to be easy for them to use. However, if users are involved in the process too late, after it has already been decided that the system will be developed, the system may not useful to the users. That is, if users are consulted only about the look and feel of the system and not about the nature or focus of the system then the system may be easy to use but not truly useful. Ives and Olson (1984, p.601) suggested that researchers, when looking at user involvement and information system success, should look at the 'characteristics of the involvement process itself such as the degree and type of interaction'.

The propositions for this study are:

Intelligent support systems that are developed with user involvement are more likely to meet the users' requirements (that is, they will be useful and easy to use). (Proposition relating to Link L1).

However, there appears to be different types of user involvement. As indicated earlier, if users are consulted only about the look and feel of the system and not about the nature or focus of the system then these systems may not be useful to users. Therefore:

The degree and type of user involvement will impact on the usefulness of the system and so will influence adoption. (Proposition relating to Link L1 and L2).

Intelligent support systems that are perceived as useful and easy to use are more likely to be adopted than systems perceived as not useful or easy to use. (Proposition relating to Link L2).

Following from the above:

Intelligent support systems that are developed with user involvement are more likely to be adopted. (Proposition relating to Link L3b).

It is anticipated, therefore, that user involvement in development of a system may not necessarily lead to system success. It would depend on the nature of the user involvement. Also, different types of systems may require different levels of user involvement. Therefore, it is anticipated that it is not possible to predict outcomes for a particular system without some understanding of the nature of the system that is developed and the nature of the user involvement.

2.10 Summary

Through reference to the literature, this chapter has developed a conceptual framework for understanding the adoption of intelligent support systems in agriculture. An integrated framework has been put forward that combines elements from Rogers' diffusion theory, the technology acceptance model, and theories relating to information systems development. Evidence concerning the adoption of intelligent systems in agriculture was presented in relation to aspects of each of these theories. This approach offers a potential explanation for the apparent low rate of adoption of these systems in agriculture. Few studies could be found that investigated success factors for intelligent support system outcomes in the agricultural industry.

From the literature, it is expected that participatory, adopter-based approaches will lead to more successful systems. While the call for a participatory approach in this area is not new, developers of agricultural intelligent support systems do not appear to have taken this issue seriously. This could be partly due to the fact that the researchers are keen to build a system regardless of whether the farmers indicate a real interest. For the farmers, it may be that they are not interested in the focus of the software product and so are reluctant to participate in its development.

An important aspect of the participatory, adopter-focused, approach is that it allows not only for user involvement in the interface design, but also in determination of the focus of the system that is developed. In fact, through the participatory approach it may be determined that farmers are not interested in using intelligent support systems and that their needs can be better served through the development of either a different type of software system or a non-computerised decision aid support tool. If development of a system can be justified, it is anticipated that a participatory approach is more likely to lead to a system that offers the farmer real advantage – that is, it is useful to the farmer - and thus is more likely to be adopted and used.

An aim of intelligent support systems in agriculture is to assist farmers in their decision-making. Is should be noted that even if these types of systems are developed using a participatory approach it will not guarantee that farmers will make 'better' decisions. Adoption of intelligent support systems is one issue. Whether the farmers use the information generated by these systems and whether these systems lead to 'better' decision-making is a separate issue. However, it is anticipated that if farmers are involved in the development process, from the conceptual level, then this will more likely lead to a system that farmers will use to aid their decision-making process.

This review of empirical findings concerning the adoption of intelligent support systems indicates these systems may not be adopted or used regularly and that there are a number of factors identifiable from diffusion theory, technology acceptance model, and theories surrounding approaches taken in system development that could explain this situation. Few successful systems could be identified and thus there was limited data on which to make judgements concerning the relative success of different development methods. There are suggestions, however, that participatory and adopter-focused approaches may lead to systems with more positive outcomes.

However, the extent of adoption of these systems targeted at the agricultural sector is not known. Nor is it known why these systems were developed and how they were developed. This purpose of this study is to explore how and why systems were developed and the outcomes for those systems.

Although the focus of this study is on the development and adoption of intelligent support systems in Australian agriculture the findings from this study have wider implications. There has been extensive research into the relationship between user involvement in system development and system outcome. However, there are still many issues that need further investigation. For example, most studies have looked at user involvement in organisational settings where use of a system is often mandatory. Few studies have looked at the adoption of intelligent support systems by individuals where the use of the system is optional. This study looks not just at involvement but also at the degree and type of user involvement and the impact that this has on system outcomes. The relationship between user involvement and the system characteristics of usefulness and ease of use are explored. There have been few studies reported examining this relationship. The study looks at the type of system being developed and the differing requirements of user involvement for simple and complex systems. In addition, this study acknowledges the importance of the communication process in system uptake and the context in which the system is developed.

This chapter identifies and reviews the theoretical dimensions of this study. Chapter 3 will present the methodology used to collect data in relation to determining the outcome of intelligent support systems for agriculture in Australia.

Chapter 3

3 Research method

Things are not what they seem to be, nor are they otherwise
Lankavatara Sutra

3.1 Introduction

Chapter 2 examined the issues surrounding the adoption of information systems in general and the adoption of intelligent support systems in agriculture in particular. A number of propositions were identified concerning the inter-relationship between involvement of users in the software development process, the context in which the software was developed and delivered, and system outcomes. This chapter discusses the evolution of the research strategy adopted for the collection of information relating to the research propositions. The accompanying philosophical reasons for selecting the data collection method are put forward.

The chapter proceeds as follows. This section outlines the structure of the chapter. Section 3.2 gives a brief overview of the research methods used. Section 3.3 explains in greater detail the underlying research philosophies of various research approaches that were considered in the selection of the final research design. This allows an understanding of why the chosen research approach was adopted.

In the fourth section, 3.4, practical details surrounding the research design are considered. The approach taken in the pilot study is also outlined along with reflections on the outcomes of the pilot study. Reflections on the research objective of this study are also given. In the fifth and sixth sections, 3.5 and 3.6, the issues surrounding the collection of data from both developers and users through the use of telephone interviews are described. A discussion of the techniques used to code the data is also provided. The concluding section, 3.7, reviews the chapter.

3.2 Overview of research methods

As outlined in Chapter 2, this study aims to investigate the reasons behind the adoption and non-adoption of intelligent support systems in Australian agriculture. Whilst researchers have suggested reasons for the failure of these systems, there has been no in-depth and wide scale study, in an Australian context, of the reasons for the development of these systems and their outcomes. In addition, the study aims to investigate the relationship between user involvement and system outcomes.

At the outset of this study, the extent of adoption or non-adoption of intelligent systems was not known, the reasons why the systems were developed in the first instance was not known, and their anticipated outcomes and whether they achieved these outcomes was not known. Furthermore, the reasons behind why systems had or had not achieved their anticipated outcome was not known. That is, why had some systems been successful whilst others had not? More importantly, for this study, the degree of user involvement in the development of these systems and the impact it had on system outcome was not known.

In order to gather information relating to intelligent support systems it was necessary to first compile a list of systems currently or recently in use. Several sources, including publications (Reynolds, 1998, 1999; Wilde & Lewis, 1995) and the world wide web were used to identify 128 intelligent support systems currently or recently available in Australia. These sources are discussed in detail later. The problem was to identify which of these systems should be included in this study. As indicated, little was known about many of the systems - the way they were developed and their outcomes. Given this fact, it was determined that information should be collected on a number of representative systems so that the results from this study could be generalized to other situations. The problem was how best to determine the number of systems to include in the study and which systems were representative of the many systems that had been identified.

A pilot study was undertaken with five systems in order to gain some understanding of (1) how to select representative systems and (2) the best approach for collecting data that would provide insights into relevant issues. The five systems represented a range of system types although it was not known how representative these systems were of the 128 systems identified. The pilot study involved an in-depth telephone interview with a developer or manager for each of the five systems. The richness of the data collected and the relative ease with which it could be collected lead to the conclusion that the best way to proceed with this study was through in-depth telephone interviews on a relatively large number of systems. Rather than do in-depth case studies on a smaller number of systems data were collected on 66 intelligent support systems via telephone interviews. These 66 systems were determined to be relevant to this study, as they were systems that had passed beyond the prototype phase or were not research-only type systems. The interviews were open-ended in nature and were conducted with an individual involved in the development of the system. Notes were taken during the interviews, as the interviews were not tape-recorded. Because only one person was interviewed for each system and only minor ancillary data were collected from other sources the method used does not neatly fit into the case study research approach. Because the amount and nature of the data collected was not only quantitative but also rich in detail the method is clearly not only a quantitative survey. Detailed discussion of the data collection approach is discussed in section 3.5.

The method chosen for collection of data for this part of the study therefore falls in between survey methods and case study methods. In this respect, the method used is a combination of aspects of survey and case study and is considered to be an in-depth survey approach that combines elements of both case study methodology and survey methodology.

In the second stage in the research, two of the intelligent support systems studied in the first stage of this study were examined in greater depth, through interviews with users of each of the systems.

Following data collection, data were transcribed into a word processor document and sent out to the interviewees for confirmation. The confirmed data were imported into the qualitative analysis software tool, NVivo[1]. The data were examined in terms of relevant categories and issues and coded accordingly. A matrix of the coded data was developed and imported in the software product, SPSS[2]. The analysis of these data, from both a qualitative and quantitative perspective, is discussed in Chapter 4.

The above gives a brief outline of the method used in the collection of data for this study. The rest of the chapter expands on issues surrounding the research method and the steps taken to ensure the validity and reliability of the data. The following section discusses the underlying research philosophies that guided the approach taken in the collection of data.

3.3 Underlying research philosophy

The overall research problem outlined in Chapter 2 concerning the impact of involving users in system development as well as the outcome of the many systems that have been developed did not initially point to a particular approach for data collection and analysis. Initially, two options seemed worthy of consideration. One

[1] QSR NUD*IST Vivo - NVivo ®
[2] SPSS for Windows © SPSS inc

approach considered was the selection of a few representative systems to allow an in-depth case study on each of the targeted systems. The second approach considered was to survey developers, using survey forms, for all the identified systems to enable the compilation of an overview of intelligent support systems development and adoption.

As stated, little information was known about how the systems had been developed and why the systems had been developed. Given this fact, it was considered important to gauge the level of uptake and outcome of these systems so that discussion of adoption levels of these types of systems in the future was not based mainly on anecdotal evidence. Therefore, it was considered important to collect data on a number of systems that were representative of how and why the systems were developed. From preliminary investigations, over 100 systems were identified that fell into the category of intelligent support systems targeted at the agriculture sector. However, it was unclear which systems would be representative and therefore which systems should be targeted. Since a major focus of the study was to explore the importance of user involvement on influencing system outcome, it was essential that the research design allowed for the collection of data that would provide information rich in detail to allow exploration of factors impacting on the relationship between user involvement and system outcome.

Thus it was important to determine the most appropriate approach to data collection that would provide rich information on many aspects of development and at the same time target a representative sample of the systems so that the results could be generalised rather than specific to a few sample cases. Reference to the literature on the strengths and weaknesses of surveys and case studies provided information in guiding the researcher in the selection of the final research design.

3.3.1 Surveys and case studies - strengths and weaknesses

Galliers (1992) outlined the key features, strengths, and weaknesses of surveys and case studies. The key feature of surveys is that they enable a snapshot of practices, situations, or views at a particular point in time (via questionnaires or interviews) to be obtained, from which inferences can be made. Quantitative techniques are mainly used to analyse the results. The strength of surveys is that they allow a greater number of variables to be studied than do experimental approaches. Surveys allow a description of real world situations, as compared to laboratory experiments, and from this it is easier to make generalisations. The fact that little insight is obtained concerning the causes or processes behind the phenomena being studied can be a weakness with data collected through surveys. There is the possible bias in respondents that results from the self-selecting nature of questionnaire respondents and the moment in time that the research is undertaken. A survey must ask all the right questions in the right way if it is to succeed in showing causal relationships or providing descriptive statistics (Gable, 1994). Therefore, the researcher needs to have a good idea of the nature of the answers before proceeding with the survey.

The approach taken with 'traditional survey research usually serves as a methodology of verification rather than discovery' (Gable, 1994, p.114), whereas the case study approach seeks to understand the problem being investigated (Gable, 1994).

A key feature of case studies is seen as the ability to describe relationships that exist in reality, usually within a single organisation or organisational grouping. The strength of this approach is the ability to capture 'reality' in greater detail and analyse more variables than is possible with, for example, surveys. Some case studies restrict investigation to a single event or organisation and some researchers see this as a weakness. Also seen as a weakness is the difficulty of generalising given the problem of acquiring similar data from a statistically meaningful number of cases. Other identified weaknesses are the lack of control of variables and the different interpretations of events by individual researchers or stakeholders (Galliers, 1992).

For this current study, a survey of developers of intelligent support systems would provide a snapshot of practices and would allow generalisations to be made. If the response rate was low, however, there would only be a small set of data to analyse and this would restrict the generalisations that could be made from the study. Insights into the reasons behind systems being developed would be limited. Another approach to data collection for this study would be a case study approach. However, it may not be possible to generalise the findings from a few in-depth case studies to the many systems that have been developed.

The survey approach is generally a positivist approach to understanding the phenomena being studied. Case study research can be carried out taking a positivist or an interpretivist stance, a deductive or an inductive approach, using qualitative and quantitative methods, and can be used to investigate one or multiple cases (Cavaye, 1996).

Initially within information systems research there was a predominance of a positivist approach to research and some authors even framed the discussion of case study research in terms of a positivist approach (Benbasat *et al.*, 1987; Lee, 1989). More recently, there have been examples and discussion of the interpretivist approach to case study research within information systems studies (Benbasat *et al.*, 1987; Cavaye, 1996; Gable, 1994; Kaplan & Duchon, 1988; Klein & Myers, 1999;

Myers, 1994a; Walsham, 1995). The pragmatics of conducting case study research is discussed by Darke *et al.* (1998).

A very brief discussion of these underlying research concepts is now given.

3.3.2 Epistemology

Qualitative research can be positivist, interpretive, or critical depending on the underlying philosophical assumptions (Myers, 1997). These assumptions are related to the nature of knowledge and how the researcher assumes that knowledge is constructed. A brief discussion of positivist and interpretivist research follows.

Positivist research can be generally viewed as an approach that tests theory. That is, if the researcher is attempting to measure variables in a quantifiable way, test hypothesis, or validate formal propositions then this approach is seen as a positivist approach (Klein & Myers, 1999). Facts and values are seen as distinct, and scientific knowledge is only concerned with fact (Walsham, 1995). The underlying ontology, or nature of reality, is that reality exists independently of our construction of it – an external realism.

Interpretivist research attempts to understand phenomena through the meanings that people assign to them (Klein & Myers, 1999). An interpretive study is not interested in identifying dependent and independent variables; rather it seeks to make meaning out of the situation as the analysis of the data unfolds. Facts and values are intertwined and both are involved in knowledge. The underlying ontology is that reality depends on how an individual constructs that reality rather than the existence of one absolute reality.

3.3.3 Research objective

The objective of research may be to discover relationships, test relationships, or a combination of both of these.

An inductive approach is one in which analysis takes place whilst coding data – that is the relationships are discovered during analysis. The analysis may suggest relationships or patterns that require further data collection. Data coding methods, coding rationales, integration of categories, abstracting from the data, and construction of theory are, thus, guided by theory as it emerges (Cavaye, 1996, p.234).

If the testing of theory is the objective of the research then this is a deductive approach. The deductive approach is concerned with supporting or disconfirming existing theory. Using the principles of analytical generalization, the early model is tested and may be modified according to case findings. This approach is more in line with the scientific method approach (Cavaye, 1996, p.235). The issues surrounding this type of approach within information systems research are discussed by Lee (1989).

It is possible to combine a deductive and inductive approach in the same study (Cavaye, 1996).

3.3.4 Research method

Quantitative methods are methods that involve statistical or experimental testing of hypotheses using categorical or numerical data. Qualitative methods, on the other hand, are applied to data that is not categorical in nature, for example, interview scripts, observation notes, extracting information from historical records. Just as there are a number of statistical methods that can be applied to quantitative data, so too are there a number of different qualitative methods that can be used to analyse data that are qualitative in nature. A qualitative research approach does not analyse data in terms of statistics or quantification of results.

There has been considerable discussion within the information systems literature on the use of qualitative methods in information systems research (Benbasat *et al.*, 1987; Carroll & Swatman, 2000; Cavaye, 1996; Davis *et al.*, 1992; Gable, 1994; Galliers, 1992; Galliers & Land, 1987; Kaplan & Duchon, 1988; Klein & Myers, 1999; Lee, 1991, 1999; Markus & Lee, 1999; Myers, 1994a; Myers, 1997; Walsham, 1995). It is now generally accepted that the use of qualitative research is a valid research approach within information systems. The ISWORLD NET web site provides an excellent 'living' record of qualitative research in information systems (Myers, 1997).

It is not the data, per se, that is qualitative or quantitative but rather the method of analysis. It is possible to turn qualitative data into quantitative data. For example, information collected in case studies can be turned into quantitative data by counting the number of times certain phrases are used. Therefore, it is possible to treat the same data in both a quantitative and a qualitative manner. It is not, however, possible to turn quantitative data into qualitative data. If data were collected in a manner that recorded only categorical responses to answers then these data cannot be analysed in a qualitative way.

Given the complexity of the interaction between the technology and the users, Galliers (1987) argues for an approach that is able to embrace the complex nature of the interactions.

> Our research methods must take into account the nature of the subject matter and the complexity of the real world (Galliers & Land, 1987, p.901).

A qualitative approach to data collection would allow an understanding of the issues surrounding the development of intelligent support systems in Australian agriculture to emerge. Since anecdotal evidence indicated that few systems had received wide spread adoption it was of interest why developers continued with the development of these type of systems. The problem, however, of identifying which systems were representative of intelligent support systems development and outcomes in Australian agriculture was still unresolved. Also, given the caution by Benbasat *et al.* (1987) that case study site selection should be carefully thought out rather than opportunistic it was determined that a pilot study, in the form of a survey, would be helpful in determining how to proceed with case site selection and data collection.

3.4 Research design

Initially it was unclear whether to use telephone interviews or mail out survey forms to determine the target systems for further study. There were some issues with regard to identifying the most appropriate person to send the survey questionnaire form to, as details on who had developed the system were not available. The only information that was available was a contact name and address that was provided in the publications by Reynolds (1998; 1999). This contact name was provided in the publications in relation to acquiring the software and so therefore may not necessarily be the individual who would be most appropriate person to fill out the survey questionnaire. The most suitable person to contact in relation to filling out a survey form would best be determined via a telephone conversation. Given this, it seemed that a pilot survey, using telephone interviews, would be a sensible initial approach to gain information to assist in determining which systems to target.

3.4.1 Identifying intelligent support systems

Several sources were used to identify and locate intelligent support systems currently or recently available in Australia.

The first source was *Computer Software for Agriculture* (Reynolds, 1998, 1999) published by NSW Agriculture. These booklets list over 270 software systems available for use in the agricultural industry. Of these, over 60 were identified by the researcher as intelligent support systems. The strategy taken for identifying systems was to read the description of the program features looking for key words, such as 'decision support system', 'expert system', or 'assist farmers in their decision-making'. A considered judgement was made by the researcher on whether to categorise the system as an intelligent support system or not. Later discussions with developers indicated that this strategy was effective in identifying most systems correctly.

The second source of intelligent support systems identified as either developed or under development was the database maintained by the Swinburne University of Technology (Wilde & Lewis, 1995). This database identified 36 expert systems but few appeared to be in use.

A third source of intelligent support systems that are currently or have recently been in use was from information acquired by the researcher in the course of this research. Interviewees often identified other systems that were of interest.

A fourth source of intelligent support systems was the world wide web.

From these four sources, a list containing the names of 128 systems was compiled. Contact details for many systems were either limited or non-existent. However, the initial source of contact details was from the publication, *Computer Software for*

Agriculture (Reynolds, 1998). Contact details were obtained for other systems from interviewees in the course of interviews. The Publication Section of the Department of Primary Industry, Queensland supplied contact information for several systems.

Many of the systems originated from one state in Australia - Queensland. Also, from information in the publication *Computer Software for Agriculture* (Reynolds, 1998) many systems appeared to have been developed by government organisations. These factors made it more difficult to readily identify a sample that would provide information that would be applicable to other situations. As indicated previously, given the lack of information concerning which systems would be representative, a pilot survey, using telephone interviews, was seen as a sensible initial approach to gain information to assist in determining which systems to target.

3.4.2 Pilot study

A pilot study of six systems, using telephone interviews, was undertaken between late July 1999 and the middle of August 1999. It was envisaged that this would: (1) confirm the suitability of an in-depth case study approach, and (2) determine the number of case studies required and provide some basis on which to identify potential target systems for inclusion in the main study.

Contact information in relation to the identified intelligent support systems was entered into a database application. Using this information the researcher worked her way through the systems in alphabetical order of the company name associated with the software. This approach was taken as a random method for selecting systems for inclusion in the pilot study. The intention was to conduct interviews in relation to six systems. Two of the companies identified were not contactable via the telephone number provided. It was assumed that these systems were unlikely to be still available. The researcher worked her way through the companies until six individuals had been interviewed in relation to six systems. One of the systems was a very small system that had never been marketed and had been developed mainly for personal use – data relating to this system were discarded leaving five systems to analyse. The systems represented a range of system types in terms of whether the system was developed by a government or non-government organisation, the complexity of the system, and the outcomes for the system. The interviews revolved around a set of questions (Appendix A) that were developed from an understanding of the issues of interest. This understanding of the issues was gained through reference to the literature as previously discussed in Chapter 2.

Individuals were contacted by telephone and the nature of the study was briefly outlined (Appendix B). Interviewees were asked who would be the best person to speak to in terms of the development and outcomes of the identified system. If they indicated that they were the person to speak to then permission was sought to interview them and more details were given concerning the nature of the study. The interviews were not taped and the researcher took hand written notes whilst conducting the interviews. The length of time for each of these six interviews ranged from 30 minutes to one hour. The average interview time was approximately 45 minutes. If the interviewee indicated that they were not the best person to speak to then contact details were obtained for the most appropriate person to contact.

Whilst there was a set of questions to be answered, the interviewee was not forced to answer these in a particular order. If the interviewee was keen to talk on the topic then they were allowed to do so as long as the topic was broadly related to the area of research. The interviewer ensured that areas not covered, in the free flowing conversation, were addressed before the interview ended. This approach allowed a balance between excessive passivity and over-direction (Walsham, 1995). The approach ensured that the data collected were still rich in detail but also allowed the interviewer to give prompts to the interviewee if the conservation was stifled.

The richness of the information that was obtained during this pilot study and the willingness of the interviewees to discuss the outcomes of the systems far exceeded the researcher's expectations. The merit of the outside observer approach, as is the case with telephone interviews, is that if a rapport can be established with the interviewee then they may be forthright and frank in the views they express (Walsham, 1995). It appeared that a good rapport could be established, in most instances, via the telephone. The results of the pilot study revealed that a variety of development approaches were used in the development of these systems, there were many reasons for developing the systems, and the perceived outcomes from these systems varied. This led the researcher to believe that the development and outcomes for intelligent support systems in the Australian agricultural sector was a complex story. There were many reasons for developing systems, many approaches in the development of those systems, and systems were viewed as successful or not successful for a variety of reasons.

3.4.3 Finalising the research design

The telephone interviews allowed the collection of data that was rich in personal insights and these were relatively straightforward to obtain. As indicated, the interviews revealed varying approaches and outcomes and this meant that in order to establish a representative sample for case study selection many developers would need to be contacted. Also, as soon as the researcher indicated the topic of the research several of the interviewees were very keen to talk in-depth about their system. This willingness to talk was partly due to the fact that the interviewees were aware of problems in the development and adoption of these types of systems. It appeared that in order to gain information on which systems to study, a large amount of valuable data would be collected because of the eagerness of the interviewees to discuss this topic – sometimes at considerable length. This caused the researcher to re-think the nature of the study.

Rather than use the telephone interviews to determine the sample for multiple in-depth case studies, it was decided to look at a large number of systems and from this glean a broad snapshot of intelligent support systems in Australia. The data collected would be rich in detail and would allow factors influencing intelligent support systems adoption to emerge. This approach would also allow the study of the outcomes for different organisations. For example, the difference between private and government development could be examined as well as the difference between systems developed in different states, or those where perhaps the price per unit impacted on the uptake of the system. Whilst this approach would not allow the in-depth study of a small number of systems, it would allow a study of many systems. The varying combination of data from all the telephone interviews would allow analysis of system outcomes from a variety of perspectives.

As a broad study of intelligent support systems and their outcomes, the study would provide rich detail not available through closed answer survey questionnaires. The benefit of this study would be that whilst it covered a range of systems it could collect data that could be analysed using both qualitative and quantitative techniques. The qualitative approach would allow for a deeper understanding of intelligent support systems development to emerge.

However, there can be problems in collecting interview data for a large number of systems. Because of the number of surveys undertaken and the amount of data collected for each system a considerable amount of data were collected. This volume and variety of data may inhibit data analysis (Cavaye, 1996). An approach was required that would allow a systemic and logical way of organising the collection and coding of the data. Surveying a large number of sites using an in-depth survey approach could result in the data being treated in a quantitative manner and the same result could be achieved by doing a quantitative survey. This would defeat the purpose of doing in-depth interviews. The researcher was aware of this problem and took it into consideration during data collection and analysis. The approach taken is discussed in Chapter 4.

An important aspect of the pilot study was the change that occurred in the researcher's perspective.

3.4.4 Reflections on data collected in pilot study

The researcher originally approached this study with a particular mindset on the adoption:success relationship of intelligent support systems in Australia. For example, it was assumed that low sales would most probably indicate low impact and that these systems could be classed as failures. However, the pilot study revealed that developers classified a system as successful for a variety of reasons. Uptake was only one aspect.

The approach taken in the pilot study was an interpretive approach. As Walsham (1995, p.76) states:

> It is desirable in interpretive studies to preserve a considerable degree of openness to the field data, and a willingness to modify initial assumptions and theories. This results in an iterative process of data collection and analysis, with initial theories being expanded, revised, or abandoned altogether (Walsham, 1995, p.76).

Myers (1997) comments on the lack of distinction between data collection and data analysis that can often occur when undertaking qualitative research:

> It is assumed that the researcher's presuppositions affect the gathering of the data – the questions posed to the informants largely determine what you are going to find out. The analysis affects the data and the data affects the analysis in significant ways (Myers, 1997).

The issue is one of research informing further research as it unfolds. That is, the researchers can draw on existing knowledge without being entirely constrained by that knowledge and believing that it 'represents final truth in that area' (Walsham, 1995, p.77). Through reference to the literature, the researcher is able to develop a framework that takes into account previous knowledge yet is not constrained by that framework. This is in contrast to a grounded theory approach where too full an examination of issues is believed to constrain the outcomes by narrowing the focus of the researcher. 'Theory evolves during actual research, and it does this through continuous interplay between analysis and data collection' (Strauss & Corbin, 1994, p.272).

The pilot study resulted in new insights that resulted in new questions being included in the survey (Appendix C). The interview structure allowed the researcher to gain some understanding of the developers' perspective. Developers initiate the development of systems for a variety of reasons. More importantly if their systems fail they often have insights into the reasons behind this failure. These insights come from a different perspective to that of the researcher who formed an understanding of the issues through literature readings. Issues raised in the pilot study provided insights that lead to the identification of important factors that needed to be considered. It allowed the researcher to identify some of the beliefs and expectations that she held in regard to the study. That is, the researcher explicitly acknowledged these assumptions and biases (Carroll & Swatman, 2000; Klein & Myers, 1999) and the influences that they had on the research strategy. However, there may be other biases the researcher held that she failed to identify. A researcher's bias may still cloud the interpretation of the data (Galliers, 1992).

The interview strategy used in the pilot study captured data of both a quantitative nature as well as information on system development and expectations that were elicited through broad open-ended questions.

Researchers have acknowledged that different research approaches have their strengths and weaknesses and that there is a trade-off between approaches (Cavaye, 1996; Gable, 1994; Kaplan & Duchon, 1988). For this reason there is 'a powerful argument for pluralism and for the use of multiple research approaches during any investigation' (Cavaye, 1996, p.229).

Kaplan and Duchon (1988) combined the use of qualitative and quantitative research in their longitudinal study of the interrelationships between perceptions of work and a computer information system. They point out that one problem with the quantitative research approach is that the 'stripping of context buys "objectivity" and testability at the cost of a deeper understanding of what actually is occurring' (p.572). However, the 'benefits of the methodological richness of qualitative research are balanced by the difficulties of coming to grips … with the diversity of approaches and their associated requirements for quality, validity and rigor' (Carroll & Swatman, 2000, p.116).

Despite the problems associated with analysis of qualitative research, an in-depth survey was determined as the best way to proceed.

The research objectives and design used in the study are now stated.

3.4.5 Research objective and design

The research objective for this study is not to demonstrate a statistical causal relationship between different variables of interest – a variance approach. Rather, the intention is to develop an explanation or understanding of the varying patterns of variables or factors that are more likely to lead to development of successful systems - a processual approach.

Variance theories are concerned with predicting levels of outcome depending on the presence of certain variables. That is, 'the cause is necessary and sufficient for the outcome' and the 'outcome will invariably occur when necessary and sufficient conditions are present' (Markus & Robey, 1988, p.590). In process theory, 'the precursor is assumed insufficient to "cause" the outcome, but is held to be merely necessary for it to occur' (Markus & Robey, 1988, p.590).

In terms of intelligent support systems, a variance theory approach would be, for example, to suggest that in order for a system to be adopted it would need to have a certain set of conditions - such as usefulness, ease of use, user involvement. In a process theory approach, a system that was useful may not necessarily be adopted - but it would be assumed that if the system was not useful then it would not be adopted.

The research design for this study involves an approach to data collection that combines aspects of interpretivist design combined with a survey approach. This allows the collection of data that can be analysed using qualitative and simple quantitative techniques and combines the strength of case study with the strength of surveys. The study by Gill (1995) on the outcome of commercial expert systems supports the validity of this approach. Gill used telephone interviews to collect mainly quantitative information but he also collected some qualitative data. For each of the systems he investigated, an individual knowledgeable in the use and development of the system was identified and a phone survey was conducted to determine the current status of the system.

The above section has outlined details of the pilot study and why the pilot study was undertaken. As well, the underlying research concepts that form the basis of this study have been presented. Before proceeding to describe the approach taken for the collection of data for the main study a graphical representation of the nature of this study is presented.

Figure 3-1 graphically represents the processes and the evolving nature of this research study. The figure is based on the work of Carroll and Swatman (2000) and the iterative nature of interpretive work. Theory building is seen as 'moving from broad ill-defined themes, collecting masses of data, analysing and interpreting them to build theory' (Carroll & Swatman, 2000, p.117). Carroll and Swatman (2000) coined the term 'structured case' for this approach. The structured case methodological framework documents the cyclical links between the conceptual framework, planning, data collection, observations and interpretations, and the influences these have on the initial conceptual framework. This current study followed this approach to the development and modification of the conceptual framework.

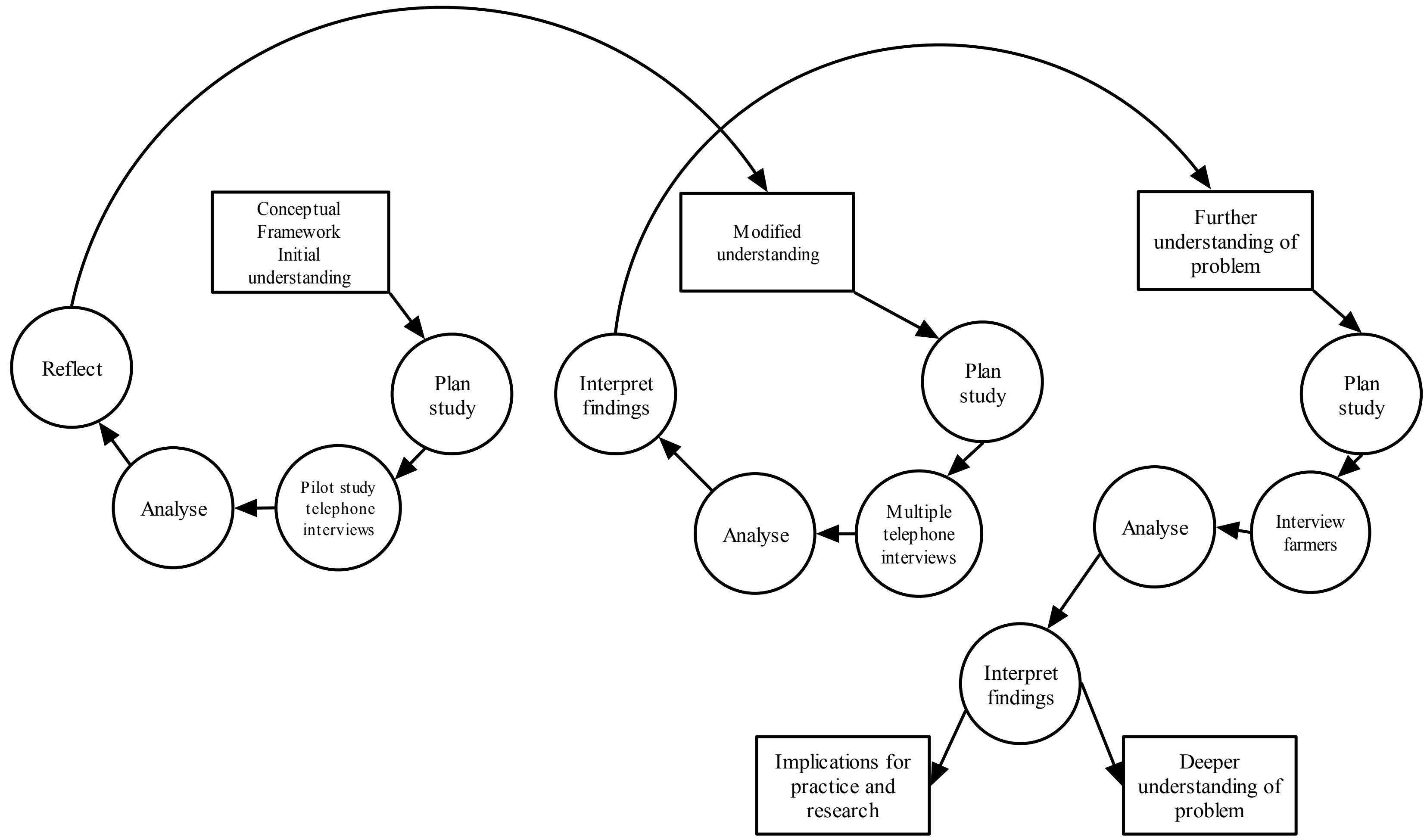

Figure 3-1 Approach taken in data collection, analysis, reflection, and interpretation

Based on Carroll and Swatman (2000)

A total of 128 intelligent support systems were identified with detailed interviews conducted for 66 systems. The other systems were either outside the scope of this study or were systems where contact details could not be obtained.

Systems were considered to be outside the scope of this study for a number of reasons:

- the system had been developed for use by researchers only
- the system never got beyond the prototype phase
- the contact person did not believe the system was either an expert system or a decision support system.

Figure 3-2 details information on the number of identified systems and the numbers included and not included in the study.

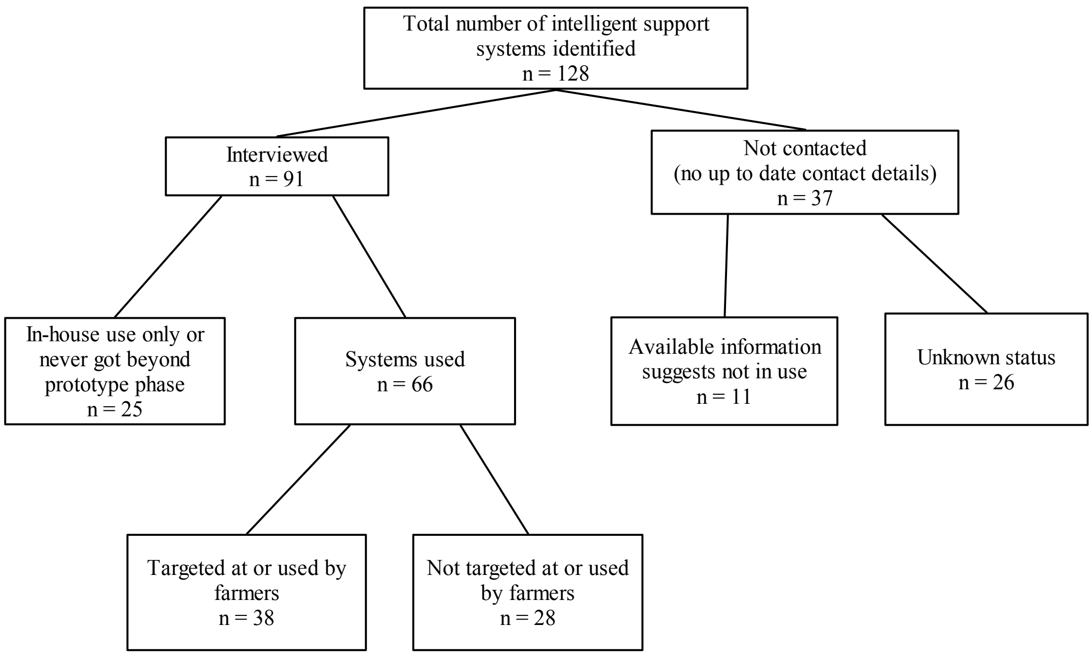

Figure 3-2 Identified systems

Of the 66 systems, 38 systems were either targeted at farmers or had been used by them. These 38 systems are of interest in this current study that focuses on the adoption and use of intelligent support systems by farmers. The remaining 28 systems were either targeted at extension staff or used within commercial enterprises as advisory services to farmers.

The data collection stages involved in this study are shown in Figure 3-3. As outlined, a pilot study was undertaken on five systems. This was followed by in-depth interviews in relation to 66 systems. From this, two systems were identified for collection of data from users of the systems. These two systems were selected because of the nature of the user involvement in system development and the outcome for each system. One system represented an example where the outcome was as expected whilst the other system represented an example where the outcome was not as expected.

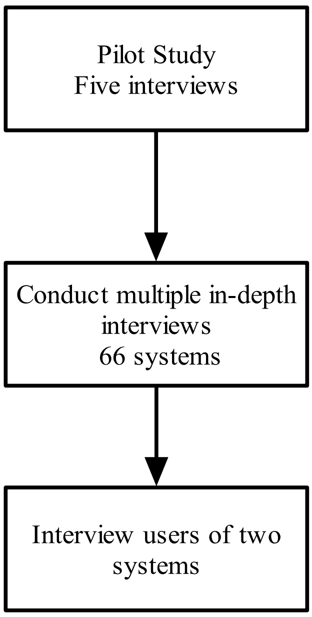

Figure 3-3 Data collection stages

An outline of the procedures used in the collection of data in relation to identified intelligent support systems follows. After this the procedures used to collect information from farmers are outlined.

3.5 *Data collection from individuals involved in system development*

3.5.1 Interview questions

The questionnaire (Appendix C) targeted at individuals involved in system development was structured in a way that would allow collection of data for both quantitative and qualitative analysis. The questions of a quantitative nature were those that related to number of units sold, years on the market, cost and the like. While this data were quantifiable the intention was never to do statistical analysis on the data to determine dependent and independent variables. Rather, they were collected to build a picture of the status of intelligent support systems in Australia.

Questions relating to how the system was developed, why it was developed and the outcome for the system, were open-ended to allow for a more qualitative, interpretive style of analysis. For example, for the question regarding why the system was developed, a prompt was given that asked 'What problem were you trying to overcome'. No other prompt was given. The interviews were focused but not closed in terms of responses.

From the pilot study it became apparent that in terms of system outcomes, success could mean different things to different people. Rather than ask a more closed question such as 'Would you regard this system as successful?' - a more open ended question was asked. The question was framed in the following terms: 'When you think back on what you hoped to achieve with the system and you reflect on what has been achieved how would you describe the outcomes for this system?' The interviewee was then asked what they considered the main reasons for the outcome. This approach arose directly from interactions with interviewees during the pilot study and resulted in a modified questionnaire (Appendix C – questions 15 and 16 in particular).

As indicated, several of the questions were relatively broad and did not prompt the user with specific words. For example, no mention was made of the terms ease of use, usefulness, developer based, technology transfer. The interviewee was never asked to rate a system in terms of ease of use or usefulness. Rather questions were framed in terms of amount of data input and complexity of output. This approach was taken to avoid the problem of leading questions which could result in an interviewee responding to a question in words that they heard from the interviewer rather than how they truly evaluated a system (Yin, 1994). If the questions had been more rigidly framed then the range and depth of responses would have been more limited.

3.5.2 Interview procedure

Interviewees were contacted by telephone to arrange a time for the interview. The purpose of the study was outlined to the interviewee. The opportunity to confirm whether the system was an intelligent support system was undertaken at this stage. An indication of the time commitment and the assurance of confidentiality were given (Appendix B). The interviewee was informed that they did not need to answer any question that they did not want to – for whatever reason. For those systems identified as intelligent support systems, all individuals contacted by telephone were willing to participate in the survey. Many of the interviewees agreed to be interviewed immediately. Others arranged a more suitable time. Only one individual requested that the survey be emailed to them rather than participate in a telephone interview. The limited data collected from this participant confirmed the value of doing interviews rather than a mail out survey.

The role of the interviewee in relation to the development of any given system varied. Sixty one of those interviewed (92%) were either developers or managers of the systems while the remaining interviews were conducted with individuals involved in the development process. If during the course of the interview it became apparent that the interviewee did not have an in-depth knowledge of the reasons behind the development of the system, how it was developed, and the outcomes for that system then the interview was terminated graciously. The interviewee was asked who they thought would be able to answer the questions that were being raised.

As indicated previously, not all systems developed were targeted directly at farmers. Some systems were targeted at farm advisers and two systems were in-house developments by commercial enterprises that provided goods and services to farmers. Information about these other systems was still collected with the view that knowledge about the outcomes of these systems would add to the understanding of scenarios that influence the adoption of these types of systems.

Approximately 28 hours of interview time was undertaken for 66 systems. The interviews were not tape-recorded; rather hand written notes were taken. Interview time for data collected specifically on the 38 systems targeted at or used by farmers was 18 hours. The majority of the data were collected between the 26th October 1999 and the 29th March 2000, with data from three systems being collected in late May, 2000.

As in the pilot study, the interviewee was not forced to answer the questions in any particular order. If the interviewee was keen to talk on the topic then they were allowed to do so. The interviewer ensured that areas not covered, in the free flowing conversation, were addressed before the interview ended. The notes taken during the interview were transcribed into a word processing package usually within one to two days of doing the interview and always within a week of doing the interview. For each question asked, the appropriate notes were transcribed alongside that question. This meant all transcripts were sent out with the same order of questions and answers regardless of the flow of the conversation. The transcripts were, in most cases[3], emailed out to interviewees for confirmation and correction. These transcript files had software tracking enabled to track any changes made. This allowed the researcher to determine if the essence of the interview had been altered. If confirmation transcripts were not returned then a reminder email was sent out after two weeks. If no response was received then another email was sent, and finally the interviewee was contacted by telephone. Of the 66 interviews that were mailed out to participants, 59 were returned corrected and confirmed. Most of the corrections were of a minor nature. Several interviewees commented on how well the essence of the conversation had been captured.

Because of the number of surveys undertaken and the amount of data collected for each system a significant amount of data were collected. As indicated previously, an approach was required that would allow a systemic, and logical way of organising the collection and coding of the data.

3.5.3 Coding procedure

A problem with collecting data on so many different systems meant that in order to gain some understanding of the data it first needed to be coded and reduced in some way. One way of achieving this was through the use of matrix tables (Miles & Huberman, 1994). Through coding and data reduction, patterns or issues can

[3] Some interviewees did not have email access

emerge. NVivo is a software tool that allows the coding and analysis of transcripts. Each transcript had been saved in a separate word processor document. These individual documents were easily imported into NVivo with each system representing a single document in NVivo. Using the coding facility in NVivo the documents were read, analysed and coded. The coding strategy is outlined in detail in Chapter 4.

NVivo also allows the establishment of matrix tables. Important key attributes were determined and then the document was perused to establish the value for the attribute for that system. For some attributes this was straight forward – for example, number of units sold, or years on market. For other attributes some judgement on the part of the researcher was required – for example – extent of success of the system. The matrix table was manipulated within NVivo and was exported to SPSS for further analysis. The criteria used in determining the values for the matrices is outlined in more detail in Chapter 4 along with the analysis of the outcomes of the coding strategy.

The use of coding and data reduction can be problematic if the value of doing a qualitative study in the first place is lost. The strategies undertaken for this study to overcome this problem are discussed in Chapter 4.

3.6 Data collection from users

The collection and analysis of data from the developers highlighted a number of systems where it would be useful to collect data from farmers on how they viewed these systems. The focus was on both the farmers' involvement in the development of the system and how they viewed the system in terms of usefulness and ease of use.

Given the size of Australia and the distance between towns and farms and given the success of the use of the telephone as a means of interviewing developers it was decided that telephone interviews would be a good approach for the collection of data from farmers. Two systems were selected for further data collection. One system, *AVOMAN*, appeared to have had a high degree of user influence in its development while the other system, *WHEATMAN*, appeared to have less user influence.

The managers of these systems were contacted to determine if they were agreeable to users of their system being interviewed. Both individuals agreed to the further study of their system.

For each system, a minimum of 10 farmers were interviewed over the telephone on aspects of the system. The interview questions are included in Appendix D. The researcher requested a list of farmers who would be suitable to interview. The researcher requested names of users who were involved in the development of the system and who were currently still users of the system; users who were involved in the development of the system who no longer used the system; and users who were not involved in the development of the system and who currently used the system. This part of the study was investigating the impact of user involvement on the users' attitude towards the system and therefore it was not appropriate to interview farmers who had never used the system – that is, non-users. The problem with the method of identification of users is that the selection of users was not random. However, the list of user names of the two systems was confidential information and could not be released to the researcher. Given this restriction, the researcher requested that the manager supply more names than required by the researcher and then the researcher would randomly select names from this list. However, it is acknowledged that the list of names supplied were not randomly selected and bias could exist.

Interviews were conducted with 11 development participants and/or users of the system *AVOMAN* between the period 5th May 2000 and the 15th May 2000. Interviews for *WHEATMAN* were conducted with eight development participants and/or users between the period 15th May 2000 and the 23rd May 2000. There were difficulties contacting users of this latter system, as they were busy harvesting their crops; therefore, an additional three interviews were conducted on the 30th October 2000

3.6.1 Interview questions

Following the same approach taken with the interviews with developers, the questionnaire was structured in a way that would allow collection of data for both qualitative and quantitative analysis. Questions of a qualitative nature related to what the farmer used the system for and how they used the system. Interviewees were asked questions on the complexity of data input and output, if the system had affected their decision-making, and what made them decide to use the software.

A small survey was administered at the end of the interview on how the user perceived the usefulness and ease of use of the software (Appendix D). This survey instrument was adapted from that developed by Davis (1993). Whilst the small number of users interviewed meant that the data from this small survey could not be analysed statistically it was still seen as useful data to collect, especially to use in conjunction with the accompanying interview data.

3.6.2 Interview procedures

Interviewees were contacted by telephone to arrange a time for the interview. The purpose of the study was outlined to the interviewee. An indication of the time commitment and the assurance of confidentiality were given. The interviewee was informed that they did not need to answer any question that they did not want to – for whatever reason. Interviewees were asked if they would mind if the interviews were taped and all gave permission for the interviews to be taped. It was decided to tape these interviews in case farmers did not want to verify the accuracy of the interview. Only one farmer indicated that they wished to see the transcript of the interview. That farmer did not reply to the email containing the transcript.

Interview times ranged from 10 minutes to 45 minutes and the average interview time was approximately 20 minutes**.** Farmers were significantly more difficult to contact than the developers. Calls often had to be made at night confirming the suitability of the telephone interview approach. The researcher gained a real sense that the farmers were very relaxed about talking about their use of the software over the telephone. The nature of a formal visit to the farmers' homes at night may not have resulted in the very relaxed and informal nature of many of the interviews.

3.6.3 Coding procedures

The amount of data collected for this part of the study was significantly less than that collected from developers of systems. However, the same approach was taken in the coding of the data.

Each transcript had been saved in a separate word processor document. These individual documents were easily imported in NVivo and each system represented a single document in NVivo. Using the coding facility in NVivo the documents were read, analysed and coded.

Again a matrix table of important key attributes was established in NVivo. Data from the usefulness and ease of use survey was also recorded in the matrix table.

3.7 Summary

This chapter has outlined the approach taken in the collection and coding of data in this study of intelligent support systems in Australia. The chapter has explained how the research approach was determined with reference to the literature.

The collection of data in the pilot study was important in determining the research approach taken in this study. It also resulted in a change in the researcher's perspective towards the problem. Rather than approaching the topic from a researcher's perspective, the interaction with the interviewees allowed an understanding of the issues from the interviewees' perspective to emerge. This in turn allowed the researcher to re-think the questions being asked and prompted the researcher to probe for additional aspects to the development of the system. This added to the richness of data collected.

The method used for data collection is a blend of survey and case study and is described as an in-depth survey. It allowed the collection of data on a relatively large number of systems and at the same time allowed data that were rich in detail to be collected and analysed. These data were analysed using predominantly qualitative techniques. Certain aspects of the systems, such as number sold and cost were quantitative in nature.

Chapter 4 discusses the analysis of the data gathered from developers in terms of relevant features of the 66 systems and also the outcomes for those systems targeted at or used by farmers. Chapter 5 discusses the analysis of the data gathered from users.

Chapter 4

4 Analysis – what does success look like and how do you get it?

We were of the opinion that if you put a package out there then people would use it. We see this as naïve now. (Interviewee)

4.1 Introduction

Chapter 3 outlined the research strategy adopted for the collection of data relating to the research propositions. Data were collected through in-depth telephone interviews from both developers and users of intelligent support systems. This approach allowed the collection of data that was both categorical and rich in detail. A brief outline of the approach taken in the coding of this data was given in Chapter 3. This chapter discusses in more detail the approach taken in the analysis of the interview transcripts through the use of various coding strategies.

The chapter proceeds as follows. This section outlines the structure of the chapter. The second section, 4.2, gives an overview of the approach taken in data analysis and briefly outlines the results. Section 4.3 explains in greater detail the coding and analysis of the data. An explanation is provided of the coding strategies employed during analysis that allowed the common elements and issues present in the data to emerge. Through this process the important constructs and attributes that form the basis of the data analysis emerged.

The fourth section, 4.4, provides an overview of the statistics gathered about the 66 systems. This section provides details on frequency of attributes such as number of systems developed by government organisations, type of systems, number of units sold, and the like.

The fifth section, 4.5, examines the outcome of systems in terms of different patterns of success. Of the 66 systems where data were collected, 38 were targeted at or used by farmers. These systems are analysed in terms of approach taken in the development of the system, user involvement, and system outcomes. The systems are divided into three main categories: low impact systems, medium impact systems, and high impact systems. These three categories are discussed in detail.

Section six, 4.6, summarises the results of the analysis.

4.2 Overview of data analysis

The investigation of the impact of differing scenarios on system outcome required coding the data so that some organised meaning could be extracted from the many pages of interview transcripts. Each transcript was coded in terms of attributes considered important for this analysis. These key attributes were drawn from the conceptual framework as well as from the transcripts as they were coded. The attributes were derived from data that were both quantitative and qualitative in nature. For example, system attributes included number of systems sold, cost, and current status. Assigning values to these attributes was straightforward. However, determining how to rate, for example, the impact that a system had, or the degree of user involvement, or the degree of influence was a more subjective process. A systematic and ordered approach was required in assigning values for the more complex and subjective attributes. Several passes through the data were required in order to ensure that the data were coded in a uniform manner. The strategies used in the coding of the data is outlined in section 4.3. Once the data had been coded and values assigned to the attributes, a matrix table was established. This matrix table was exported to SPSS where frequencies of attributes were analysed. Cross tabulation was undertaken in relation to some attributes.

4.3 Coding of interview data

In order to investigate the impact of the differing scenarios on system outcome, it was necessary to code the 66 interview transcripts to extract the key factors and issues recurring throughout the transcripts. These key factors were drawn initially from the conceptual framework. However, issues also emerged from the transcripts as they were coded.

This section outlines the different coding techniques used in the data analysis process. The intention throughout the process was to make sure a consistent approach was taken in the coding of the transcripts and also to allow important factors to emerge from the data.

Given the volume of data to analyse a method had to be used that enabled the common elements and issues to emerge from the transcripts without losing the richness of the interview data. Care had to be taken not to reduce the analysis of the data to a quantitative approach of counting the occurrence of different values with no reference to the underlying rich text.

The transcripts were imported into the qualitative data analysis software tool NVivo and each transcript was coded and re-coded using a number of coding strategies. Coding forms part of the analytical process in dealing with qualitative data in an attempt to 'make sense' of the data. Coding allows the linking of different segments of data to create categories of data having common elements. The coding links the data segments to particular ideas or concepts (Coffey & Atkinson, 1996). The real analysis takes place in establishing and reflecting on the relevant linkages and codes. The coding is not done merely to allow counting of concepts. Rather, coding allows the researcher to re-order the data and hence think about it in new ways. This new way of thinking about the data can allow new issues and patterns to emerge.

Therefore, the approach taken in coding the data is discussed in this chapter as it focuses on analysis of data. That is, coding and analysis are intertwined.

Several different approaches can be taken when coding data (Coffey & Atkinson, 1996; Miles & Huberman, 1994). For this study, two approaches were taken – (1) codes were generated prior to reading the transcripts from concepts outlined in the propositions or conceptual framework, (2) the data were coded as the researcher read through the text noticing new issues or categories and so generating new codes – in vivo coding. In vivo coding is an approach to coding that codes the terms and phrases that the subjects use – codes emerge from terms and concepts that are important to the subjects. Both of the above approaches were used for coding of data in this study. This approach ensured that each transcript was coded in terms of factors considered important from the researcher's perspective as well as from the interviewees' perspective.

4.3.1 Method of coding and developing constructs

The coding of data, the determining of key attributes in relation to this study, the formation of complex constructs, and the assigning of values to the attributes are outlined in the following sections. The discussion is framed in terms of a four-step process used to identify the key attributes through the coding process and the assigning of values to attributes. These four steps are (1) pre-defined coding, (2) in-vivo coding, (3) defining attributes and complex constructs, and (4) assigning values to attributes.

4.3.1.1 Step 1 – pre-defined coding

Prior to importation into NVivo the information within each transcript had been grouped according to the questions that formed the basis of the interviews (Appendix C). When imported into NVivo, these headings formed section headings within the

NVivo package allowing information from all interview scripts pertaining to one question to be readily linked to form a new document. The purpose of this step was to link the answers to any given question. This allowed the researcher to easily scan through the interview data in relation to any one question and see the varying responses. For example, all responses to the question relating to why systems were developed could be linked to form a new document to allow reflection and comparison between responses for different systems. The section headings that represented the questions meant that many aspects of the transcripts were coded almost automatically when imported into NVivo.

4.3.1.2 Step 2 – in vivo coding

In addition to the coding of responses to questions, each transcript was perused in detail and additional coding was undertaken. This coding approach allowed for issues or categories to emerge from the transcripts. Sometimes the codes were formed from phrases or words that the interviewee used. The codes were not pre-determined. Rather, the codes initially emerged from the data through a process of reading and re-reading the transcripts.

The coding approach undertaken in this part of the analysis was to code at the level of sentences and paragraphs as opposed to individual words or lines of text. A full list of coding attributes that arose using this approach is shown in Appendix E. A selection of this list is shown in Table 4-1.

Table 4-1 Issues or categories arising during the coding process

champion	different needs	easy to use
evolved	learning	maintenance problems
niche market	no real need	over engineered
training	use by date	user support

The researcher anticipated some of the coding terms but not others. For example, many interviewees mentioned the need for a champion for systems to survive and do well. This code emerged from the data. The main benefit of this aspect of the analysis is that it allowed the researcher to think about the issues surrounding the development and outcomes of intelligent support systems from the interviewees' perspective.

At this point the transcripts had been coded according to the questions asked and key coding terms that arose from the transcripts.

The following section outlines the approach taken in identifying key attributes and determining how to assign values to attributes that were not quantitative in nature. The approach taken in determining and defining complex constructs, such as degree of influence, and assigning values to these constructs in relation to a given system is outlined.

4.3.1.3 Step 3 – identifying and defining key attributes

The next step was to determine which attributes were important in the analysis of the systems and to determine on what basis values should be assigned to these attributes. A standard approach was required when assigning values to any given construct or attribute. For example, assigning the number of units sold to the attribute 'units sold' was straightforward. However, there is no absolute measurement for degree of user involvement, or impact of a system, or even adoption levels. Adoption levels could be measured in terms of units sold, or units sold as a percentage share of the target audience, or it could be measured in terms of usage. Even if questionnaires had been used that asked the user to rate, for example, the degree of user involvement in system development on a Likert type scale of 1 to 7 this rating system would mean different things to different people.

4.3.1.3.1 Factors considered important for examining scenarios influencing system outcomes

The following attributes arose from reference to the conceptual framework and from several readings of each of the transcripts as part of the coding process. These attributes were considered important factors to include when examining scenarios that could influence system outcomes. It is important to note that this list arose over a period of several weeks and many passes through the transcripts. The attributes are:

- Degree of user involvement

This is a complex construct that involves determining the degree of user involvement in relation to three aspects in system development. The three aspects are: (1) involvement in development, (2) involvement in testing, and (3) whether user feedback is incorporated into the system. This complex construct is discussed in detail in section 4.3.1.3.2.

- Type of user involvement

This attribute records the nature of the user involvement – ranging from none to consensus. The differing types of user involvement are drawn from Mumford's (1979) work but modified in relation to this study. The three types of involvement, from least to most direct are: (1) consultative – consulted with users from time to time or consulted with users after the system was developed, (2) representative – involvement of users through reference group or a testing group of selected users, and (3) consensus – involvement of users through working groups that involved many users on an on-going basis.

- Degree of user influence

This is a complex construct that involves determining the degree of user influence in relation to at least two aspects of system development. These two aspects are: (1) type of user involvement, and (2) degree of involvement. These two factors determine the degree of influence that users have in system development.

It is not just the type of involvement that impacts on influence but also the degree of involvement. Involvement, for example, may be consensual in that all users are involved but the developers may not talk with users that often - maybe just a couple of times and maybe only about superficial issues. Therefore, the degree of influence that users had over the system may not be that extensive. For this example, the type of involvement would be consensual but the degree of involvement would be low, resulting in, most probably, low user influence. Degree of influence is gauged by reference to type of involvement and the degree or depth of involvement.

Type of user involvement + Degree of user involvement → Degree of influence

If there was no user involvement of any type then clearly users had little or no influence on system features. If a few users were involved in testing at the end of the system development or input was sought but not really incorporated then this was seen as token involvement and coded as weak influence. If the views of many users were incorporated from the conceptual stage and/or the software was continually refined as a result of user feedback this was seen as extensive influence.

- Extent of required data input

This attribute records the extent of data input – ranging from none to extensive. The extent of data input was determined from the interviewee's response to a question relating to data input and in most cases was relatively straightforward to ascertain

(Question 21, Appendix C). However, the determining of how many data entry items represent basic input, reasonable input, or extensive input is specific to this study but is consistently coded for all systems. For this study the following criteria were used in determining levels of data input. Systems were coded as minimal input that used mainly point and click for data entry. For example, most data could be entered using drop down lists and users had very little typing to do. Basic input was when the user had to enter around five data categories and/or if the interviewee indicated input was basic. Reasonable input was for around six to 15 data categories or if indicated by interviewee. Extensive data input was when over 15 data items were required for input or if indicated by interviewee that data input was extensive. If data input appeared to be of a complex nature it was coded as extensive.

- Who initiated

This attribute records the status of the person who initiated the development of the system, for example, researcher, extension officer, and the like. The interviewee provided this information.

- Current status

This attribute records the current status of the system. The interviewee provided this information.

- Adoption outcome

This attribute records the adoption outcome for a given system. Typically it is in terms of units sold. If an interviewee knew the percentage of the target audience that the units sold figure represented, then this information was used when known as it represents a more meaningful figure. A system was coded as having a low adoption level if less than 100 units were sold or if this figure represented less than 10% of the market share. A system was coded as having a reasonable adoption level if it sold between 100 and 300 units or had reached between 10 to 20% of the potential market. A system was coded as having a high adoption level if it sold over 300 units or reached more than 20% of the potential market. If, for example, the sale of 15 units represented 30% of a target market then the system would be coded as having a high level of adoption. It is the case that the actual numbers of units sold to indicate low, reasonable, and high adoption were arbitrarily determined. The main point is, however, that within this study these figures are applied consistently. As well, this method allows for better cross study comparisons than the situation where a user is asked to rate the adoption level in terms of, for example, a 1 to 7 Lickert-type scale.

Information from the transcript could over-ride this coding. For example, a system where hundreds of units were distributed freely may not be coded as high adoption if information in the transcript indicated that the number of users was considerably lower than the number of units distributed. This over-riding of the adoption code was seldom done.

- Technical outcome

Technical outcome relates to the impact that development of the system had on the understanding of the issues surrounding the original problem. This attribute arose from the data itself. That is, it became apparent that there were a number of ways developers judged their systems – adoption level was one aspect of success while technical outcome was another. The target users may not have adopted a system but through the process of developing and using the system the researchers' or developers' knowledge and understanding of issues relating to the problem may have improved. The fact that developers had more than one way of judging the outcome of their software raises the interesting issue of how to determine whether a system is successful or not. Lyytinen (1988) raises the issue of information systems failures and the fact that failure is not all or nothing. There are differing degrees of failures. He also comments on the static view of failure. The same is true for success. There are many dimensions to success. A system may be viewed as successful at one point in time and unsuccessful at another point in time.

A system was coded as having a poor technical outcome if there were technical problems with the tool. If a system had an impact on how researchers/advisory staff viewed a problem or if it aided understanding of a problem then the outcome for the system was reasonable. If the system was viewed as a very useful tool for research or was used by farmers or if it had considerable overseas interest in the product then the technical outcome for the system was high.

- Reason for developing

This attribute records the reason why a system was developed. Many systems were developed as a tool to deliver research findings to the user. This type of approach was classified as a 'technology transfer approach' to system development. Other systems were developed because of a 'perceived need'. That is, users were asking for something that would help them. Alternatively, a service provider developed a system for their own use to allow them to provide a better service to the farmers. These systems were classified as developed because there appeared to be a need for such a system. Some systems appeared to be developed from both a technology transfer approach as well as because of a perceived need. These systems were classified as being developed because of both a perceived need and also as a mechanism for technology transfer.

- Reason for outcome

This attribute records the reason the interviewee gave for their perception of the outcomes from the system.

- Impact of the system

The impact of the system is a complex construct and involves examining the number of units sold, percentage share of the market, and other information provided during the interview. This complex construct is discussed in detail in section 4.3.1.3.2.

Table 4-2 details the above attributes and provides information on the range of values allocated for each attribute and the guide that was used in assigning these values.

Table 4-2 Coding of key attributes

Key attributes	Range of values	Guide to assigning values
Degree of user involvement	None Minimal Reasonable Extensive	Depending of the involvement in all of the following: • Involved in development • Involved in testing • Feedback from users incorporated into updates.
Type of user involvement	No involvement	Basically little to no involvement.
	Consultative	Consult with users from time to time or consult with users after the system is developed.
	Representative	Involvement through reference group or a testing group of selected users.
	Consensus	Involvement through working groups that involves many users on an on-going basis.
Degree of user influence	Little or no influence	No involvement.
	Weak influence	Involve testers at end or sought user input but not really incorporated – token involvement.
	Reasonable influence	User has impact on system (mainly through feedback or beta testing) but either not involved in the conceptual stages or minimal input in early stages.
	Strong influence	Incorporate views of users from conceptual stage and continually refine software from user feedback.

Key attributes	Range of values	Guide to assigning values
Data input	Minimal	Mainly point & click - most data entered using drop down lists etc. User has very little typing to do.
	Basic	Around five data categories or if indicated by interviewee.
	Reasonable	Around six to 15 data categories or if indicated by interviewee.
	Extensive	Over 15 data items to enter or if indicated by interviewee that it is extensive or if data that are required appeared to be of a complex nature.
Who initiated	List of professions	Identified by interviewee - simply list
Current status	Active Growing Prototype Slow/Dormant/Plateau Under Revision Withdrawn Withdrawn-upgrade &/or Y2K	As indicated by interviewee
Adoption outcome	Low	$\leq$ 100 units sold OR $\leq$10% market share
	Reasonable	>100$\leq$300 units sold OR >10$\leq$20% market share
	High	>300 units sold OR >20% market share
	Over-riding of above	If compelling reason to over-ride above
	Unclear	Not enough information to determine

Key attributes	Range of values	Guide to assigning values
Technical outcome	Poor	Technical problems with tool.
	Reasonable	Tool had an impact on how researchers/advisory staff view problem. Aided understanding.
	High	Very useful tool for research or used by farmers. Sold overseas.
	Unclear	Not enough information to determine.
Reason for developing	Saw need	Example: if interviewee used term such as 'saw need' or if system was developed to help farmers overcome some perceived problem.
	Technology transfer	Example: if interviewee used term like 'technology transfer' or indicated reason was to combine years of research.
	Saw need & technology transfer	Used when it appeared to be a combination of above two.
Reason for outcome	Coded according to answer given by interviewee	
Impact of system	Low	Adoption score plus other information. Generally impact is similar to adoption. An example where they differ is when units distributed and uptake appear to be different. This over-riding option was seldom used.
	Medium – not low and not high	
	High	

4.3.1.3.2 Determining the elements involved in complex constructs

Two complex constructs were identified: (1) user involvement, and (2) impact of the system. These attributes were constructed through reference to a number of factors. The process of determining the factors that constitute the formation of a complex construct, such as degree of user involvement, was the result of many passes through the data. The approach taken was to read through the transcripts to determine the factors that together formed a particular construct.

The factors involved in each of the two complex constructs are now discussed.

(1) user involvement

The construct of user involvement was determined to be composed of three different aspects of user involvement in the system design - involvement in development, involvement in testing, and whether user feedback, as a result of using the system, was incorporated into the system (Table 4-2). From these three ratings, a value was assigned to the attribute 'degree of user involvement'. For example, if users had been involved in a minor way in testing then the degree of user involvement was minimal. If users had been involved in a minor way in testing but as well the system had been changed to incorporate user feedback then user involvement would be scored as reasonable – depending on the nature of the changes made. Generally, the extent of user involvement was clear from reading the transcripts. The above process made the assigning of values more systematic.

(2) impact of the system

The coding strategy for the impact of the system involved looking at the adoption levels, market share, the technical outcome, and other information that gave some indication of the impact that the system had amongst users. An example where additional information was used to determine the impact code is the system *WHEATMAN*. *WHEATMAN* had sales of around 200 units representing just 4% of the potential market. This would result in this system being coded as low adoption. However, information generated by the *WHEATMAN* system is available to farmers through newsletter, fax sheets, and newspapers. It seemed that the information generated by the system had impacted on farmers even though they have not interacted with the system. Generally, however, adoption and impact assessment were the same.

The issue of determining the impact of a system highlights the problem of determining what constitutes success. In their review of the literature on system success, DeLone and McLean (1992) suggest that there are six major dimensions or categories of information systems success. These are: system quality, information quality, use, user satisfaction, individual impact, and organisational impact. They suggest that these categories are six *inter*dependent dimensions to information systems success rather than six independent success categories (p.88), and that information systems success is a multidimensional construct and should be measured as such.

Myers (1994a) points out that success is not easy to measure. 'Any attempt to define success in terms of fixed categories simply misses the dynamics of what success and failure really means in the context of social and political life (p.196)'. Success is a construct that is open to many interpretations. Myers also points out that implementation success or failure is a matter of interpretation and that the interpretations can change over time (Myers, 1994b). Davis *et al.* (1992) suggest that failure is 'easier to define, identify, and agree upon than success' (p.295).

However, Lyytinen (1988) suggests that there are many dimensions to information systems failure and that it is not the simple notion that many would suggest.

As this research unfolded the researcher was confronted with several differing evaluations of what constituted a successful system. To ask developers to rate whether the system was successful on a one to 10 scale would not necessarily mean that from system to system the scale would be measuring the same outcome. The scale would be recording the respondent's interpretation of whether the system was successful with no understanding of what the interpretation entailed. As outlined, adoption levels, which included market share when known, and other relevant information indicated success in this study. It is acknowledged that sales or distribution of copies of software does not necessarily indicated system usage. Users may no longer be using the system and may have never used the system. However, a 'sense' of the outcome for each system was gained through the interviews. The method adopted enables a system that had sold nine units to be coded as high impact (nine units representing 100% of the market). The impact of a system is very hard to determine. The interviewee for the system, *NPDecide*, raised the issue of determining the impact of these types of systems.

> *It is very difficult to assess the impact of these types of systems. Information is sent out when extension staff/producers seek info. There is a multiplier effect as agency staff pass on info and it becomes incorporated into general knowledge. It is very hard to draw a direct line between cause and effect - you cannot do a with and without type of analysis. For example, what would have happened if this information wasn't generally available.*

In further studies a fuller assessment of the impact that a particular system has could be gained by interviewing users of a system or any one who had used the information generated by the system to determine what impact it had made on their decision-making. To gain more information on impact, data could be collected prior to release of the system and again after the users had interacted with either the system or the information generated by the system.

The limitations of assigning impact outcomes to the systems in the current study are acknowledged.

4.3.1.4 Step 4 – constructing the matrix table – assigning values

The next step in the coding of the transcripts required the assigning of values for each of the 44 attributes for each of the 66 systems. A full list of the attributes is shown in Appendix F. The list also indicates attributes not discussed in this thesis. The full list shown in Appendix F contains attributes that either did not add any value to understanding the status of intelligent support systems in Australia or else had large numbers of missing data. Information for some questions was not common knowledge for many interviewees resulting in a high level of missing data.

During this process of assigning values to the attributes, the transcripts were again thoroughly perused several times by the researcher and notes were made on key points. Using this information the attributes within the matrix table were assigned values. The attributes in the matrix table relate to features about the systems, for example, number of units sold, as well as aspects of the development process, for example, degree of user involvement. While degree of user involvement is shown as one field in the matrix table, it reflects information drawn from a wide-ranging set of information provided by interviewees.

For many of the attributes the issues of assigning values was relatively straightforward as the data could readily be categorised. Examples of this type of data are: number of systems sold, years on the market, operating system, role of the interviewee in relation to the system, web presence. The results from this type of data are presented in section 4.4 and in Appendix G where interesting details of the intelligent support systems included in this study are discussed. For other attributes, however, the assigning of values required critical analysis and reflection. The assigning of values was guided by reference to Table 4-2.

Once values had been assigned to the attributes, the systems were grouped into two groups - those systems targeted or used by farmers and those systems not principally targeted at or used by farmers. The systems were then grouped into four groupings - systems perceived to have had a high impact, low impact, medium impact (not low or not high), and systems where the impact could not be clearly determined. Each system within each of these levels of impact groups was again re-examined. The outcome of this further examination of the transcripts is discussed in section 4.5.

An independent researcher checked the coding method and was able to code the transcripts to match the coding values assigned by this researcher. Despite this, however, it is acknowledged that there is still a certain amount of subjectivity to assigning values using this method. However, within this study the coding approach is uniform and hence the study allows for a reliable within study comparison of factors.

This section has outlined the approach taken in analysing and coding the data. Section 4.4 highlights the important details collected in relation to the 66 systems. The analysis represents a snapshot of the status of intelligent support systems in

Australian agriculture around the start of the year 2000. An overview of the analysis of system success is then discussed.

4.4 Details of intelligent support systems surveyed

From the initial list identifying 128 intelligent support systems, 66 systems were included for analysis in this study. These 66 systems were in the public domain and represent the more successful systems in that they have moved beyond the prototype stage and had some acceptance – at least initially. Details of these 66 systems provide a snapshot of the status of intelligent support systems in Australian agriculture at the time of the interviews (July 1999 – May 2000).

4.4.1 All systems

Fifty three (80%) of the 66 systems were classed as decision support systems, the remainder were expert systems (Table 4-3).

Table 4-3 System type

System type	Frequency	Percent
DecisionSupportSystem	53	80.3
ExpertSystem	13	19.7

Most systems, 56 (85%), were developed by government organisations. Only 10 systems (15%) were developed by non-government organisations (Table 4-4).

Table 4-4 Developed by

Developed by	Frequency	Percent
Government	56	84.8
Non-government	10	15.2

There are a disproportionate number of systems developed from one state – the state of Queensland (Qld). Twenty seven of the systems (41%) were developed in this state. Sixteen systems (24%) were developed in the state of New South Wales (NSW). Tasmania had the next highest number, 7 systems (11%). One individual developed six of the systems from Tasmania (Table 4-5).

Table 4-5 State where developed

State where developed	Frequency	Percent
NSW	16	24.2
NT	1	1.5
Qld	27	40.9
SA	5	7.6
Tasmania	7	10.6
Vic	2	3.0
WA	6	9.1
Unclear	2	3.0

Of the 66 systems, 37 (56%) were either still active or growing (in terms of sales). Twenty systems (30%) were either withdrawn or dormant (Table 4-6).

Table 4-6 Current status

Current status	Frequency	Percent
Active	26	39.4
Growing	11	16.7
Slow/Dormant/Plateau	11	16.7
Withdrawn	9	13.6
UnderRevision	4	6.1
Withdrawn - upgrade & Y2K	1	1.5
Prototype	2	3.0
Not known	2	3.0

Fifty one systems (77%) had primary users who were either farmers or service providers (Table 4-7). Many systems were used by both of these groups. The commercial industry group represented 11% of systems. Systems that are used by seed merchant companies or fertiliser companies fall into this group. A service provider is an individual who works for either a government or non-government organisation and provides advice to farmers in relation to farming strategies.

Table 4-7 Primary users

Main users	Frequency	Percent
Commercial_Industry	7	10.6
Contractors	1	1.5
Educationalists	1	1.5
LandCareGroups	1	1.5
LandManagers	1	1.5
Farmers/Producers	27	40.9
Researchers	2	3.0
ServiceProviders	24	36.4
Unclear	2	3.0

However, the scenario of who actually uses the system, that is, the primary user, is different from who the systems were actually targeted at (Table 4-8). Thirty five of the systems (53%) were developed with farmers in mind as target users. Yet, only 27 (41%) of the systems identified farmers as the main users. So clearly, not all of the systems targeted at farmers are being taken up by them to the level anticipated by the developers.

Table 4-8 Target users

Target users	Frequency	Percent
Commercial_Industry	7	10.6
Contactors	1	1.5
LandManagers	2	3.0
Farmers/Producers	35	53.0
ProfessionalFarmers	1	1.5
ServiceProviders	16	24.2
Service	3	4.5
Veterinarians	1	1.5

Forty four (67%) of the systems sold for $500 or less. In addition, 8 systems (12%) were distributed free of charge (Table 4-9). That is, 79% of the systems were priced at $500 or less. The pricing of these systems is an issue that concerns commercial companies who must place a realistic price on their software to cover development and maintenance costs. Systems developed by government organisations, on the other hand, are often not priced to cover development and maintenance costs. All the systems distributed for free or for under $250 were developed by government organisations.

Table 4-9 Cost

Cost - $AUD	Frequency	Percent
free	8	12.1
≤100	14	21.2
>100≤250	5	7.6
>250≤500	25	37.9
>500≤1000	3	4.5
>1000≤2000	2	3.0
≥9000	1	1.5
Not known	1	1.5
Not applicable	3	4.5
Not for sale	3	4.5
Service fee	1	1.5

The systems developed by non-government organisations did not receive any public funding – further disadvantaging the private developer in terms of setting a competitive price for their software (Table 4-10). Many of the government systems received funding via either government grants or else grants from related industry groups or agencies.

Table 4-10 Cross tabulation – funded and developed by

Funded	Developed by		
	government	non-government	Total
Yes	33	0	33
No	20	9	29
Unclear	3	1	4
Total	56	10	66

While it is obvious that success cannot be entirely gauged by number of units sold or distributed, the number of units sold or distributed does give an indication of the level of interest in a system (Table 4-11). Forty three systems (65%) had sales of 200 units or less. Twelve systems (18%) had sales between 200 and 500 units. Six systems (9%) sold 500 or more units.

Table 4-11 Units sold/distributed

Units sold/distributed	Frequency	Percent
<50	18	27.3
≥50<100	9	13.6
≥100<200	16	24.2
≥200<300	9	13.6
≥300<400	2	3.0
≥400<500	1	1.5
≥500<600	-	-
≥600<700	1	1.5
≥700<800	-	-
≥800<900	-	-
≥900<1000	1	1.5
≥1000<3000	2	3.0
≥3000<4000	1	1.5
>4000	1	1.5
Unclear	2	3.0
Not applicable	3	4.5

As indicated, some of these system were distributed free of charge. Table 4-12 outlines the relationship between the number of units sold or distributed and the cost of the unit. Of the six systems priced over $500, 4 had sold over 200 units. One of the systems had sold over 3000 units. This system, PAM, is a management tool with decision support facilities that is owned and managed by a private organisation[4].

Table 4-12 Cross tabulation – units sold/distributed and cost per unit

		Sold/Distributed													
		<50	≥50 < 100	≥100 < 200	≥200 < 300	≥300 <400	≥400 <500	≥600 <700	>900< 1000	>1000	>3000	>4000	Not known	Not applic	Total
Cost	Free	3		1		2			1				1		8
	≤100	5	3	4	1					1					14
	>100≤250			4	1										5
	>250≤500	7	5	7	2		1	1		1		1			25
	>500≤1000				2						1				3
	>1000≤2000		1		1										2
	≥9000	1													1
	Not known												1		1
	Not applicable	1			1									1	3
	Not for sale	1			1									1	3
	Service fee													1	1
	Total	18	9	16	9	2	1	1	1	2	1	1	2	3	66

4 www.fairport.com.au

For the six systems priced at over \$500, the outcome for four of the systems was coded as having had a high impact, one a medium impact, and one low impact (Table 4-13). Non-government organisations or individuals developed three of the four systems priced over \$500 and rated as high impact. Impact can be roughly related to units sold (Section 4.3.1.3.2). These four high impact systems are regarded as successful systems.

Table 4-13 Cross tabulation – impact of system and cost per unit

		Impact of system					
		High	**Medium**	**Low**	**Not clear**	**Too early**	**Total**
Cost	Free	2	2	1	3		8
	≤100	2	6	4	1	1	14
	>100≤250	1	4				5
	>250≤500	7	7	8	2	1	25
	>500≤1000	2	1				3
	>1000≤2000	1		1			2
	≥9000	1					1
	Not known			1			1
	Not applicable	1		1		1	3
	Not for sale	1			1	1	3
	Service fee				1		1
	Total	18	20	16	8	4	66

Ten of the systems were developed by non-government organisations (Table 4-14). Seven (70%) of these systems were coded as high impact systems. This is in contrast to only 11 (20%) of the 56 systems developed by government organisations being coded as high impact.

Table 4-14 Cross tabulation – impact of system and developer

		Impact of system					
		High	**Medium**	**Low**	**Not clear**	**Too early**	**Total**
Developer	government	11 (19.6%)	20 (35.7%)	13 (23.2%)	8 (14.3%)	4 (7.1%)	56 (100%)
	non-government	7 (70%)		3 (30%)			10 (100%)
	Total	18	20	16	8	4	66

Given that public funding only went to systems developed by government organisations the issue of system outcome could be an issue for funding agencies who would clearly be interested in outcomes in terms of their investment.

Table 4-15 shows details on the 56 systems developed by government organisations, 33 of which received funding through either government grants or industry levies. The outcome for those systems in comparison for systems that did not receive funding is shown. Whether a system received funding or not does not appear to impact on the outcome. Of interest to funding agencies is the fact that only 6 (18%) of the 33 systems that received funding were coded as having a high impact. The level of funding varied from system to system and so caution must be taken when interpreting the results.

Table 4-15 Cross tabulation – impact of system and funding

		Impact of system					
		High	**Medium**	**Low**	**Not clear**	**Too early**	**Total**
Funded	Yes	6 (18.2%)	11 (33.3%)	7 (21.2%)	6 (18.2%)	3 (9.10%)	33 (100%)
	No	4 (20%)	7 (35%)	6 (30%)	2 (10%)	1 (5%)	20 (100%)
	Not known	1	2				3
	Total	11	21	13	7	4	56

The conceptual framework proposed that user involvement in information system development is one way of developing systems that meet the needs of users and this can lead to better adoption rates. Thirty eight systems (58%) had minimal to no user involvement (Table 4-16). Eight systems (12%) had user involvement coded as extensive.

Table 4-16 Degree of user involvement

User involvement	Frequency	Percent
Extensive	8	12.1
Reasonable	13	19.7
Minimal	28	42.4
None	10	15.2
Not clear	7	10.6

The relationship between user involvement and system outcome is explored in detail in section 4.5.

Systems developed by private individuals or organisations had a higher degree of user involvement than those developed by government organisations (Table 4-17). The small number of systems developed by non-government organisations indicates caution should be taken when interpreting the results. However, 6 (60%) of the 10 systems had user involvement coded as reasonable to extensive. In contrast, 15 (27%) of the 56 systems developed by government organisations had user involvement coded as reasonable to extensive.

Table 4-17 Cross tabulation – user involvement and developer

		User involvement					
		Extensive	Reasonable	Minimal	None	Not clear	Total
Developer	government	7 (12.5%)	8 (14.3%)	27 (48.2%)	8 (14.3%)	6 (10.7%)	56 (100%)
	non-government	1 (10.0%)	5 (50.0%)	1 (10.0%)	2 (20.0%)	1 (10.0%)	10 (100%)
	Total	8 (12.1%)	13 (19.7%)	28 (42.4%)	10 15.2%)	7 (10.6%)	66 (100.0%)

Project management during the development of the systems was low (Table 4-18). Project management requires the formation of a committee or group to oversee system development. It consists of a relatively structured process of defining tasks and planning and scheduling those tasks before beginning the project. The progress of completion of the tasks is monitored during the life of the project. Only 19 systems (29%) had used project management when developing the system. Project management was rarely in terms of information systems project management. This type of management involves a methodical approach to system development involving analysis, planning, development, testing, and maintenance. Two systems, *Feedmania* and *Herbiguide*, were identified as using an information systems approach to project management. Both systems had good adoption levels. Of the 19 systems that used project management, eight (42%) had an outcome of high impact. Of the 26 systems that did not use project management, three (12%) had an outcome of high impact.

Table 4-18 Project management

Project management	Frequency	Percent
No	26	39.4
Yes	19	28.8
Not know	21	31.8

Further details concerning the 66 systems are included in Appendix G.

4.4.2 Summary of system details – all systems

Fifty three (80%) of the 66 systems were classed as decision support system. Of the 66 systems, 37 (56%) were still active. Fifty two (79%) of the 66 systems were either free or priced at $500 or less. All the systems distributed for free or for under $250 were developed by government organisations.

In terms of units sold or distributed for free, forty three systems (65%) had sold or distributed under 200 units. Ten of the 66 systems were developed by non-government organisations. Seven (70%) of these 10 systems were coded as high impact systems. This is in contrast to only 11 (20%) of the 56 systems developed by government organisations being coded as high impact.

Thirty eight systems (58%) had minimal to no user involvement. Only eight systems (12%) had user involvement coded as extensive. Only 19 systems (29%) had used project management when developing the system. Project management was rarely in terms of information systems project management.

4.5 Different patterns of success

The previous section provided an overview of the salient details of the 66 systems that were studied in this research. Of those 66 systems, a total of 38 systems were identified as targeted at farmers or used by farmers and 28 systems were not directly targeted at farmers. The 38 systems have been categorised into high impact, low impact, medium impact (not high/not low), not known or not clear, and too early. As pointed out earlier, these 38 systems represent the successful systems in that they moved beyond prototype stage and had some usage amongst farmers.

Table 4-19 identifies the 38 systems studied in detail and the outcomes for those systems.

Table 4-19 Perceived impact of systems

High	**Medium (Not high Not Low)**	**Low**	**Not known**	**Too early**	**Total**
n=9 (24%)	n=14 (37%)	n=11 (29%)	n=2 (5%)	n=2 (5%)	38
AVOMAN CottonLOGIC* FeedLotto FeedMania Herbiguide Pam ProfitProbe PYCal * Rainman	Ausvit BreedCow CamDairy DSFM GrazeOn # Herd-econ LambAlive LCDP NPDecide * Proplus # Takeaway WeedWatch # WHEATMAN Zack	Applethining Beefin BreedBull (alias) ChickBug DairyMaster Littermac Milkcool PastureMaster Sheepo WaterSched WeedMaster	HowOften * HowWet *	DairyPro HotCross	

Notes: * free (no charge); # Borderline high impact system
Impact of system - See section 4.3.1.3.2 for criteria used to determine impact

Before considering the impact of the systems the researcher would like to point out that classification of the systems into these categories is from her interpretation of the information gathered. The main aspect from the researcher's perspective was to try to clearly separate low impact systems from high impact systems. The many systems that fall in between these too extremes may be borderline between being classified as either low impact or high impact, or may have clearly fallen into the medium impact category. The point that needs to be stressed is that no value judgement is being made on the integrity of individual developers or on the value of individual systems. The intent of the research is to try to determine those scenarios that are more likely to lead to success in terms of adoption and impact. Through the collection of this data, many developers shared valuable insights into why they developed their systems and what they hoped to achieve. As well, some interviewees reflected on underlying reasons for failed systems. One of the intentions of this research is to share these insights with others.

Initially the discussion will focus on those systems that were classified as low impact systems. This will be followed by discussion of high impact systems. These systems lie at the two extremes of outcomes; by examining these systems it is anticipated that a clearer understanding of the different scenarios that impacted on the outcomes will emerge.

4.5.1 Low impact systems

Table 4-20 details features of the 11 systems coded as having a low impact. These features or attributes have been coded using the coding strategy outlined in Table 4-2. The systems in Table 4-20 have been sorted firstly by degree of influence, then by degree of user involvement, and then by type of involvement.

The 'Reason for outcome' attribute reflects the interviewee's understanding of the reason behind the system outcome. In some instances this will be inline with an evaluation of low impact. In other instances, for example, *Chickbug* and *WaterShed*, the comments suggest that the interviewee believes the systems had been successful and the comments indicate the reason for this success. This aspect of evaluation is discussed later.

Eleven of the 38 systems that were either developed with farmers in mind, or that have been used by farmers, have been coded as having an outcome of low impact. Of these 11 systems, all of the systems (where the information was available) had either no user involvement or minimal user involvement resulting in either minimal or no user influence. Nine of the systems have been withdrawn (one for Y2K modifications) leaving only two of the systems still active – *Littermac* and *Applethining*.

Table 4-20 Low impact systems – 11 systems

System	Degree of influence	Degree of user involvement	Type of involvement	Data input	Who initiated	Current Status	Adoption	Technical outcome	Reason for developing	Reason for outcome
Beefin	No influence	None	None	Reasonable	Researcher	Dormant	Low (50 sold, 75 free)	Not clear	Technology Transfer	Not enough marketing
WaterSched ++	No influence	None	None	Reasonable	Service Provider	Withdrawn – Y2K	Low (30-40 units)	Reasonable	Saw Need	Learn from using
WeedMaster ++ (ES)	No influence	None	None	Minimal – point and click	Service Provider	Withdrawn	Low (70-80 units)	Reasonable	Saw Need & Technology Transfer	No real need
PastureMaster ++ (ES)	No influence	None	None	Not clear	Service Provider	Withdrawn	Low (40 units)	Not clear r	Technology Transfer	Non buoyant market
Sheepo	No influence	None	None	Extensive	Researcher	Dormant	Low (103 units – few use it)	Reasonable	Technology Transfer	Data input problems
DairyMaster	Weak influence	Minimal	Consultative	Extensive	Veterinarian	Withdrawn	Low (80-90) units)	Not clear	Saw Need & Technology transfer	Not enough marketing
Applethining (ES)	Weak influence	Minimal	Consultative	Reasonable	Service Provider	Active	Low (20 units sold 10% market)	Reasonable	Technology Transfer	No real need
Littermac	Weak influence	Minimal	Consultative	Extensive	Service Provider	Active	Low (15 units – 2% market)	Not clear	Saw Need	Not enough marketing
Chickbug ++ (ES)	Weak influence	Minimal	Consultative	Reasonable	Researcher & Service Provider	Withdrawn	Low (20-30 units)	Reasonable	Saw Need	Useful
MilkCool ++	Weak influence	Minimal	Consultative	Reasonable	Domain authority	Not known - assumed dormant	Not known	Reasonable	Saw need	No champion
BreeedBull (alias) ++	Not clear	Not clear	Not clear	Reasonable	Researcher	Withdrawn	Low (nbr units - NFP)	Unclear – tech problems	Not clear	No real need

Notes: ++ developed for both farmers and service-providers; ES – Expert System; NFP – not for publication

The systems will be discussed in the order that they appear in Table 4-20.

The following five systems had no user involvement in system development resulting in users having no influence on system features.

Beefin

Beefin maximises diets for cattle using a least cost formula. *Beefin* was developed by a researcher from a technology transfer perspective. There was no user involvement and the system is currently dormant. The level of data input required by users was seen as reasonable. The system sold 50 copies at $50 while 75 copies were distributed free. The system is now available free of charge. From the interview data, the technical outcome of the system was unclear.

Testing for *Beefin* was from a technical perspective – not from a users' perspective.

> *Testing was mainly on the nutritional accuracy - rather than user testing.*

The interviewee believed that there was a large amount of work for not much gain. The system was a 'spin off' from a Beef Farm model. That is, the DSS arose from a research model. The interviewee believed that the outcome for the system was due to limited marketing. There was no mention of the fact that the system may not have met the needs of users.

WaterSched

Watersched was developed to assist farmers determine when to schedule the next crop irrigation. There was no farmer involvement in the development of this system. The system was withdrawn as it was not Y2K compliant. It sold around 30 to 40 units for $50 each. The system was developed by a service provider because of a perceived need. The level of data input for the system was seen as reasonable. The technical outcome for the system was reasonable. The system was developed with farmers as the target audience but mainly extension staff used it.

The interviewee was involved in the development of this system and the *ChickBug* system. For both systems the interviewee indicated that the systems had a good outcome – despite the low number of units sold. For *WaterSched* the outcome was seen as good because:

> *A number of people used the system and learnt from using the system.*

This is an example of the differing ways of classifying a system as successful.

WeedMaster

WeedMaster is an expert system that provides the farmer with three herbicide options to deal with a weed infestation. When the user inputs details on the name of the cereal crop, the stage in the life cycle of the crop, and the name of the weed infestation the system returns the best three herbicide options. It was developed by a private consultant with research interests in this area.

There was no user involvement as the interviewee indicated that he had 25 years of advising experience and had a belief that he had a good idea of what was required. Data input was minimal and the system was developed from both a perceived need and also to deliver technical information. The system sold around 70 to 80 units at a cost of $300. Output was tested in terms of matching experts' recommendations and the level of matching was between 80-90%. The system gave unbiased advice quickly. Given this, the technical outcome for the system was coded as reasonable.

However, farmers did not buy the system; rather, young salesmen in the agronomy area used it. This represented too small a market to warrant continuation. Some agricultural merchandise stores used it plus some private consultants. The interviewee described the system as a failure given the fact that farmers did not buy the system.

PastureMaster
PastureMaster is an expert system used for weed control in pastures. The service provider who developed *WeedMaster* also developed this system. There was no user involvement and the system is currently withdrawn having sold around 40 units at $300 each. The technical outcome for the system is unclear. The developer had 25 years of advising experience and once again, as with *WeedMaster*, was of the opinion that he had a good idea of what was required. Output was tested in terms of matching experts' recommendations. The interviewee saw the system as a failure resulting from a non-buoyant wool market. Failure was not seen in terms of the system not meeting the users' needs but rather because of farmers' limited money to spend on software.

Sheepo
Sheepo was designed to help farmers make better management decisions. There was no user involvement and the system was developed from a technology transfer perspective. The amount of data input required by the system was extensive and it required data to be entered that was not readily available. Researchers developed the system and it is currently dormant. It had sales of around 100 units. The technical outcome for this system was coded as reasonable because information from the interviewee indicated that it was a powerful tool in terms of performance indicators. The interviewee indicated that the reason for the outcome was because of problems with data input requirements. The interviewee for *Sheepo* was the programmer involved in the development of the system. The interviewee felt that it was a system that was ahead of its time and that the role of researchers was to be leaders. The system was developed for farmers but only a handful use it. Of interest is the fact that the advisory officer involved in testing this system uses the package. It can be assumed that the system meets his/her needs.

The following five systems had minimal user involvement resulting in users having weak influence over the nature and look and feel of the systems.

DairyMaster

DairyMaster enables the identification of animals requiring attention. The system was targeted at veterinarians but few use it and it is mainly used by farmers. There was minimal user involvement with users having weak influence in the development of the system through a consultative process. The system was developed by a veterinarian to meet a perceived need and also as a technology transfer tool. The system required extensive data input by users and had output that was complex to interpret. Approximately 80 to 90 units were sold and the system was withdrawn. The technical outcome for the system is unclear.

The interviewee stated that it is one thing to write a program but another completely different issue to market it. This lack of marketing skills was seen as a major problem in the uptake of the program. It appears that the system may have been too complex for the users:

> *Disappointed with the feedback. The system did too much. Farmers did not use the system properly. They tended to use it for record keeping and not as a decision-making tool/aid. Lots of farmers processed the data but were not interested in the results.*
>
> *A lot of data is required. Some of this data, farmers would keep. Some of it they may not keep but should do. Often their data is all over the place - the system allows them to collate all their animal records.*

It would seem that the developer wants the users to meet his expectations of their needs rather than the developer meeting the users' needs. The purchase price for the software was revised downward on a number of occasions but sales remained low. The interviewee was of the opinion that it was hard to make a living in the dairy industry and farmers felt they had neither the time nor the money for this type of system.

The interviewee was disappointed that the farmers used the system as a record-keeping tool. He did not perceive this as indicating that users wanted a record-keeping tool rather than a decision support system.

Applethining

AppleThining is an expert system that assists farmers determine the correct concentration of chemical application required to thin crop load. The system had minimal user involvement and was developed by a service provider from a technology transfer perspective. Users had weak influence over the nature of the system through a consultative process. The amount of data input required by users was reasonable and the technical aspect of the system was reasonable. It sold 20 copies representing 10% of the market. The reason given for the outcome was that there was no real need for the system at the current moment.

The system was developed because a department officer who held the knowledge was about to retire and many farmers were seeking advice from the department. However, few farmers have taken up the software. The interviewee felt that farmers already knew what to do with the current varieties of apples and indicated the outcome for the system was because there was currently no real need, although it was believed that this would change as new varieties of apples were introduced. The software tool had a good technical outcome because:

The knowledge engineering of the problem itself has changed the way in which those involved in spray thinning research think about new experiments for other cultivars and possible new spray thinners.

This system has undergone some revision that incorporates user feedback and a new version is to be released. While there was little user involvement during development the developer indicated that he always listens to what the user has to say. There are several examples of systems where user feedback is incorporated after users have used the system rather than user involvement from the early stages of development. The system did not meet a need and so was not taken up.

Littermac

Littermac was developed by a service provider to record and analyse pig farm data. There was minimal user involvement. The involvement was of a consultative nature resulting in users having a weak influence on the design of the system. It requires extensive data input and has sold around 15 units that represents around 2% of the market. The system is still currently active; however, the technical outcome for the system is not clear. The interviewee identified lack of marketing as the reason for limited uptake. However, the amount of data required for input may have contributed to low adoption.

Requires constant input. The user needs to enter data every week otherwise results are less meaningful. Requires constant, but not complicated, input. The more regular the better.

Chickbug

Chickbug is an expert system that was developed to help farmers identify and deal with insect infestation on a newly introduced crop. It was developed because of a perceived need but appears to have had minimal user involvement. This involvement was consultative in nature with users having a weak influence on conceptual issues. The amount of input required was reasonable. *Chickbug* had low sales of 20 to 30 units and sold for around $30. However, the developer saw this system as being successful because learning occurred through using the system.

> *Learning occurred through using the system and so it is no longer needed as much. It served its purpose.*

However, the interviewee then goes on to state that there is still a need for the system but it currently has no champion driving it. The system is currently withdrawn. The system was developed by research and extension staff, received no funding, and took about one year to develop. This system had a technical outcome coded as reasonable.

While the system had limited uptake the interviewee who was the developer of the system was happy with the outcome for this system and indicated that the system had a good outcome because it was useful.

MilkCool

MilkCool was developed to help dairy farmers evaluate the optimum milk cooling system for their farm. The system had minimal user involvement that was consultative in nature and resulted in users having weak influence over the nature and design of the system. The level of data input required from users was reasonable. The system was developed by a domain authority because of a perceived need to help farmers reconsider their cooling systems. The current status is unknown but assumed to be either dormant or withdrawn. One reason identified by the interviewee for *MilkCool* not having a better outcome was the fact that it did not have a champion. In fact, because it did not have a champion, information about this system was very hard to obtain. However, it appears that while the concept and the tool were technically good, the need for the system passed by very quickly.

It was a big issue at the time because of the phasing out of R12 (ozone problems). Farmers needed to reconsider their cooling systems. The decision support systems enabled them to evaluate and consider different options.

It was technically successful. However, in a practical sense it did not achieve much at all.

There were some meetings with Department of Primary Industry extension staff. However, staff were not keen to use software. Not enough user involvement. No champion.

The fact that departmental staff were not keen to use the software would indicate that there may be underlying problems with the development of this system. The software was seen as only one aspect of the project.

The project was bigger than just development of the software. The main aim of the project was to evaluate and demonstrate the two basic types of systems. The software was more an offshoot from that.

This system had a technical outcome of reasonable. However, it appears that the software may have been developed with little thought of the underlying market or the work involved.

The only remaining system coded as low impact is BreedBull (alias).

BreedBull (alias)

BreedBull was designed to improve breeding management. It allowed the user to rank bulls according to the breeding objectives of their farm. The interviewee requested that an alias be used for this system and that exact details on the number of units sold not be made public. Little could be determined about the degree of user involvement for this system. The system was initiated by industry through research bodies. The level of data input was simple and user friendly.

The interviewee provided interesting insights into problems associated with the development of these systems.

> *… farmers do not need to put much effort in selecting bulls. They select bulls easily from the regular publicly released ranking and these are the elite genetic material. Farmers are not interested in the next more complex level of bull selection. Not worth the effort. Since BreedBull came out the Australian Selection Index is better. It is easy and simple to use - a generic solution. Prefer to use a generic solution than one that requires a large amount of input.*

The system was seen to have failed because there was no real need for the system. The technical outcome for the system is unclear.

4.5.2 Summary – low impact systems

All of the systems identified as having a low impact had little or no user involvement resulting in little or no user influence. A number of common issues emerged in relation to the systems. Several interviewees felt that lack of marketing had played a part in the limited uptake of their system. Others felt that the system needed a champion to ensure its success. This was a recurring issue for many systems that were developed as a sideline by government advisory staff and where management did not see the system as core business. Others identified the lack of a real need for the system as the reason for the low uptake. For one system, extensive data input was identified as the reason for the low uptake.

For these systems identified as low impact systems developers appear to have built systems: (1) without consideration of the needs of their target audience, (2) without consideration of how to reach their target market, and (3) without consideration of maintenance issues.

In terms of technical outcomes, six of the systems were coded as having a technical outcome of reasonable. This aspect of the coding illustrates the varied dimensions of system success.

While lack of user involvement and user influence was evident in all the systems discussed, there are systems, as shall be shown later, that have had a medium impact and had little user involvement. Clearly, while user involvement and influence appears to be a factor in system outcomes there are other issues at stake. Examining systems that were coded as having a high impact provides further insight into the interplay of factors involved.

4.5.3 High impact systems

Table 4-21 details features of the nine systems coded as having a high impact. As in the previous analysis, these features or attributes have been coded using the coding strategy outlined in Table 4-2. Again, the attribute 'Reason for outcome' reflects the interviewee's understanding of the reason behind the system outcome. In most instances this will be in line with an evaluation of high impact. In one instance (*Herbiguide*) the comment by the interviewee suggests that he believed the system could have been more successful if there had not been pirating of the software.

The systems in Table 4-21 have been sorted firstly by degree of influence, then by degree of user involvement, and then by type of involvement.

Eight of the nine systems were identified as being developed because of a perceived need. The remaining system, *AVOMAN*, was initially developed from a technology transfer approach but this approach changed after extensive consultation and involvement with users. Developing a system because of a perceived need does not necessarily lead to success as was seen in the low impact section. However, the systems in the low impact section had little or no user involvement. It is argued that systems that have user involvement and that are developed because of a perceived need would be more likely to focus on the needs of users than systems developed from a purely technology transfer perspective. All systems in the high impact group are still active – with one withdrawn at the time of the interview for updating for Y2K and at the same time updating to a Windows[5] version.

Six of the nine systems had a degree of user involvement coded as reasonable or more. Only one of the systems had involvement of the consensual type and where users had a strong influence on design through involvement - *AVOMAN*. From the propositions this system would be predicted to have a good outcome. For those systems where the user involvement was known, the degree of influence that users had on the system design ranged from little or no influence to strong influence. Reference to the transcripts provides further understanding of the issues involved and why systems with little user involvement achieved success.

[5] Windows ®

Table 4-21 High impact systems – 9 systems

System	Degree of influence	Degree of user involvement	Type involvement	Data input	Who initiated	Current status	Adoption	Technical outcome	Reason for developing	Reason for outcome
AVOMAN	Strong influence	Extensive	Consensus	Reasonable	Researcher	Active	High (200 units – 25% market)	High	Technology Transfer	User involvement
Rainman ++	Moderate to strong influence	Reasonable	Consultative	Minimal – point and click	Researcher	Growing	High (>1500 units)	High	Saw Need	Met need
Herbiguide (ES)	Moderate influence	Reasonable	Representative	Basic	Private (Service Provider)	Active	High (600 units)	High	Saw need	Pirating
FeedMania ++	Moderate influence	Reasonable	Consultative	Reasonable	Private (Programmer)	Active	High (units sold NFP approx 20% market)	High	Saw need	Met need
CottonLOGIC * ++	Moderate	Reasonable - changed over time	Consultative and then more representative	Extensive	Researcher	Active	Not clear (1000 units - 28% market are registered users)	High	Saw Need & Technology Transfer	Record keeping tool and underlying information
Potential Yield Calculator *	Weak to moderate influence	Minimal	Consultative	Basic	Researcher	Growing	Not clear (300 units)	High	Saw need	Easy to use – simple tool
FeedLotto	Weak influence	Minimal	None	Reasonable	Service Provider	Withdrawn - upgrade & y2k	High (300 units)	High	Saw need	Easy to use
PAM ++	Not clear	Not clear - appears reasonable to extensive	Not clear	Extensive	Private (Farmer)	Growing	High (>3000 – > 20% market)	High	Saw need	Met need
ProfitProbe ++	Not clear	Not clear	Not clear	Extensive	Service Provider	Growing	High (4000)	Unclear	Saw need	Training

Notes: ++ developed for both farmers and service-providers;* Distributed free of charge; ES – Expert System; NFP – not for publication

The systems will be discussed in the order that they appear in Table 4-21. That is, systems where users had the most influence on system features will be discussed first.

AVOMAN

AVOMAN provides growers with management tools in addition to information relating to improving avocado orchard productivity and fruit quality (Newett *et al.*, 1999). Researchers were looking for a technology transfer approach that was novel. They determined that a decision support system was the approach to take. However, interaction with users changed the focus of the system from one that was a decision support tool to a management tool with decision support facilities. The system provides users with a comprehensive recording tool that also allows for the inclusion of quality assurance aspects of avocado growing. This is one of the few systems that had a business plan in place before the release of the system. One of the stated objectives was to make the system user friendly.

AVOMAN had an extensive degree of user involvement that was of a consensual nature resulting in users having a strong influence on system design and features. The system is currently active and has sold over 200 units representing 25% of the target market and sells for $250 including manual and training course. The level of data input required by users is reasonable.

As indicated, there was extensive user involvement in the development of the system.

> *We used a prototype approach. Not sure where we were headed when we first started. Lots of testing with the three prototypes. Beta ver 1, 1995, 128 testers; beta ver 2, 1996, 191 testers; beta ver 3, 1997, 247 testers. Testers*

received copy free. There were 14 regional productivity groups. These groups were used for testing. As well, farm walks were undertaken. The development group was strongly focused on better adoption and useability. Growers helped with the development of the software. Took part in weekly observation of trees - allowed creation of 30 templates of growth cycles. Users can modify growth cycle templates to suit their circumstances. The software uses these growth cycles to determine the timing of recommendations. Good help file - over 500 pages of help and extra info.

The interviewee identified user involvement as the reason why the system was successful. The high level of user support is seen to have contributed to the system's success along with the fact that it met a need. The technical value of the system is high.

This system was the only system in the study that used a consensus approach in the development of the software. Users had a strong influence on system features. From the propositions presented for this study, this system would be expected to meet the needs of users and users would perceive the product as easy to use and useful. Because this system is the only system coded as being developed from a consensus perspective it was identified as a system where discussion with users would be useful.

Rainman

RainMan assists industry to achieve better management of climate risk and raises awareness of El Nino and the Southern Oscillation Index. The system has a wide range of users with farmers being one sub-set of users. The system had a reasonable degree of user involvement that was consultative in nature and resulted in users having a moderate to strong influence on the look and feel of the system. Testing and prototyping were used and version 3 is a result of a survey undertaken with users of version 2. There was user testing of a beta version. However, the interviewee felt that problems may arise if a beta version is not sound, as one's reputation can be tarnished. The product was improved through feedback. The hardest part of the development was "getting the people bit right".

> *You have to work hard on the people side of things (users). The whole area of the user side is overlooked.*

Input is minimal with the user clicking on where they live. The system was developed by a research/extension type person and was developed because workshops with farmers indicated that although they knew about El Nino they did not believe that it impacted on their area - and hence on their farming decisions.

> *It has been successful because it meets a need and touches Australians' paranoia concerning droughts.*

Over 1000 units of version 2 were sold and over 600 units of version 3 have been sold within a three month period. The standard version sells for around $100. The interviewee believes that for every package sold there could be 10 to 20 other people accessing it. For example, seed and grain advisers use the system to give advice to clients. The interviewee indicated that the success of the system was due to the fact that it met a need.

The issue of government institutions developing software packages was raised by this interviewee.

> *Government felt that the public sector had an unfair advantage when competing against private industry* (Hilmer, 1993). *Software industry was one*

industry that was targeted - raise issue of whether government organisations should be involved in software industry at all. The RainMan project used industry to develop the front end while the scientist focused on the back end - the science aspect of the package. RainMan is part of a whole decision-making package. It is another tool in the decision-making process. Used in vocational institutes around Australia.

In relation to DSS in general:

Users are deterred when they have to enter too much information. Producing a DSS is just 10% of the story. How is the system promoted? Through extension, promotion, workshops? How is the market segmented? Older folk have problems operating the keyboard; often do analysis in their head. Younger people take software up in a totally different way - they have a different way of absorbing information.

Herbiguide

Herbiguide is an expert system that was developed to provide tactical weed and pest control. There was some involvement of farmers, advisers, and chemical companies but mainly through user testing. This is seen as a weak degree of influence. However, because feedback from users was incorporated the degree of influence is seen as reasonable. The interviewee was disappointed that fewer farmers used the system than anticipated. He had anticipated that 75% of users would be farmers when, in fact, only 33% of users are farmers. The interviewee thought that pirating of copies may have contributed to the lower number of sales to farmers. The system is currently active and with over 600 units sold this system is clearly successful when compared to other intelligent support systems. Data entry is mainly through drop down lists. The technical outcome for the tool is high.

This is one of a few systems where software development methods were used during the development of the system. The system was developed, without funding, by an ex-farmer who is now a weed consultant. The system has to be realistically priced in terms of providing an income. This puts it at a disadvantage compared to systems developed by government organisations. The system is sold for around $500 with a small fee for updates.

> *It is a labour of love. You have to have a commitment to the idea and not be worried about returns. Need to maintain enthusiasm.*

Feedmania

Feedmania formulates optimum feed rations for a variety of animal species. It is the only optimum feed rations software that is not species specific. The system was developed because of a perceived need and was initially targeted at farmers but the software was modified to target three separate groups - farmers, feedmills, and consultants. The uptake by farmers has been the weakest as users need to have some nutritional knowledge to use the software.

> *To really get the most out of the system you need to have a good understanding about feeds and nutrition. Typical farmers would not feel confident, as it requires specialist knowledge. The input is not data that a farmer would normally collect.*

While this system has been coded as having achieved a high impact, the level of success amongst farmers is not as high as anticipated. The fact that the system requires specialist knowledge and requires data that a farmer would not normally collect presents problems for farmers. To overcome this problem, three versions were developed that specifically targeted farmers, consultants, and feed mills.

This is one of many systems where user involvement was limited at the start of development. However, feedback from users was sought and incorporated into the software impacting on the look and feel of the software. While this type of involvement is preferable to no involvement, it again means that either the users have weak influence over the conceptual basis of the system or else the software needs to undergo extensive changes.

The number of units sold represents around 20% of the target market. This is one of a small number of systems that were developed by non-government individuals or organisations. The software was not funded and achieved commercial success. The fact that the software has not been as successful amongst farmers points to the importance of ensuring that systems meet users' needs and skill levels. The fact that the system required specialist knowledge and data input that farmers do not normally collect almost guarantees that farmers will not use it. The technical outcome for the system is high.

Impact on agriculture in Australia and New Zealand is significant.

The system was seen as successful because it met the needs of the clients. However, in terms of use amongst the initial target audience, the success of the system is less marked.

CottonLOGIC

CottonLOGIC incorporates the science that has been developed by researchers at the Australian Cotton Research Centre. It has evolved from the widely known expert system, SIRATAC. The system was developed from both a technology transfer perspective and because of a perceived need to reduce the amount of spraying of cotton crops. The system is a decision support system, a record-keeping tool, incorporates best management practices, ordering forms, and education for new bug checkers. The development of this system has been an ongoing process from a mainframe application to a stand-alone PC application. It has evolved through a number of products.

The system has been distributed free to the cotton industry and therefore the level of actual adoption is unclear. However, it has over 1000 registered users, which represents 28% of the target market. There is good user support for this system. The technical outcome for the system is high. The system appears to have influenced farmers in their use of pesticides and for that reason the system has been coded as high impact although the exact level of use by farmers and consultants is unclear.

The system appears to have had limited user involvement in the early stages of development.

> *Scientists knew what they wanted. Scientists defined the concept. Users were consulted about the system.*

However, over a period of time user feedback has been incorporated into the system.

A developers' group has been formed and this group has influenced the features of the software. Initially, the researchers were more closely involved in the development of the system. However, feedback from users has resulted in major changes to software features. There is a good telephone support system and changes are continually made to the product as a result of user feedback.

The system has been coded as having a reasonable degree of user involvement that was initially representative in nature. In the early days of development it seems that users had weak control over system design features. However, this appears to have changed and users now appear to have a moderate influence on the design features of the system. The degree of user influence on system design features appears to be increasing over time. The system requires a large amount of data input and the developers are aware that this is a problem and are currently addressing the issue.

The success of the system is seen to be due to the large underlying database that contains relevant information and the fact that users can use the system as a record-keeping tool.

An evaluation of *CottonLOGIC* was undertaken by the management of *CottonLOGIC* project to improve the development of the system and achieve wider adoption (Van Beek, 1999, 2000). The report indicated that the two outstanding features of *CottonLOGIC* were that it was based on science and its versatility meant it was useful for many purposes. The system was seen to be moving away from only a DSS as was originally intended and could be used to ensure farmers meet Best Management Practices. It was suggested that the system could be improved in terms of ease of use and that the significance of the system may need to be increased – especially to farmers and consultants. In order for *CottonLOGIC* to realise its full potential it was suggested that the significance of the system to key stakeholders needed to be strengthened.

Potential Yield Calculator

Potential Yield Calculator (PYCal) provides a framework for farmers to calculate potential yields and assists in making planting decisions. A researcher developed the system because he saw a need for farmers to do potential yield calculations easily. While the interviewee indicated that there was no target audience in mind - it simply evolved - clearly farmers were part of the intended audience. This system had very little user involvement in the early stages and is another example of a system where user involvement was minimal in the initial stages. However, through feedback, the views and requirements of users were incorporated. User involvement was minimal and was consultative in nature resulting in users having initially a weak influence on system features. This system is a simple software package requiring basic data input from users.

> *There are few simple software packages available in the farming community. People do not understand how to make simple systems.*

This system has been modified in response to feedback resulting in users having a moderate influence on system features. Again, incorporating the needs of users in this manner has problems in that the users were not involved from the conceptual development of the software and it may be more problematic to include users' requirements once the software has already been developed.

Over 300 units have been distributed free of charge. The fact that the software is distributed free makes the level of adoption hard to determine and so has been coded as Unclear. The software has a technical outcome of high as the record keeping software, *TopCrop* has acquired the rights to include *PYCal* in their software. There is a facility for farmers to fax in their rainfall data and receive information on the progress of the season relative to rainfall deciles, stored soil water, and yield estimates. The system has been coded as high impact because of the number of units distributed, the incorporation of the software in the *TopCrop* package, and the fax service provided to farmers.

The developer of *PYCal* expressed disappointed that he did not know about the *HowOften* software. *HowOften* and *PYCal* are very similar. The issue of developers either not being aware of each other's work or not wanting to collaborate is of concern given limited resources – both personnel and monetary.

The simplicity of the software was seen as the reason for its success despite limited user involvement.

FeedLotto

FeedLotto is a budgeting program that provides estimates of the profitability of a proposed feedlot operation. It was developed by a service provider because:

> *People were ringing up all the time seeking advice on the profitability of putting their cattle into feedlots. So it just grew from there. Evolved out of a need. It is easy to use. Also, when it was first released other similar types of systems were around $500/600 to $1000. These were extensive systems. However, farmers only wanted simple systems at that time. Didn't want anything too fancy - a spreadsheet type approach was fine.*

Because is such a simple program to use it allowed farmers to develop confidence as they used this system. This helped them to move on to other more complex systems. The interviewee believed that other programmes on the market were too hard to use and were too big too early. The interviewee identified the ease of use of the software as the reason for the system's success.

The system provides first time users with a step-by-step guide to entering data. Once familiar with the product, users had the option of going to the 'backend' and entering data directly. As well, the output of the system was in simple terms – it informed the user if they had made money, broken even, or lost money. Around 300 units have been sold at a cost of $70 per unit. The system has been withdrawn to make it Y2K compliant and to update to a Windows version.

Users were not involved in the development of this system because it was initially developed for use by the interviewee. Some testing was done with work colleagues but no testing was done with farmers. This system is simple and has achieved a high impact because it meets the needs of users. The success of this system illustrates that systems can be successful with minimal user involvement. It seems that the nature of the system - simple as opposed to complex - has contributed to its success. Additionally, the system met a need, in that it was a response to requests from farmers.

PAM

PAM is an extensive record keeping system that incorporates decision support facilities and in addition has precision farming capabilities. It can be used by livestock and cropping farmers. The technical outcome for the tool is high. The interviewee indicated that some users have reported amazing production results from using the data analysis capabilities. This system is managed by a professional organisation that was founded by the developer of this software. It has an extensive support service for users. The system was developed because:

> *… thought the financial software market had been catered for and saw a need to improve production (paddock and livestock) records and reporting for improved management.*
>
> *In 88/89 there were only a couple of these types of products on the market. More came along but most have fallen into disuse. Many were too*

sophisticated for the market at that time. Product needs to be right for market to succeed

The system has sold over 3000 units which represents over 20% of the market. The interviewee highlighted problems with maintaining these types of systems:

User feedback is incorporated all the time. From DOS to Windows took 6 years of redesign. User feedback was incorporated then. Rewrite took 7 man years and a lot of money.

The extent of data input by the user is quite large and this issue is being resolved gradually as more and more data are available in digital form from external sources.

This system is a management tool with decision support capabilities. The system has a champion in terms of the company and is professionally marketed. The relatively harsh farming conditions in Western Australia and the Eyre Peninsula of South Australia were seen by the interviewee to have contributed to its success.

ProfitProbe

ProfitProbe is a rural business analysis tool that was developed by a consultant because there were ‘no good business analysis systems available’. This system was the one system where the contact person did not wish to participate in a telephone interview and requested that the questions be emailed to him. The limited nature of the responses means that little can be ascertained about this system. The system has sold over 400 units at a cost of $300 per unit. It appears to be a management tool with decision support aspects. The reason given for the success of the system was ‘training, training, training, support and analysis’.

4.5.4 Summary – high impact systems

All, but one, of the systems identified as having a high impact had some degree of user involvement resulting in users having some influence on system design. The one system that did not have any user involvement, *FeedLotto*, was developed from a perceived need as farmers were requesting a tool. That system was very simple and farmers found it easy to use. This outcome indicates that the importance of user involvement is contingent on the type of system being developed and the reason for development.

Many of the systems did not involve users at the start of the development process but incorporated the views and needs of users by changing the system as a result of feedback from users. This type of user involvement is better than no user involvement or involvement where users have only weak influence over the system design. However, involving users later rather than earlier may mean that their requirements cannot be incorporated without considerable system re-design.

Only one system had extensive user involvement that was consensual in nature resulting in users having a strong influence on system features. The involvement of users in development of this system resulted in a change of focus in the nature of the system.

For those systems coded as low impact system, users had either no influence or weak influence during system development. For the high impact system, where the degree of influence could be ascertained, the degree of influence ranged from moderate to strong. There was only one system where users had little or no influence. It appears that this system was successful because it met a need and was a simple tool.

4.5.5 Medium impact system

Table 4-22 details features of the 14 systems that have been coded in the medium impact section. These systems did not clearly fall into either the high or low impact sections. Some systems in this section may be on the borderline of high impact or on the borderline of low impact or anywhere along this continuum. Clearly, determining the issues in system outcomes for these systems is important – but perhaps more challenging.

The systems in Table 4-22 have been sorted firstly by degree of influence, then by degree of user involvement, and then by type of involvement. The systems are discussed in order of user influence beginning with moderate to strong user influence.

Table 4-22 Medium impact systems – 14 systems

System	Degree of influence	Degree of user involvement	Type of involvement	Data input	Who initiated	Current Status	Adoption	Technical outcome	Reason for developing	Reason for outcome
WeedWatch	Moderate to strong influence	Extensive	Representative	Minimal – point and click	Service Provider	Growing	Reasonable (160 units)	Reasonable	Saw need	Easy to use
GrazeOn ++	Moderate to strong influence	Extensive	Representative	Basic	Advisory Committee	Active	High (100 units around 20% market)	Reasonable	Saw need	Wrong Time
Proplus	Moderate influence	Extensive	Representative	Extensive	Service Provider	Growing	Reasonable (120 units)	Reasonable	Saw need & Technology Transfer	User involvement
DSFM ++	Moderate influence	Reasonable	Representative	Reasonable	Service Provider	Active	Reasonable (150 units - 11% market)	Reasonable	Saw need	Useful
WHEATMAN (farm fax)	Moderate influence	Reasonable to extensive	Representative	Extensive	Researcher	Under revision	Low - (200 units 4% market)	High	Technology Transfer	Useful
AusVit	Weak to moderate influence	Minimal	Representative	Extensive	Researcher	Active	Reasonable (220 units)	High	Technology Transfer	Unique product
Herd-econ	Weak influence	Minimal	Representative	Extensive	Researcher	Dormant	Reasonable (200 units)	Reasonable	Technology Transfer	Big and complex
CamDairy ++	No influence	Minimal	None	Reasonable	Researcher	Active	Reasonable (233 units)	Not clear	Technology Transfer	Easy to use
LambAlive	No influence	No	None	Not known	Researcher	Dormant	Reasonable (200 units)	High	Technology Transfer	Data input problems
NPDecide ++	No influence	No	None	Extensive	Researcher	Dormant	Low to Reasonable (hundreds free)	Reasonable	Technology Transfer	Learn thru using
BreedCow & Dynama ++	N/A	Minimal	N/A	Extensive	Service Provider	Growing	Reasonable (350 – dos 122 - windows)	Reasonable	Saw need	Met need
TakeAway	N/A	Minimal	N/A	Minimal – point and click	Service Provider	Slow	Reasonable (150 units)	Reasonable	Saw need	Reliable

System	Degree of influence	Degree of user involvement	Type of involvement	Data input	Who initiated	Current Status	Adoption	Technical outcome	Reason for developing	Reason for outcome
Zack ++	N/A	No	N/A	nk	Researcher	Withdrawn	Low (110 1st phase 40 2nd phase)	Reasonable	Saw need & Technology Transfer	Met need
LCDP ++	N/A	No	N/A	Reasonable	Service Provider	Withdrawn	Low (200 units 5% market)	Reasonable	Saw need	Needs change

Notes: ++ developed for both farmers and service providers; N/A –Not applicable
CamDairy was targeted at farmers but they did not use it
TakeAway not targeted at farmers but they use it. About half of sales are to farmers.

The first two systems discussed are seen as borderline high impact systems. These two systems were developed because of a perceived need and had extensive user involvement. Users had moderate to strong influence over system features.

WeedWatch

WeedWatch is a herbicide system that was developed by a service provider to assist farmers with weed control in cereal, pulse, oilseeds, and pastures. It has been on the market since 1997 and has sold over 160 units at $100 per unit. Since the sales for this system are still growing the system is seen as a borderline high impact system. The system had extensive user involvement that was representative in nature resulting in a moderate to strong influence on the system design and focus. Data input requirements are minimal. This system was developed because the information that farmers needed was hard to access. The interviewee believed the system was easy to use and identified this as the reason for its success. The technical outcome for this system is reasonable.

The system has a component where farmers can record aspects of their herbicide use, so the tool is both a decision tool and a record keeping tool. The developers worked with agronomist staff and a farmer reference group. Two dozen users tested the system before its release. The system is on target in terms of sales and won second prize in the Australian Farm Software Competition in 1997.

Grazeon

Grazeon is a tactical feed budgeting program that compares feed supply with feed demand to establish optimal stocking rates. There was extensive user involvement in the development of the system that was representative in nature resulting in users having a moderate to strong influence on system design. The idea for the system came from an advisory committee that consisted of farmers, extension staff, and other advisory staff. Members of the group helped test the program. The system was developed because of a perception that farmers needed to sustainably manage the countryside and at the same time improve profitability. A software program was seen as one way of doing this. The program has basic input and simple to understand output.

Approximately 100 copies of the software have been sold for $55. Workshops are conducted where feedback on the system is obtained. Around 60 units have been sold to farmers, representing around 20% of the target market. The system is coded as high adoption. Overall, this result is on the border of being coded as a high impact system. The interviewee felt the outcome for the systems was disappointing and believes the fact that they were in a bad drought meant that farmers were in survival mode. The interviewee perceived a problem with user involvement.

> *It was useful to involve graziers but it would be better to involve less producers, ie two, and use them as consultants.*

> *System has not been widely marketed. There are geographical constraints on who can use the system as it looks only at Mitchell Grass region.*

> *It is good to have control over sales information as otherwise no accurate records are kept on who buys it. Extension staff are trained in the use of the product - most sales come through staff.*

This system was developed from a perceived need and had a good user involvement. This system highlights the problems of potential sales when the target market is small.

PROPlus

PROPlus was developed to assist beef, sheep meat, and wool producers in the management of producer-developed grazing plans. The software has been on the market since 1998 and has sold 120 units with sales still growing. The cost of the software is $350 including a course and manual. It was developed by advisory staff from both a technology transfer perspective and also because of a perceived need. It had extensive user involvement that was representative in nature and resulted in users having a moderate influence on system design. This is a system that would be expected to achieve a reasonable level of adoption.

The system requires a large amount of data input but this appears to be overcome through support in workshops. The *PROPlus* software is part of the Prograze Plus course. There are reports of the use of this software resulting in increased stocking rates, better management control, and winning feedlot contracts. The technical outcome for the tool is reasonable. User involvement was seen as the reason for the success of the system.

Decision Support for Farm Managers

Decision Support for Farm Managers was described as a decision support tool that aids decision-making on a range of farming decisions. A service provider developed the system in 1987 because he saw a need for a simple spreadsheet tool. The system has a side benefit of providing training for farmers in the use of Excel[6] and is seen as a step up from cashbook packages. The intention was to develop a simple tool that would train farmers in the use of computers for decision-making. The software is sold for $150, including a two day workshop. The system is currently active with approximately 150 units sold which represent 11% of the market.

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[6] Microsoft®Excel

There was a reasonable degree of user involvement that was representative in nature, resulting in users having a moderate influence on system features. The extent of data input varies from template to template but is seen as a reasonable level of input. The technical outcome for the tool is also seen as reasonable.

The interviewee saw it as a tool that was aimed at the level of computer skills that farmers had at that time. There was a test group that looked at the software. The system was used in conjunction with a workshop. This small system is one that evolved and is seen as being successful because it is a useful tool.

WHEATMAN

WHEATMAN is a wheat growth simulator. The software grew from a paper-based version and this approach was seen as a way of incorporating current research knowledge into one product. The software has been on the market since 1989 and had major changes made to the interface in 1993/4, and more recently in 1999 when it was changed from a DOS to a Windows version. An extension team with the aid of a programmer developed the system. The development of the system has had continuing problems with changes in programming staff. The system was developed by a researcher from a technology transfer perspective and is seen as very successful from a scientific point of view. It is used by Department of Primary Industry staff in Queensland and New South Wales and influences their decisions when working with clients. The system had user involvement that appears to be reasonable to extensive. However, it is unclear in what way the agronomists and the farmers interacted with the software. It may have been at a token level of checking out how the system looked, or at a more fundamental level of looking at what the system did and whether it met farmers' needs.

… received feedback all the way through development as they worked with farmers. A team of agronomists (team of 6) developed the software. Each member worked with farmers in their region - software was modified as a result of feedback.

In terms of reasons for the outcome:

Data generated was accurate. Lot of farmers found it useful. However, there are around 5000 wheat farmers - but only 200 copies sold. But some of these are farm consultants who would use it with a number of clients. It is a success in the fact that it is used by Department of Primary Industry staff in Queensland and New Sales Wales and influences their decisions when working with clients. Also, used with TopCrop program. The number of sales could have been better - the potential is there. Of the 200 copies sold, three quarters of these would be to farmers. But not all farmers who have brought it use it regularly. The product is easy to use. Unsure as to why not more widely adopted.

The 200 copies represents 4% of a potential target market of 5000 wheat farmers. The impact that *WHEATMAN* has, however, is higher than the number of sales. The frost probability data that is generated by the software is published in industry newsletters, plus this information can be accessed through farmfax hotline. While '*hits on the 'FarmFax' sheet service number are considerable at certain times*' no data have been collected on usage.

While the information generated by *WHEATMAN* appears useful to farmers they do not seem willing to use the software itself. It appears that the generic solution offered through the Farm Fax facility is adequate for their needs. The effort involved in using the software may not result in significant improvements over the generic advice of the fax. The system requires extensive data input. The interviewee suggested that farmers can understand the output easily. However, he also indicated that farmers understand the output better if there is a team member present who can guide them through it initially. This may indicate that the output is not simple in nature.

The reason for the poor uptake of this system is of interest. Of particular interest is the view of how farmers saw their involvement in the system and their influence on the design and focus of the system. Given this fact and the fact that the developer was unsure of why the system was not more widely adopted, this system is the second system where users were interviewed about their use of the system and their involvement in development.

AusVit

AusVit is used as a mechanism for delivering research centre outcomes in the wine-growing industry, that is, it is seen as a tool for technology transfer. Researchers initiated the system to:

> *deliver research knowledge to growers. Originally intended for a bureau type of environment - issue recommendations - innovative farmers wanted to play with it.*

The system is used to determine pest and disease pressure. The software also contains a spray diary. The system is seen as a learning tool and incorporates best practice. The system currently targets the top 10% of farmers. It was initially envisaged that it would be used by extension staff, but some innovative farmers wanted to play with it.

The system initially had minimal user involvement that was representative in nature resulting in users having a weak to moderate influence over the system.

> *The researchers did a great job but if commercialisation advice had been sought earlier, and in parallel with technical development, many pitfalls would have been avoided.*
>
> *User input - long way to go.*

There is a beta group that tests prototypes but it was unclear whether users had an influence over the features of the system or whether they tested from a look and feel aspect. The system contains a spray diary so the system is also, to some extent, a record keeping system. Users need to enter a considerable amount of data. Over 220 units have been sold. The technical outcome for the software is high.

This system raises the issue of a system being released to farmers when the system was not originally intended for use by them. The issue is a complex one and determining the right mix between research push and user pull is not easy. Consideration of the system making enough returns to cover maintenance is a real issue. Because the system has been targeted at such a small section of the market (top 10%) it means that there are few customers out there to make it commercially viable. This is of importance to the developers because the department where the system was developed is working towards cost recovery for products developed.

Some reflections from the interviewee in terms of DSS in general.

> *Systems often grow out of research. It needs to come from both directions, that is, researchers and farmers. Need to develop trust and understanding, it must be market driven with scientific input else there is no success. Hard to get both without putting participants offside – there is mistrust.*

AusVit was seen basically as a research-based product with commercialisation expertise not included until very late in the product's development. However, it is seen as a world first with no other product like it overseas.

Maintenance issues are seen as a big problem with the ongoing success of the system unclear.

Herd-econ

Researchers initially developed *Herd-econ* as a tool for extension staff. The idea was to develop a tool that allowed farmers to understand ecological issues in farming. It started out as a vague concept in 1986/87. It was developed from a technology transfer perspective. The degree of user involvement was minimal and representative in nature resulting in users having a weak influence on system design features.

> *We were of the belief that if you put a package out there then people would use it. See this as naive now.*

> *From an extension perspective - extension staff are only just understanding the enterprise approach rather than the paddock approach - so the tool was ahead of its time. From a user's perspective, it was too complicated to use. The concepts that underlie it take time and effort to understand in order to use it.*

The developers expected extension agencies would take it up. However, farmers were more interested in it. However, there were problems with farmers also.

> *The whole process was an eye-opener for us into the fact that, for producers, the ecology was not important. Program highlighted that extension agency were not aware of issues of importance to producers. Also, changed researchers' outlook. Now more realistic about what matters to pasture*

decision-making. It was a major investment of time to develop the system. However, the development of the system has allowed climatic variability to be demonstrated. This has impacted on government and policy makers. The system allows investigation of the complexity of climate on day to day decision-making - run out over many years.

The importance of understanding the needs of the users is highlighted in the interview transcript. As well, the transcript reveals the many dimensions to determining whether a system is successful or not. While the outcome for the system was not the intended outcome, there were certainly benefits to both the researchers and to government organisations.

The system requires extensive data input. Over 200 independent copies were sold. The developers looked at commercialising it with a company that handles software for agriculture but did not proceed with this option. The interviewee believed they would have had a better outcome if they had given it to a commercial company to handle the marketing. Maintenance was a problem and the interviewee believed this would still be an issue even if the system was handed over to a commercial company. The system was used in workshops that incorporated case studies, leaflets, and publications. This fact could account for the number of sales. The system is now available at cost price but this option has been not taken up and it is now dormant in terms of sales.

While the system had some initial success, the problems associated with the complexity of the system have most likely lead to its demise. However, from a technical outcome perspective it has some success as it is still used as a research tool.

CamDairy

CamDairy helps improve dietary formulation for dairy cows resulting in increased profits. The system was targeted at farmers, but has not been used by them. In this respect it has not been successful. However, advisers have taken it up. The system was developed by a researcher with very little input from target users. Therefore, the target users had no influence over the features included in the software. The software was modified from an existing system using postgraduate students to help make the changes to the acquired software. Testing was undertaken with a New Sales Wales senior dairy nutritionist and the system was extensively modified as a result of feedback. However, no farmers appear to have been involved in the development of the system. The developer hoped farmers would use the system, but this has not eventuated. The system was developed from a technology transfer perspective.

> *Farmers were approaching nutrition as an imprecise science. Many dairy farmers were giving supplementary feed on a trial and error basis - hit and miss. Software was seen as a way of overcoming this approach.*
>
> *Hoping farmers would use - but this has not eventuated. Mainly agri-advisers and educationalists.*

The developer was hoping that farmers would adopt a more scientific approach to nutrition. This is an example of a developer approaching the development a system from their perspective rather than from the users' perspective. The system has been on market since 1983 and has sold over 233 units at $500 per unit. It currently has 80 to 100 active users and the friendly interface is seen to have contributed to the degree of success it has with advisers.

LambAlive

LambAlive was used to help determine best lambing dates to decrease lamb mortality. This system was targeted at farmers but was never taken up by them. Mainly extension staff used the system. There appears to have been no involvement of users in the development of the system. Rather, the focus was on enhancing the ability to do better research and provide scientifically sound information to improve farm productivity. There were problems with obtaining data for the underlying models because the software needed 'wind run' information that was not readily available. The system is no longer updated. However, it is anticipated that the code from this system will be used in more complex models that are now available or being developed. The data input problems would have made the system unattractive to farmers.

NPDecide

NPDecide is a phosphate fertiliser recommendation system. A researcher developed the system as a mechanism for technology transfer. It was given away free of charge which makes it more difficult to determine the outcome for this system. The fact that the software was given away presents some problems for the developer as the department is looking for cost recovery. The interviewee believed that if a system is free it takes the pressure off in terms of maintenance and updates. The decision support tool also serves as a repository of everything that the staff know about phosphorus and nitrogen. The system was extensively tested against data sets to verify the model.

There was no user involvement in the development of this system. It requires extensive data input and its current status is dormant. The technical outcome for the tool is seen as reasonable.

Whilst the uptake of the system was seen as initially good there is now very limited demand for the system. As this system was given away there is no way of determining if the system was used. Of course, this is also true of systems that are purchased. However, systems that are purchased or have an annual fee provide some indication on uptake. Systems that are given away freely may never be installed on a computer. It was believed that the reason for the drop in demand for the systems was due to the fact that once farmers developed a fertiliser regime that worked they tended not to change it. It is not something that needs to be changed constantly. A number of interviewees identified this issue - the user needs to interact with the system only once or twice, in total, or once or twice a year.

The system was identified as becoming big and cumbersome as the model tried to incorporate more and more aspects. However, the issue of what a farmer does with the recommendation from intelligent support systems was raised.

> *It is important to remember that the recommendation is the starting point for the farmer. What they do with that information will depend on a range of issues. For example, they may not have money to spend on the level of fertilisers recommended. So they will make some adjustment to suit their needs. They adjust their practice a bit in the direction to the level they can afford.*

From the interviewee's perspective the system was seen as initially good because it met a need. However, because farmers do not often need to change their fertiliser regime this resulted in limited demand for the system.

Went into this very naively 30 years ago. Thought it would be easy to develop a simple computer system. Resources were wasted. Need to ask why we are doing what we are doing.

The concept has been adopted in a similar product that is used by soil testing service agencies and has enjoyed considerable success in this form.

Breedcow&Dynama

Breedcow&Dynama allows the user to estimate profits on different stocking strategies. The system was initially developed to support the interviewee in his job and it evolved from there and has been improved over time. Other individuals wanted copies as they had heard about it. Because it was developed for the interviewee's needs this system had minimal user involvement and is the reason why degree and type of involvement are coded as not applicable. However, this system requires extensive data input, and has an output that is considered to be of medium complexity in terms of interpretation. From the propositions, one would expect this system would not be widely adopted. The original DOS version, which went out of circulation two years ago, sold over 350 copies making it a high adoption system. More recently, however, the newer Windows version, has sold 122 units, 42 of these to individuals outside the department – most of these are farmers. The system sells for $350. Advisory officers now mainly use the system and these officers receive the package for free.

While the system was originally developed to assist the interviewee in his job, once it was placed on the market it required continual upgrading. This participant raised the issue of systems needing champions.

Unless someone is driving these products, they will die. Software is moving all the time - operating systems change, authoring systems change. So you need someone to support it and be prepared to ensure changes happen.

This particular system identifies an important issue when attempting to evaluate the impact of user involvement in the development of software systems. At first glance it would be assumed that this is an example of a system that was developed without user involvement. However, as the interviewee was developing the system for use by himself in some respects it had 100% user involvement. Clearly, when determining user involvement and system outcomes, more than just whether there was user involvement needs to be considered. However, the system would be more likely to meet the needs of service providers given that the developer was a service provider who developed the system for his own use. Service providers are currently the main users suggesting that the system meets their needs.

The interviewee considered the system's success was because it met a need.

TakeAway

TakeAway was developed by a service provider:

... to work out ration formulation that took 1 hour to generate a calculation. If producer then asked a 'what if" question then the new calculation took another hour! Perfect use of the technology. Has evolved since then.

The system calculates least cost rations for sheep and cattle. It was developed during a severe widespread drought and evolved from a need. User involvement is coded for this system as N/A – not applicable. The system arose initially as a tool to help the interviewee perform his job more efficiently. It was initially developed for agency staff. Over a period of time it was refined and made easier to use before being released to farmers. The system requires basic data input from users. The current status of the system is described as slow with over 150 units sold for $300 per unit. The technical outcome for the system is reasonable.

The interviewee believed the system would have had higher levels of adoption if the state of livestock production was better. He felt there was less money for this type of purchase. It appears that the system was developed due to a need arising from drought conditions; however, the interviewee saw the impact of the drought affecting uptake.

The system was seen as successful in terms of use by departmental staff.

> *It is seen as a good tool in the hands of staff. The fact that it was taken up by producers was seen as an advantage as it was not targeted at producers.*

The interviewee identified the outcome for this system being attributed to its ease of use. A lot of money was spent on advertising but this was not seen as successful. There have been some sales to overseas markets.

Zack

Zack was a whole farm management decision system that grew out of a need to assist farmers confront issues that were requiring them to make significant changes to their farming systems. In was released in 1986 and was on the market for around three years. A researcher produced the product as an in-house tool to allow staff to model year-in/year-out cash flow. This was modified to make it more comprehensive and to model more aspects of the farm business system. It was used with farmers - sitting down with them, working through scenarios. Some farmers requested a copy of the software. The developers originally said no, but requests from farmers and consultants increased. Changes were made to the software, a manual was produced and it was commercialised. The system sold for $150 with 110 units being sold in the first phase and 40 in the second phase. It was removed from the market around 1989.

The interviewee saw *Zack* as a successful tool in the hands of extension staff because it met a need. The move to a compiled program was not successful, with many users experiencing problems with the product. The main benefit of *Zack* was that it looked at decision-making from a whole farm basis but this presented problems with data input for many farmers. The system was targeted at farmers and their advisers but was used mainly by advisers.

The unfolding story with this system demonstrates the problems that can occur when systems move from one stage to the next. Initially the system was developed as an in-house modelling tool. Then it was used with farmers to demonstrate outcomes from different scenarios. Next, a stand-alone system was developed for use by farmers. Finally the system was withdrawn from the market. The comments by the interviewee illustrate problems that occurred.

> *Went into the development naively. Support cost alone was greater than returns on software. As better products came along we thought we could fill the niche without imposing huge costs. However, the second phase (pre-compiled version) didn't work well. Baler software had many problems. Five different version of Baler - just kept getting different sets of problems. Decided that software development was not our core business. Competing with commercial enterprises unfairly. Today you could do what Zack did quite easily in Excel.*

LeastCostDietProgram

LeastCostDietProgram was targeted at pig and poultry farmers and allows the formulation of the least cost diet. A service provider developed it because it was tedious for staff to work out the least cost diet ration by hand. This is clearly a system that arose from a need. The interviewee was happy that extension staff used the system as this was the target audience. However, when farmers saw it they also wanted to use it so it was put on the market. This was seen as a bonus. However, the system was not very user friendly by today's standard. The technical outcome for the system was seen as reasonable.

For extension staff the benefits were clear as a paper calculation that took 2-3 hours to do took only 20 minutes using the system. As computers got faster the time taken for the calculation reduced to one minute. Data entry is relatively complex but the output was simple. Approximately 200 units were sold which represents about 5% of the target market. The system sold for $300. The system was withdrawn due to limited demand. There are other products on the market and also extension staff no longer advise on diets - although this could be seen as an opening for the product.

This system arose directly from a need and so user involvement was not an issue to the developer. The interviewee saw the outcome of the system as a result of changing needs.

4.5.6 Summary – medium impact systems

Many interviewees believe workshops play a useful role in the adoption process for intelligent support systems.

The systems coded as medium impact are interesting to examine as they provide rich detail on the many reasons why systems were developed as well as an understanding of the various ways of measuring outcomes.

Two of the systems are considered borderline high impact systems. These are *WeedWatch* and *GrazeOn.* These two systems had extensive user involvement that was representative in nature. Both systems were developed because of a perceived need. Users were seen to have a moderate to strong influence on system outcomes. A third system, *Proplus*, is seen as having the potential to be a high impact system. This system had extensive user involvement that was representative in nature and was developed because of a perceived need as well as a mechanism for technology transfer. Users were seen to have a moderate influence on system design.

The system, *Decision Support for Farm Managers*, provides some interesting insights into determining whether a system has been successful or not. This system was developed in 1987 when the level of computer ownership amongst farmers would have been less than 10% (Worsley & Hartley, 1994). The tool was aimed at the computer skill level of farmers at that time. The system has been coded as a medium impact system but in some respects its impact could have been quite high if indeed it did influence farmers to consider using computers in decision making.

WHEATMAN and *Ausvit* appear to be systems that had the potential to have had a high adoption level if the needs of users had been incorporated more fully into the systems. Both systems appear to be technically sound tools that were not taken up by farmers to the extent expected. This is particularly true of the *WHEATMAN* package. A more sociological view surrounding the development of *AusVit* is told by Glyde and Vanclay (1996). The researchers concluded that it was not likely that *AusVit* would be widely adopted - not because farmers were not likely to be owners or users of computers - but because they were unlikely to be convinced that a DSS would provide information that they ought to consider above their own experiences.

Also, the management style of the farmers did not match the input requirements of the computer systems.

The development of *Herd-econ* highlights the importance of understanding the needs and concerns of the users. The developers had an extension/consultant perspective of the problem that turned out to be completely different to the users' perspective.

CamDairy is an example of a system where a system initially had some success but use has fallen off in more recent times. This system is an example of a developer wanting to change the way that farmers approached nutrition with no involvement of users in the development process. The system is used more by advisers and so in this respect is unsuccessful in terms of reaching the target audience. However, the impact of the system could be wide given that advisers consult with many farmers.

Of interest, a number of systems in this category were developed originally by extension staff to help them do their jobs and then sold to farmers at a later stage. Interviewees were able to reflect on the learning outcomes that resulted from this process.

LambAlive and *NPDecide* are examples of systems that had significant problems because of their complexity. *NPDecide* also highlights the fact that for some systems users only rarely need to interact with the system.

The systems that fell into the medium impact range have provided interesting insights into why these systems were developed. Problems associated with the development, marketing, and maintenance of these systems have been revealed.

4.5.7 Too early or not clear

Four systems were placed into the categories of either being too early to determine the outcome for the system or else there was insufficient information to determine the outcome. These systems are now discussed.

Table 4-23 Too early to determine – 2 systems

System	Degree of influence	Degree of user involvement	Type involvement	Data input	Who initiated	Current Status	Adoption	Technical outcome	Reason for outcome	Reason for developing
DairyPro	Moderate to strong influence	Extensive	Representative	Basic	Researcher	Under revision	Low 12 units – 1% target population (15 of previous version)	Reasonable	User involvement	Technology Transfer
HotCross	Moderate influence	Changed over time – limited then reasonable	Consultative	Reasonable	Researcher	Prototype	Not sold	High	Met need	Saw need & Technology Transfer

Table 4-24 Impact not clear – 2 systems

System	Degree of influence	Degree of user involvement	Type involvement	Data input	Who initiated	Current Status	Adoption	Technical outcome	Reason for outcome	Reason for developing
HowOften	No influence	None	None	Minimal (point & click)	Researcher	Active	Unknown	High	Outcome not known	Saw need
HowWet	No influence	None	None	Basic	Researcher	Active	High (>300)	High	No champion	Saw need

DairyPro

DairyPro was developed to assist farmers benchmark their dairy farm against other dairy farms and make strategic decisions about their farm. It is a combination of an expert system and a decision support system. A researcher developed it from a technology transfer perspective:

Mainly to overcome problems associated with component research. That is, research would suggest that if you applied a bag of fertiliser you would get so much more milk. However, it is more complicated than that. Response rates differ for different areas. Wanted to encourage a more whole systems approach to farming. Encourage the farmers to realise what the big levers were in terms of profit. For example, for a small farming enterprise the relative cost of a bag of fertiliser or wages for a day is more than for a large company. Compare income to capital ratios and labour to cost efficiencies.

The degree of user involvement was extensive and was representative in nature. Users appear to have had a moderate to strong influence on system design features.

Did evolutionary prototyping, 60 farmers shown system. Core of 9 was involved in the development of system. Iterative process - iterated 3 times. The upgrade version was tested on 60 farmers prior to release. Had good user input.

The expected outcomes changed due to user involvement. Developers wanted a tool that allowed farmers to benchmark their farms against Industry Standard. Farmers wanted a tool that would allow them to ask 'what if' scenarios. The program was modified to user requirements. Was cautious about releasing as a product to farmers because of concerns about farmers misinterpreting the *results of a consultation. Farmers have found it useful. Wanted to ensure that the product was useful and easy to use.*

The level of data input is basic. The system has been on the market for one year and has sold 12 copies at $100 per copy. This represents less than 1% of the target audience. A previous version sold 15 copies at a cost of $50. The system is under revision to the next version. The technical outcome for the tool is seen as reasonable. The interviewee saw the system as being successful and identified user involvement as the reason for this success. The target audience for the system was extension officers but dairy farmers have been the main purchasers.

HotCross

HotCross was developed to allow farmers to predict the crossbreed performance in beef cattle. Researchers initiated the development of the system although the idea came from farmers. Initially there was limited involvement of users in the development process. However, feedback was obtained through workshops and this feedback was incorporated into the system. User involvement was seen as consultative in nature resulting in a moderate influence on system features. Data input requirements is of a reasonable level. The system is a prototype version and is not sold, rather it is used with farmers during workshops. The workshops last two days and *HotCross* is used in the last two hours.

This system has had a long drawn out development process with user involvement being minimal at the start of the project. The system is seen as:

Successful in that the software has allowed producers to acquire increased knowledge. Improvement in making logical cross breeding decisions. Have seen this happen in the workshops.

The reason given for this success is that it met a need. There are problems with the ongoing maintenance of this program.

> *The workshops are the only form of marketing. However, there is a marketing plan. Once the system is completed it will be made available to departments of agriculture throughout Australia. The departments will be given the software and workshop materials and train the trainer workshops. This will all be supplied free. The source code will be made available.*

Since this interview was conducted the champion for this system has left the organisation. He indicated that the system could now be considered a failure as there was no one in the organisation to drive the distribution of the system to various departments. This outcome highlights the tentative nature of success and how a system can be seen as successful at one point in time and unsuccessful at a different point in time.

HowOften

HowOften is a simple tool that looks at the probability of how often rain would occur on any day over a given period. It was developed by a researcher because he saw a need for a simple package to assist farmers in determining when to plant crops. It requires minimal user input. The system is free and can be downloaded from the web. No information has been collected on how many copies have been downloaded or who uses the system. Users were not involved in the development of the system but feedback was obtained from other extension staff and researchers.

This system highlights the many reason why systems are developed.

> *I did what I did as an experiment in its own right. Put something together cheaply, and see where it goes. I have been using it in modelling workshops as*

an instructional tool, and it has been great. Good return on investment so far for me.

HowWet

HowWet was developed by the same researcher who developed *HowOften.* The system provides information on soil water and nitrogen profiles based on farm records. It was originally sold for $30 but is now available free downloaded from the web. The interviewee was unsure of the number of units sold but suggested 300 as a 'wild guess'. A researcher developed the system because:

> *When conducting a workshop in Dalby on soil water modelling I realised that participants were missing some basic concepts. Decided to develop system to help educate farmers about how water is stored and used. Also, wanted to demystify work of the APSRU modelling group.*

In relation to development methodology:

> *Done by complete amateurs. Lots of iterations - probably because of the lack of planning. Trialed with staff.*

And in terms of success:

> *Got back as much as we put in. It hasn't been championed. Good as we could have hoped for.*

4.5.8 Summary – too early or not clear systems

One of two systems coded as too early to determine outcomes has since been identified by the interviewee as a failure due to the departure of the system champion.

The two systems where the outcome is unclear highlights the problems associated with systems that are developed by individuals where intelligent support system development is not seen as part of their core business. The time involved in marketing, maintenance, and distribution of the system becomes too high and because it is not core business involvement must be scaled back.

4.6 Tying it all together – scenarios of success; scenarios of failure

This section briefly examines the patterns relating system outcome and user influence in system design. The 'degree of influence' represents information drawn from many aspects of user involvement – degree of involvement (involved in development, testing, feedback incorporated) and type of involvement. Table 4-25 details the relationship between degree of influence and system outcome.

Table 4-25 Cross tabulation - impact and degree of influence – all 38 systems

Level of Impact	Degree of influence users had over system design								
	Strong	Mod-erate to strong	Mod-erate	Weak to mod-erate	Weak	None	Not known	NA	Total
High	1	2	3		1		2		9
Medium		3	2	1	1	3		4	14
Low					5	5	1		11
Not clear						2			2
Too early		1	1						2
Total	1	6	6	1	7	10	3	4	38

In order to more clearly see the pattern between user influence and system outcome the systems at the two extremes of impact – low and high – are presented in Table 4-26. The table explores the relationship between the high and low impact systems and the degree of influence that users had during system development.

Table 4-26 Cross tabulation - impact and degree of influence – high and low impact systems

Level of Impact	Degree of influence users had over system design						
	Strong	Moderate to strong	Moderate	Weak to mod-erate	Weak	None	
High	1 AVOMAN	2 CottonLOGIC Rainman	3 Feedmania Herbiguide PYCal		1 FeedLotto		7
Low					5 Beefin WaterSched WeedMaster PastureMaster Sheepo	5 DairyMaster Applethining Littermac Chickbug MilkCool	10
Total	1	2	3		6	5	17

From the above table a pattern emerges between the degree of user influence in system design and system impact. Many factors contribute to the level of impact of a system – user involvement and the degree of influence that users have during system development are just two factors. However, the results support the proposition that user involvement, and more particularly user influence, is a contributor to the degree of success of an information system project.

The majority of systems coded as high impact systems had user influence that was in the range of moderate to strong. Only one system, *AVOMAN,* had extensive user involvement that was consensual in nature resulting in strong user influence. For two systems, *CottonLOGIC* and *Rainman*¸ users had a moderate to strong influence over system design. *CottonLOGIC* is distributed free of charge and so the level of actual use is not as clear as the implied use for systems where users have to pay for the system.

Although *Feedmania* has been coded as high impact, the level of success amongst one of the user groups – the farmers - is not as high as anticipated. The fact that the system required specialist knowledge and required data that a farmer would not normally collect means that this system does not truly meets the needs of farmers.

This is one of many systems where user involvement was limited at the start of development. *Feedmania* was developed by a non-government organisation.

Herbiguide is an example of a system were users initially had a weak degree of influence. However, because feedback from users was incorporated the degree of influence was seen as reasonable. *Herbiguide* was developed by a non-government organisation.

PYCal is a very simple system and is another example where user involvement was minimal in the initial stages but through feedback the views and requirements of users were incorporated. The fact that this system is distributed for free makes the true level of adoption and use by farmers less clear.

Only one high impact system, *FeedLotto*, had weak user influence. The outcomes for this system support the proposition that the degree of user involvement and influence is not as important for simple systems. The developer of this system intentionally developed a very simple system because he perceived that there were many programmes on the market that were too hard to use and were too big too early. The ease of use of the software was the reason identified for the success of the system.

From the analysis, all the systems coded as low impact were systems where users had either weak or no influence over system design. For the high impact systems, users had either consultative, representative, or consensus involvement – although for many systems the type of user involvement changed over time. For the high impact systems users had, in general, a higher degree of influence over system design

Reference to transcripts explained the success of a system where there was no user involvement in system design and the system was successful. These systems were generally simple, designed specifically with ease of use in mind, and developed because of a perceived need rather than from a technology transfer perspective.

For those systems that were coded as medium impact the relationship between degree of influence that users had over system design and the outcome of the system is less clear. As can be seen in Table 4-27 the systems had a degree of user influence ranging from moderate/strong to no influence

Table 4-27 Cross tabulation - impact and degree of influence – medium impact systems

Level of Impact	Degree of influence users had over system design							
	Strong	Moderate to strong	Moderate	Weak to mod-erate	Weak	None	NA	Total
Medium		2 WeedWatch GrazeOn	3 Proplus DSFM WHEATMAN	1 AusVit	1 Herde con	3 CamDairy LambAlive NPDecide	2 BreedCow & Dynama TakeAway	7

This chapter has looked at information relating to the 66 intelligent support systems that formed the basis of this study. In addition, 38 systems were examined in greater detail in relation to user involvement in system development and the outcome for those systems.

Chapter 5 discusses the outcome of interviews with users of the two intelligent support systems, *AVOMAN* and *WHEATMAN*. *AVOMAN* was coded as high impact and users had extensive influence over system design features. It is the only system where the type of involvement of users was seen to be consensual. *WHEATMAN* was coded as having a medium impact although the actual level of adoption by users was less than anticipated. The degree of influence that users had over system design was seen as moderate and the type of user involvement was seen as representative.

Chapter 5

5 The users' perspective

Feel it is our (producers) product - because of involvement. It was a team effort. Producers put a lot of effort into it as well. There is joint ownership. (Interviewee)

Didn't come around and ask what we wanted. The developers came around and told us what they were doing. Were not interested in what farmers were thinking - we probably wouldn't know anyhow. (Interviewee)

5.1 Introduction

Chapter 4 discussed the approach taken in the analysis of data collected through interviews principally with developers and managers of intelligent support systems. Results of that analysis were examined. Discussion was firstly in terms of an overview of the systems' details. This was followed by an in-depth look at the differing scenarios related to systems' outcomes. From this analysis two systems, *AVOMAN* and *WHEATMAN*, were identified for further data collection. Interviews with users of these two systems were conducted to obtain further insights into how farmers used these systems and their involvement in the development process. Data was collected on how farmers perceived the usefulness and ease of use of the software. This chapter analyses the data collected from the interviews with users.

The chapter proceeds as follows. This section outlines the structure of the chapter. The second section, 5.2, gives an overview of the approach taken in the collection of data from users using telephone interviews. Section 5.3 provides information about the view of the users in relation to the intelligent support system *AVOMAN*. An overview of the results of the interviews is given and this is followed by an examination of the transcripts in relation to key attributes that relate to propositions in the conceptual framework. Section 5.4 details the same type of information in relation to users' views of the intelligent support system *WHEATMAN*. Finally, section 5.5 provides an overview of the results.

5.2 Overview - interviews with users

During the analysis of systems discussed in Chapter 4, the focus was on the developers' or managers' views of system development and success. This allowed the systems to be categorised according to system outcomes. User influence in system design was one factor identified as having an impact on system outcome. Influence was noted as being different to involvement. Two systems, *AVOMAN* and *WHEATMAN*, were targeted for further investigation on the basis of the perceived degree of influence users had on the system design features and the outcome for those systems.

AVOMAN had an extensive degree of user involvement that was of a consensus nature resulting in users having a strong degree of influence on system design. *AVOMAN* was the *only* system in the study that had user involvement that was consensual in nature. Because of this fact, it was considered important to obtain users' views on both the development process for this system and their views of the system in terms of usefulness and ease of use. *WHEATMAN* had user involvement that was rated reasonable to extensive. Involvement was representative in nature and the degree of influence on system design was coded as moderate. It was unclear from the transcripts, however, how the agronomists and the farmers interacted with the software. It may have been at a token level of checking out how the system looked or at a more fundamental level of looking at what the system did and whether it met farmers' needs. Regardless of the type of involvement, it was clear from the transcripts that users of *WHEATMAN* did not have the same degree of influence in development at the conceptual level as the users of *AVOMAN*. The outcome for

WHEATMAN was less than what the developers had hoped for. The reasons for the poor uptake of *WHEATMAN* were seen as worth investigating especially given the involvement of some users during development. The fact that both systems had at least a reasonable degree of user involvement, but different degrees of influence on the nature of the software, would allow the validation of the coding method and provide further insights into the differing degrees of user involvement and user influence on system outcomes.

AVOMAN is discussed first.

5.3 AVOMAN

5.3.1 Background

AVOMAN provides growers with management tools and information for improving avocado orchard productivity and fruit quality. It is both a record keeping tool and a decision aid tool. The *AVOMAN* software was developed for use by commercial avocado farmers, consultants, and extension staff. Its primary purpose is to provide record keeping and reporting facilities, recommendations based on information about the grower's own orchard, and agronomic information (Newett *et al.*, 1999).

A survey of 11 farmers who were either users or non-users of *AVOMAN* was undertaken in the week beginning the 8th May, 2000. The person who was initially interviewed about the system provided a short list of users and non-users. All names on the list had some involvement with *AVOMAN*. They were either current users or were farmers who were not currently using the product but had participated in prototype testing. Seven current users were interviewed and four non-users were interviewed. The interview times ranged from five to 30 minutes with an average time of 14 minutes. At the end of the interview, the users of the system were asked to rate *AVOMAN* in terms of ease of use and usefulness, as well as the compatibility of the system with their usual way of working (Appendix D).

5.3.2 Users view of *AVOMAN* – an overview

Of the farmers interviewed, seven were current users of *AVOMAN*. All users stated that they found the system both useful and easy to use. The level of computer skills required was not an issue. Even new users who had purchased a computer to use *AVOMAN* still found it easy to use. The following user is 60 years of age:

> *Never had used a computer before, needed to buy a computer. Bought a computer, got a copy of AVOMAN and away we went. No trouble from the first minute - it is so simple to use. It was no problem to use - very simple.* [5][7]

All users used *AVOMAN* for record keeping. The spray diary was very popular given the fact that detailed recordings of spraying regimes are required by industry. Most users mentioned quality assurance issues. Users liked the quality of the reports produced by *AVOMAN* and found them easy to generate

The use of the decision aid feature of *AVOMAN* revealed some interesting issues. Only one user was not using the decision aid component of *AVOMAN*. This was a new user who had not entered enough data at this stage to make use of the decision aid feature. Most users still used a consultant and compared the consultant's recommendations with *AVOMAN*. All found *AVOMAN* to be in agreement with the consultant's recommendations within grams of fertiliser.

> *We use AVOMAN primarily as a recording tool. Use the decision aspect to check against the recommendation of the consultant.* [1]

[7] The numbers in the square brackets relate to the Ids shown in Table 5-1 and Table 5-2

Only one user was relying solely on *AVOMAN* for recommendations.

The users seemed reluctant to not continue with their consultants and appeared happy to be able to check the consultant's recommendations against *AVOMAN* and as well, to check *AVOMAN* against the consultant.

As one user stated:

> *We use a horticulturist but cross-reference AVOMAN with the horticulturist's recommendations. AVOMAN is generally very similar to horticulturist's recommendations. We did a test once - ask horticulturist and AVOMAN for recommendations for a whole year. Only one thing that the horticulturist did more than AVOMAN and this was because he knew the property personally. AVOMAN was almost to the gram accurate with the horticulturist. It was amazing. I would never have believed it. That convinced me that it just wasn't a game program but was a serious thing.* [7]

Users have a high opinion of *AVOMAN*. As one user commented:

> *If upgrades were on a user pay basis I would still use it. Feel it is our (producers) product - because of involvement. It was a team effort. Producers put a lot of effort into it as well. There is joint ownership.* [1]

One user saw it as a 'must get' tool. Another user stated:

> *There are two good tools for the farm - four wheel bikes and AVOMAN.* [5]

For some users it has impacted on decision-making.

> *- makes it easier - especially in relation to fertiliser applications - know when is the best time to apply fertiliser applications. Now apply fertiliser applications differently than I used to. It has refined our farming practice*

rather than changed it dramatically - especially in relation to fertiliser application. [6]

One user felt that the program would be better if it was structured differently so that it would be more useful for farmers who grow more than one crop. This user suggested that there should be a basic module that links to other modules - one for each crop. The user liked *AVOMAN* so much that they wanted to use it for all the crops that they grew.

5.3.3 Non-users' view of *AVOMAN* – an overview

Four farmers who had interacted with *AVOMAN* during the development phase but who no longer use it were interviewed.

One user did not use *AVOMAN* because he was critical of it.

Used the system when prototype testing was occurring but no longer use it. Thought that the data that is used to interpret results was not fine enough - too broad - as it came from only one person's farm. Never interacted with full release version. I use a horticulturist to interpret leaf and soil analysis. [11]

This farmer uses a computer for record keeping. However, he does not use *AVOMAN*. (Note: The view that the data came only from one person's farm is incorrect.)

One user indicated that their farm was too small and did not warrant the use of *AVOMAN*.

Wasn't worth it as it is not our primary source of income. Decided to keep going without it. Only have 270 trees. Too much effort for the benefit. [8]

One user did not use it because he was not computer literate. However, this grower had a positive attitude towards the system and recommended it other growers.

> *It is harder to use the program than it is to record the data manually. I am not a good example as I am not very good with computers. Using the program is too much hassle. The program is good for new growers who know nothing. I recommend AVOMAN to people who are new to the industry* [9].

The fourth non-user was interested in the software when he did the prototype testing and thought it was quite good. However, he indicated that his farm was small (700 trees).

> *If I had a big farm it would be wonderful.* [11]

Generally, users and most non-users had a good opinion of *AVOMAN*.

To gain further understanding of the users' view of *AVOMAN*, the interview transcripts were coded in relation to key attributes that form a basis of the propositions put forward in relation to the conceptual framework.

5.3.4 *AVOMAN* – users' views in relation to research propositions

The research propositions for this study are that for systems to be adopted they must be useful and easy to use. That is, they must capture the needs of users, in this instance, farmers. It was argued that this farmer perspective could only be truly incorporated into the system by involving farmers very early in the development process. Segments of the transcripts are now presented in relation to eight main attributes or propositions that form part of the conceptual framework. These attributes or issues are: user influence, user confidence in system, usefulness of the system, ease of use of the system, data input, data output, impact on decision-making, and limitations of the system. In addition, some non-users' views are given on the reasons for non-adoption.

The data presented below are taken directly from the interview transcripts.

5.3.4.1 User influence

Users had a strong sense of ownership. They could see that their ideas were incorporated into the final product so that it better suited the needs of users. Views of users were sought at workshops, through questionnaires, and prototype testing.

- *Feel it is our (producers) product - because of involvement. It was a team effort. Producers put a lot of effort into it as well. There is joint ownership.* [1]
- *The final product is more advanced, more detailed, fits in better. Feedback from growers has been incorporated. More was added to suit farmers, ie wages, mixing of fertilisers.* [3]
- *There was a prototype in 1996/97 and I provided some comments on that system. System was up by the time I saw it. Comments were incorporated. Program is pretty good in the way that it matches the way I would think about things. Had workshops where they requested feedback and I fed back info on how it could be improved - for example, the setting up of the spray diary.* [4]
- *There were many prototypes and users were sent questionnaires to capture as much feedback as possible from the farmers. What else do you want - good points and bad points. Comment on different parts of AVOMAN - what were farmers using and not using etc. The final version was a big improvement over the prototypes. Final program was much easier to use. The prototypes were hard to use and we ended up not using them - it was a battle.* [6]

- *No - we were not part of the development but used the prototype - the first prototype was very basic program- but could see the potential. I think the team has done a very, very good job - input from a lot of sources - development by a lot of different groups. The amount of effort put into the development shows up in the accuracy of the recommendations.* [7]

5.3.4.2 User confidence in system

Users had a lot of confidence in the system. Many users compared the output from *AVOMAN* with their consultant's recommendations. Generally they were very similar.

- *The recommendations given by AVOMAN and consultant are always right down the line.* [1]
- *I see it as a must to get. Not disappointed with it. Will suspect that there will be things that I might like changed in future versions.* [2]
- *Much the same recommendations as given by consultants - only differ by a small amount. If not the same then try and investigate why not the same. However, no differences have been of concern, as they are only very small differences.* [3]
- *I compare notes with what consultant says and what AVOMAN recommends. Sometimes it is the same sometimes it is different. If consultant recommends, for example, a large amount of chemical use in comparison to that recommended by AVOMAN I may use an amount that is in between the two recommendations.* [4]
- *AVOMAN is really good - handy in terms of recording fertiliser applications as well as using it for recommendations. Enter leaf and soil sample information and the system will recommend fertilisers that need to be applied. Use it to determine what fertiliser to put on and when. It gives assurance that what we are*

doing is correct. It saves time having to ring someone to check what we should be doing. [6]

- *Use a horticulturalist but cross-references AVOMAN with the horticulturalist's recommendations. AVOMAN is generally very similar to horticulturalist's recommendations. We did a test once – asked horticulturalists and AVOMAN to give a recommendation for a whole year. Only one thing that the horticulturalist did more than AVOMAN and this was because he knew the property personally. AVOMAN is almost to the gram accuracy with the horticulturalist. It was amazing. I would never have believed it. That convinced me that it just wasn't a game program but was a serious thing.* [7]
- *I recommend AVOMAN to people who are new to the industry. I believe that for the younger farmers who use a computer more the system is good for them. I think the program is good as there are upgrades all the time - it is a very good program.* [9]

One user had less confidence in the system.

- *Used the system when trialing was occurring but no longer use it. Thought that the data used to interpret results was not fine enough - too broad - as it came from only one person's farm. Never interacted with full release version. Use a horticulturalist who interprets leaf and soil analysis.* [10]

5.3.4.3 Usefulness of system

Users found *AVOMAN* a very useful system. Users saw it as a good tool to help them meet quality assurance requirements. They found it a useful record keeping tool and useful decision support tool. They were pleased with the professional output of reports that the system generated.

- *The cost of buying AVOMAN is not great. Time spent doing data entry is worthwhile because of the reports you get out of it are good. Decided to use it as a means of record keeping, decision-making, and information source. Knew about it when I took up avocado farming.* [2]
- *Using AVOMAN has not impacted on my decision-making because I have an established farm and am on track. But it has made a difference to my record keeping. Lots of farmers have not taken it up. They see it as something that will load them up but not make money. I trialed it to see what it was like. It is like having a consultant on-board.* [3]
- *Best features - spray diary is the most important one that we use at the moment. The agents in Sydney and Melbourne require this information for QA purposes. Put in info and AVOMAN prints out report - with certification number, month etc. It is only as good as the information you put in. Direct benefit - saving of time, fertiliser cost, and chemical cost has saved money. Also, ensures that you are using the correct chemical. Always trying to find better ways of managing farm - competitive edge. Brought the computer just for AVOMAN. QA is also an issue – we must use a spray diary so may as well use the computer to store the information rather than entering it manually. Manually takes too much time.* [4]
- *Five years ago when things started getting serious about food safety (HACCP - Hazard Analysis Critical Control Point) we decided that we needed to change our record keeping system otherwise we would not be able to be part of the industry quality audit system. We are looking at becoming exporters of mangos and need good quality assurance to be part of that. Our paper record keeping system was not up to HACCP requirements. We had seen a prototype version of AVOMAN and around that time the full release version was soon to be available.*

Decided to wait for that and use it as our record keeping system. One of first to order. Attended training days. [5]

- *Used to get soil and leaf test interpreted - now get plugged straight into AVOMAN. So do not seek advice from extension staff as often.* [6]
- *Use AVOMAN for record keeping. Because of the HACCP requirements we must keep a spray diary. A spray diary is a must for every supplier. AVOMAN spray diary produces a professional looking form that we can send out. It is in our best interest to look professional as this helps make money.* [7]
- *The information in AVOMAN is information that is normally recorded - rates, blocks, fertiliser types. System goes further than that and looks at soil type, wet season info, size crop load. For some of this info you can just enter a rough estimate.* [9]

5.3.4.4 Ease of use of system

Users found the system easy to use. Even first time computer users did not appear to have any problems.

- *Don't need to use the support-line as the system is easy to use. It is an excellent program, wish we could do the same for olives. It is very reliable.* [1]
- *Data entry is easy and I am no computer expert. Output - reports - no problems understanding them.* [2]
- *I am not highly skilled in computers - but AVOMAN is easy to use. There is a good backup service that I can contact if required.* [3]
- *Not a computer person - reasonably user friendly, pretty good to use, if you make a mistake it lets you know. Had a few bugs with it but we have ironed them out. If you were a computer person then it would be very easy to use. I am not computer literate. I get the kids to help when I have problems. However, the*

system has been made user friendly for non-computer people. It shows up if you are trying to enter something that is not correct. [4]

- *Never had used a computer before, needed to buy a computer. Bought a computer, got a copy of AVOMAN and away we went. No trouble from the first minute on - it is so simple to use. It was no problem to use - very simple.* [5]
- *The system is pretty user friendly.* [6]

5.3.4.5 Data input

Users had no real problems with data input. The only problem mentioned was making sure that the system was up to date.

- *Data entry is easy and I do not see myself as a computer expert.* [2]
- *Still put stuff in a notepad and then enter the data into AVOMAN once or twice a week - depending on what jobs I have done in that time, ie how often I am fertilising. Takes about 20 to 30 minutes for data entry each time I use it. Data input is okay, they skilled up farmers to work well with system.* [3]
- *The biggest thing is keeping it up to date. You need to enter information every day or two days. I spend about half an hour per day entering the information. Lot of work involved in setting it up.* [4]
- *Data input - is generally good - AVOMAN is good in the way it requires data input.* [6]
- *Not using it properly, do not sit down everyday and record what we have done so we can determine what needs to be done in the next few days. We record data on a monthly basis. If our computer was on every day then perhaps we would enter data daily.* [7]

5.3.4.6 Data output

Users were very happy with the output generated by the system. Some users found the output a little confusing at first but found the training days and manuals very helpful.

- *Output - reports - no problems understanding them.* [2]
- *Output is alright.* [3]
- *Output is pretty good - sometimes it is hard to understand. Rang support team for help when had problems understanding output.* [4]
- *Data output- took a little bit of getting used to but with the training days and the manuals it didn't take too long to get used to. It was a little bit daunting at first to be certain that we had interpreted the recommendations correctly. With a little bit of help from Department of Primary Industry we overcame this.* [6]

5.3.4.7 Impact on decision-making

Farmers were happy to use *AVOMAN* as a record-keeping tool and as a double check on consultants' recommendations.

- *It has impacted on my decision-making.* [1]
- *Do not use for decision-making as I have not entered enough data to get back fertiliser recommendations.* [2]
- *Look at it in the role of record keeping and as a backup to the farm consultant.* [3]
- *It has lots of information for starters. However, I do not use it as a bible. But it has altered my decision-making. In terms of cost/benefit it is worth the effort of using it. It is worth the cost of the computer, software, and effort. It gives print outs of fertiliser used, workers who did work in paddock. I use sections of it -*

can ask it who did the spraying in a particular paddock. Good management tool. [4]

- *Do not particularly use it to assist with decision-making. Use it mainly for record keeping. Use an agronomist who does leaf and soil samples and he advises in regards to decisions to be made. ... compare notes with what consultant says and what AVOMAN recommends.* [5]
- *Use it for both record keeping and decision-making. Impact on decision-making - makes it easier - especially in relation to fertiliser applications - know when is the best time to apply fertiliser applications. Now apply fertiliser applications differently than we used to. It has refined our farming practice rather than changed it dramatically - especially in relation to fertiliser application.* [6]

5.3.4.8 Limitations of the system

The limitations reported by users were really additions that they would like the system to have. One user was confident that the changes he wanted would be incorporated. No users reported limitations with the system that affected their use of the system in a major way.

- *Use a micronutrient approach to farming and AVOMAN is not prepared for this. Using this approach soil and leaf analysis is not so important. Still compare consultant recommendations with AVOMAN. Will use it for recommendations when AVOMAN handles micronutrients.* [5]
- *I would have structured the whole program differently as most farmers have more than one crop. A limitation with the program is that AVOMAN is for only one crop. Most farms do not have only one crop. Should have a basic module with other plug in modules for each crop. For example, an avocado module, mango module, and a lychee module. I have adapted AVOMAN for mangos as*

well. Cannot use the recommendations but can use the record keeping part. I call the mangos by a variety of avocados. I strongly believe that these type of systems should be linked. [7]

5.3.4.9 Not useful or not worth effort

Some farmers chose not to use *AVOMAN* because of the small size of their farms, or they felt they did not have the necessary computer skills. For one user, their preferred form of decision-making was by consulting a horticulturalist.

- *Wasn't worth it as it was not our primary source of income. Decided to keep going without it - only have 270 trees. As well, I have limited computer skills and am happy to use a consultant.* [8]
- *It is harder to use the program than it is to record the data manually. I believe I am not a good example as I am not computer literate. I think using the program is too much hassle.* [9]
- *Instead of using AVOINFO I prefer to ring and ask my horticulturalist, as it is more efficient. Save hunting through all the information on the CD.* [10]
- *If I had a big farm it would be wonderful. However, with only 700 trees you get to know all your trees quite well. It seems to me that it requires as much time to enter information into the system as it would for a big farm so it is not worth the effort.* [11]

5.3.5 Summary of users' views

The users of *AVOMAN* believed they had considerable influence over the design features of the system. They indicated that their views and requirements either were or would be incorporated into the system. The users had confidence in the recommendations of the system. They found it a useful record-keeping tool, especially in relation to generating reports that they were required to submit for quality assurance reasons. They found the system easy to use. The data entry requirements presented some problems for users in that many of them do not like to sit down each day and enter the data. Some users used the recommendation output from *AVOMAN* as a backup to the consultant's recommendation. One user used *AVOMAN* in lieu of a consultant. Only one user was using the record keeping facility of *AVOMAN* alone and not the decision-making facilities but this was because he was a new user and had not entered enough data at that stage.

5.3.6 User profile

Table 5-1 summarises aspects of the seven users interviewed for this study. Five of the seven users were over 50 years of age (where the information was available). Six of the seven users strongly agreed that *AVOMAN* was easy to use. Five of the seven users strongly agreed that *AVOMAN* was a useful tool. All users rated *AVOMAN* in terms of usefulness and ease of use at least at the agree level (Appendix D). In terms of compatibility with the way they liked to work, four users rated it at the level of strongly agree, three users at the level of agree. From the transcripts it was clearly evident that users had considerable confidence in the system and had a sense of ownership of the product. Those that were part of the development process appeared to have a greater sense of ownership.

> *If upgrades were on a user pay basis I would still use it. Feel it is our (producers) product - because of involvement. It was a team effort. Producers put a lot of effort into it as well. There is joint ownership.* [1]

Table 5-1 *AVOMAN* - interviewee profile

Id	User	Age	Computer-skills	Uses a consultant	Rate *AVOMAN* as easy to use	Rate *AVOMAN* as useful	Uses *AVOMAN* for decision-making	Uses *AVOMAN* for record-keeping	Involved in testing - data collecting	Number of avo trees	Why do you not use *AVOMAN*?
1	Yes	60	Skilled	Yes	Strongly Agree	Strongly Agree	Comparison with consultant	Yes	Yes	1000	NA
2	Yes	38	Limited	?	Strongly Agree	agree	Not yet	Yes	No	1500	NA
3	Yes	65	Limited	Yes	Strongly Agree	Strongly Agree	Comparison with consultant	Yes	Yes	1000	NA
4	Yes	?	Limited	Yes	Strongly Agree	Strongly Agree	Comparison with consultant	Yes	No	?	NA
5	Yes	60	Limited	Yes	Strongly Agree	Strongly Agree	Comparison with consultant	Yes	Minimal	1250	NA
6	Yes	22 & 53	Skilled limited	Not mentioned	Agree	Strongly Agree	Yes	Yes	Yes	1500	NA
7	Yes	60s	Skilled	Yes	Strongly Agree	Agree	Comparison with consultant	Yes	Yes	400	NA
8	no	65	Limited	Yes	NA	NA	NA	NA	Yes	270	Not worth it
9	no	50	None	?	NA	Thinks program useful	NA	NA	Minimal	1000	Too much hassle
10	no	?	Skilled	Yes	NA	NA	NA	NA	Yes	2500	Problems with underlying data
11	no	73	None	Yes	NA	NA	NA	NA	Minimal	700	Not computer literate & small farm

5.4 *WHEATMAN*

5.4.1 Background

WHEATMAN is a wheat growth simulator. It is a decision support tool with some record keeping facilities. When the developer of the system was interviewed, *WHEATMAN* was undergoing extensive revision from a DOS version to a Windows version. Discussion with the developer was in relation to the DOS version. Users of the system were asked their opinion of the DOS version, however, many had strong views on the Windows version. These views are included when relevant to this study.

A survey of nine farmers who had purchased *WHEATMAN* was undertaken in the week beginning the 15th May, 2000. A further three interviews were conducted in the week beginning the 20th October, 2000.

A list of current users and individuals, who appeared not to be current users in that they had not updated their versions of *WHEATMAN,* was provided by the interviewee of the previous survey phase. Determining which users had participated in the development of *WHEATMAN* was difficult. This was because involvement was determined at a local level and the names of participants were not recorded centrally. Nine current or recent users were interviewed and three users who had purchased the product but were not currently using the system were interviewed. The interview times ranged from 10 to 45 minutes with an average time of 25 minutes. At the end of the interview, users of the system were asked to rate *WHEATMAN* in term of ease of use, usefulness, and compatibility with how the farmer works (Appendix D).

5.4.2 User view of *WHEATMAN* – an overview

Of the farmers interviewed, nine were users of *WHEATMAN*. In general, users did not perceive that they had any real input into the design of the *WHEATMAN* software.

> *Not really involved in development. When first started - few growers meetings. Wasn't much. Didn't come around and ask what we wanted. The developers came around and told us what they were doing. Had info about frost and soils - package that was presented to farmers. Were not interested in what farmers were thinking - we probably wouldn't know anyhow. I did some prototype testing.* [4]

Users were mixed in their views of the usefulness of *WHEATMAN*.

One user commented:

> *Haven't got a real lot out of it in terms of hard data.* [1]

While another stated:

> *I use it a lot to make decisions on time of planting - frost risk and the like.* [2]

Again, there were varying views on the ease of use of the software.

> *... if you have 10 paddocks and use the same procedure on each paddock you need to enter the same data 10 times. They are just little annoying things.* [4]

Another user commented.

> *In terms of ease of use - must be okay. I normally have problems with computers so must be okay.* [5]

Users also had varied views on how much confidence they had in the system.

It terms of water stored - I use it as a guide only - it is not the ultimate. I use a soil probe. With regard to nitrogen I use it as a guide only. It gives some indication of how much nitrogen you should apply - but you have a gut feeling also. [2]

From another user.

Couple of years ago used it to determine what type of wheat to plant. June planting - which was late. It helped me realise that I had made the right decision - confirming. [9]

The level of computer skills was an issue for only one of the non-users. All users, however, had reasonably good computer skills. Three of the interviewees were clearly highly innovative growers. There seems to be some evidence that farmers who are more innovative are more likely to use *WHEATMAN*. One interviewee commented on the low level of record keeping amongst wheat growers.

Only around the top 10% of growers keep really good records. 20-30% keep basic records. The rest – I wonder how they survive [3].

Given this low level of record keeping by wheat farmers, one could have almost predicted a low level of adoption of *WHEATMAN* by farmers, although it is true that the system can also be used for decision-making without entering on-farm data. Three users commented on the time commitment required to keep records up to date. However, another farmer commented that:

Using WHEATMAN encourages you to keep better records. To enter the details for one paddock takes only 5 minutes. [3]

Eight of the nine users interviewed used *WHEATMAN* for both record keeping and decision-making (Table 5-2). However, the extent to which they used either of these facilities varied.

Again, as with the other aspects of the software the level of impact of the software on decision-making varied amongst users.

> *How much it has affected what I would have done anyway I am not sure. Usually have some plan - rotation. One paddock I put chickpea in, another canola, another wheat. In the final analysis you mainly do what you would do anyway. If we have rain and have moisture then we must plant, as you may not get another planting rain. WHEATMAN indicated a 47% risk of frost but still had to plant. Planted - regardless of the frost risk. Hasn't influenced what I did.* [1]

Another user's view:

> *WHEATMAN has saved me money. I have stopped wheat farming in one particular paddock, because of frost, as a result of the advice it gave. This paddock was susceptible to frost. These types of tools can help you make decisions. They do not tell you how to run your farm.* [3]

Users had varying views on all aspects of the software.

5.4.3 Non-users view of *WHEATMAN* – an overview

Two of the non-users had not interacted with the software at all. Both had purchased the product but had not used it. One user had not used it because they had not been able to plant a crop because there had been no rain. The other user cited his poor computer skills as the reason for not using the software.

The third non-user had initially been a user of *WHEATMAN* but had stopped using it because he did not like its recommendations.

> *Problems with WHEATMAN - would ring programmer to get sorted out. It wasn't exactly what I was looking for. Pulling reports and using information - accessibility - more difficult through WHEATMAN - that turned me off. Hard copy was easier to grab information from. Went back to keeping records manually. Looked around quite a bit for paddock recording software but couldn't find one that was suitable.* [10]

To gain further understanding of the users' view of *WHEATMAN*, the interview transcripts were coded in relation to key attributes that form a basis of the propositions put forward in relation to the conceptual framework.

5.4.4 *WHEATMAN* – User views in relation to research propositions

As with the *AVOMAN* transcripts, segments of the *WHEATMAN* transcripts are now presented in relation to seven main attributes or issues that form part of the conceptual framework. These attributes or issues are: user influence, user confidence in system, usefulness of the system, ease of use of the system, data input, impact on decision-making, and limitations of the system. In addition, user comments on DSS in general are presented.

The data presented below are taken directly from the interview transcripts.

5.4.4.1 User influence

In general, users did not believe they had much influence in the development of the *WHEATMAN* software. Farmers viewed the system as up and running by the time they saw it. There was a sense that they saw the demonstration sessions as being more about showing what the system would do rather than seeking input from farmers.

- *WHEATMAN was up and running when it was sent out. Didn't involve growers. Amateurs trying to do it.* [1]
- *Not really involved in development. When first stated - few growers meetings. Wasn't much. Didn't come around and ask what we wanted. The developers came around and told us what they were doing. Had info about frost and soils - package that was presented to farmers. Were not interested in what farmers were thinking - we probably wouldn't know anyhow. Did prototype testing.* [4]
- *I was not involved in the development of WHEATMAN.* [7]
- *Looked at the beta version and made a few suggestions and comments. Only had a minor influence.* [8]

5.4.4.2 User confidence in system

Some users had a lot of confidence in *WHEATMAN* whilst others did not believe the output generated by the system. Some users believed the output on some occasions and not on others.

- *It wasn't a real big help with record keeping. It made me keep the records. Didn't help much with decision-making. Went back to WHEATMAN - never quite believed it - I still don't quite believe it - yields are conservative. Tells you that you will get 1.5 tonnes per hectare when expecting a lot more.* [1]
- *It terms of water stored - I use it as a guide only - it is not the ultimate. I use a soil probe. With regard to nitrogen I use it as a guide only. It gives some indication of how much nitrogen you should apply - but you have a gut feeling also.* [2]

- *WHEATMAN is a good record keeper. As well, I rely on it for frost prediction. It is very accurate. I have used it for over 10 years and so now have info going back that far. If only I had started with something like this. It makes it easy to keep records. It doesn't take long to enter information from Palmtop into the computer.* [3]
- *Output - varied sometimes I would think it was wrong, sometimes it was right.* [5]
- *I don't use it - didn't like the recommendations. When I became involved with the WHEATMAN program I was learning about Nitrogen, Phosphorus. Now involved in biodiversity association. Did consider decision-making aspects - did consider what WHEATMAN was suggesting. I may have been looking at it in the wrong perspective - was thinking of it as gospel but things were happening different to what the program was saying. Yield predictions – I didn't really believe them. Initially yes, then did some fertiliser trials on my own farm - compared to WHEATMAN but nothing worked out. When confronted Department of Primary Industry - couldn't give answers.* [10]

5.4.4.3 Usefulness of system

WHEATMAN does not appear to be as useful to farmers as the developers may have hoped. For some farmers it has been a very useful tool but for others they have not found it as useful as they had anticipated.

- *I was searching for something to keep records in - not getting much out of it – hoped it would be better.* [1]
- *Use it mainly for planting times and also to a degree nitrogen and moisture. I can use it after planting for real time runs. I need to do a report to my superiors about what I think the potential yield is going to be. Use WHEATMAN for this. Gives an ongoing estimate. The estimates are pretty good. One thing they do not*

take into account is that they assume there will be no adverse effects from plant disease, weed effects, or water logging. Program assumes all is well. [2]

- *Use WHEATMAN for frost but not for record keeping - didn't have the time. To be honest I never got a lot out of use out of it. There were always droughts or floods. Handy thing - but was primitive in a lot of ways. Started using it in 1992 - the trouble is there was a drought from 1990 - 1995. Everything was useless in those periods. Later on I got a bit of use out of it. You would plan an early crop and then it wouldn't work so you wouldn't plant early. The whole thing was a bit debatable - need consistent years - but there is no such thing. WHEATMAN was a fairly primitive program. I was farming for 40 years. Most of the things I needed to know were instilled in my head. Use other things (like WHEATMAN) as a backup.* [6]
- *I believe that WHEATMAN does meet the needs of users. Information on different varieties of wheat and frost risk is provided in a pamphlet that is put out by Department of Primary Industry each season (based on WHEATMAN information). It is pretty broad and general and for most people this is enough information. But if you want more specific information you would need to use WHEATMAN. Also many farmers just go on what their dad did. Pamphlet would be guiding many farmers especially the older generation who would not want to use a computer. It is debatable how much more you would get out of actually using the WHEATMAN system as opposed to just accessing the information in the pamphlet.* [7]
- *We use it to keep paddock records for what we do on a paddock. Everything we do on the farm we record in WHEATMAN - rainfall, SOI. When we want to plant wheat we work out what would be the best kind to put in.* [9]

- *Haven't had any crops because of the weather so have not used WHEATMAN. Installed it. Did not have a local rainfall chart for this area. The one we have to use is based on Dalby as we didn't have rainfall records.* [11]
- *Stopped using it around 18 months ago. Used it for at least 2 years. I think simple spreadsheet programs are the way to go.* [10]

5.4.4.4 Ease of use

Generally, users found *WHEATMAN* relatively easy to use. One user described it as slow and cumbersome.

- *Data entry is quite easy - if had all the data - historical data - that would take a bit of time. Starts off using historical data. The more of your own data that you enter the better. Wasn't hard to use - different.* [1]
- *The output from WHEATMAN is good. I like the amount of detail. The results are straightforward. Farming is a complex business and it does a good job of simplifying complex issues.* [3]
- *In terms of ease of use - must be okay. Normally I have problems with computers so must be okay.* [5]
- *Output took a bit of thinking - it wasn't just straight in front of you - you had to analyse it but that wasn't a problem.* [6]
- *WHEATMAN is not too difficult to use, fairly simple to follow.* [7]
- *The DOS version is slow and cumbersome. Keen to move over to the Windows version.* [8]
- *It is easy to use - compared to other programs. Hadn't used a computer before WHEATMAN. Am used to DOS - am worried how I will cope with the new Windows version.* [9]

5.4.4.5 Data input

Users had very different views on data input. Some found the amount of data input required as just too daunting as they only entered the minimum data required. Other users found data input straightforward.

- *I am a bit slack some times. You are suppose to put in every operation - every herbicide, every time you do anything. I do not bother to do every operation every year. I do harvest and initially tillage or spraying after harvest. Program assumes fallow and accumulation of soil water.* [2]
- *Trouble is getting time to put data into it. Wanted to make a few suggestions to improve the data input. Using it for record keeping. Sitting down and using all the things it can do - nitrogen and variety comparisons - bit slack - main reason. Just use it for paddock records.* [4]
- *No problems with data input. Just click on options. Just options to select - enter chemicals and rates used on a paddock. Everything is just click on. I do not enter detail for every paddock. Need to enter info like basic soil type, variety planted. I have 16 paddocks on my farm and have entered data for 3 paddocks in the computer. The info would be the same for each paddock not worth the time of entering it. Would need to enter same information over and over.* [7]
- *Haven't had time to keep it up to date - haven't included information since the beginning of the year.* [9]

5.4.4.6 Impact on decision-making

WHEATMAN was developed to help farmers with their decision-making. For some users it has been helpful and output from the system has been used to alter farming practice. Others see it as confirming their decision-making. For others, they see that they have limited options anyhow and they have to continue with a particular farming practice even if the system is indicating that to do so is risky.

- *It wasn't a real big help with record keeping. It made me keep the records. Didn't help much with decision-making. Went back to WHEATMAN - never quite believed it - I still don't quite believe it - yields are conservative. Tells you that you will get 1.5 tonnes per hectare when expecting a lot more. In the final analysis you mainly do what you would do anyway. If we have rain and have moisture then we must plant as we may not get another planting rain. WHEATMAN indicated a 47% risk of frost but still had to plant. Planted - regardless of the frost risk. Hasn't influenced what I did.* [1]
- *Use it as a record keeping tool and a predictive tool. Use it to evaluate frost risk. WHEATMAN has saved me money. I have stopped wheat farming in one particular paddock, because of frost, as a result of the advice it gave. This paddock was susceptible to frost. These types of tools can help you make decisions. They do not tell you how to run your farm.* [3]
- *Quite accurate in forecasting. It is more confirming. In the end the farmer makes the decision - whether you can afford to do it. Don't use a consultant - if straight cereal no need for a consultant. Check the crop two times. Use some of the 'what ifs'.* [4]
- *Use mainly as a decision support tool because the record keeping is not up to date. Use decision-making for frost, planting date for the different varieties, fertilisers to use.* [5]
- *Used decision-making aspect of WHEATMAN but did not make too many decisions from it - planting date outside the frost period. Didn't change farming practice minimal impact- there were no choices to make - you had to plant when*

it rained. Still a pretty good little program. I would still use it if I was still farming. Use it as a check on things - wouldn't do exactly what it said but would take notice of it. [6]

- *Use WHEATMAN as a planting guide. Use for decision-making and useful as a record keeper. The big issue is really decision-making in relation to planting dates. Newer version is more extensive. Using it does not change my farming practise. It just gives you more information - more informed. If you are going to plant early then you will use a different variety get better frost probability so you can work out if you want to take that risk or not.* [7]
- *Use it for record keeping and decision-making to a certain degree. It doesn't alter it so much as help to confirm that you are doing the right thing. Allows me to check on certain aspects. It is matching my decision-making style more and more. The program can help you make decisions. Points you in the right direction. Do not take output literally. The output from WHEATMAN seemed to agree with what we found in practice.* [8]
- *Couple of years ago used it to determine what type of wheat to plant. June planting - which was late. It helped me realise that I had made the right decision - confirming.* [9]

5.4.4.7 Limitations - not matching working style

Users identified problems with the structure of *WHEATMAN* not matching their farming practice or record-keeping needs.

- *Haven't got a real lot out of it in terms of hard data. Got in it all my paddock records. Used mainly for record keeping. Used for estimating expected yields - hasn't been too helpful. The newer one is a lot better. In the old version, once* *the wheat was planted WHEATMAN didn't take into account events that happen after. What can I expect as a result of the rain - couldn't tell me.* [1]

- *The new version - they have tried to go too far. It is too complicated. You also need to have a planting date in order to do a simulation run. This is not the way I like to operate. Prefer to add planting date in after wheat is planted. In windows version, there are all sorts of error functions and exits the program. Too many things. If they had got the existing program that they had and converted from DOS to Windows and done no more extra modules that would have been better. I was going to ring up and let them know. They have sorghum and all sorts of things. What the hell do we want to know all that for? All you want to know is that you are going to plant a winter cereal, whether it is wheat, barley, chickpea, or some other crop like that. You want to know the optimum time to plant, how much nitrogen to put on, frost risk if you plant too early and the potential yield. More basic stuff - not complicated comparison with all sorts of other things that are to do with rotations rather than growing that particular crop in that field. It seems to focus more on simulation of rotations rather than growing one particular crop.* [2]
- *If you have 10 paddocks and use the same procedure on each paddock you need to enter the same data 10 times. They are just little annoying things.* [4]
- *Problems with WHEATMAN - would ring programmer to get sorted out. It wasn't exactly what I was looking for. Hard copy was easier to grab information from. Went back to keeping records manually. Looked around quite a bit for paddock recording software but couldn't find one that was suitable.* [10]

5.4.4.8 Decision support systems – general comments

Two farmers had views on DSS in general.

- *There is a tendency with decision support programs to make farmers feel as if they would not be able to cope with them. They are not encouraged to use these types of products. There needs to be more encouragement and training. Every farmer in Queensland should have a copy of WHEATMAN so that when the farmers come together they can be talking in like minds. To get the best out of these decision support tools there should be more encouragement and training to show that they are quite easy to use. They should run workshops and encourage farmers to bring their own data along with them so that they see the relevance of the output in relation to their property. This way the figures will mean much more to them. Otherwise they tend to be sceptical about the results. If you have good support and training then marketing is not such an issue - the software will market itself. Excel spreadsheets are simple and easy to use. There are some very good decision aid templates around that have not been pushed enough. I use these to do comparisons. Lets me see whether to sell or keep cattle. These Excel templates are so easy to use. They have not been promoted enough. They are real time savers. Use HowWet - a good, simple tool. Gives very accurate nitrogen requirements and very accurate soil water. Also, use it as the main rainfall chart. Need rainfall for WHEATMAN as well and need to re-enter the same data. It is a pain that you need to enter the data twice. It is very annoying.* [3]
- *I am on the northern panel of Grains Research Development Corporation that fund these types of systems - my argument is that these systems are used by the elite farmers and consultants. If people do not want to use them then what can you do.* [4]

5.4.5 Summary of users' views

The users of *WHEATMAN* did not appear to have had any major influence over the design features of the system. Many of the users did not appear to have confidence in the recommendations of the system. Some users, however, had changed their farming practice as a result of using the software while others appeared sceptical of the recommendations given by the system. Some found it a useful record-keeping tool, while others were critical of its record-keeping abilities. Generally users appeared to find the system easy to use but were less clear on the usefulness of the system.

5.4.6 User profile

Table 5-2 summarises aspects of the eight users interviewed for this study.

Five of the eight users were over 50 years of age. Three of the eight users strongly agreed that *WHEATMAN* was easy to use. Two of the eight users strongly agreed that *WHEATMAN* was a useful tool (Appendix D). In terms of compatibility with the way they like to work, three users rated it at the level of strongly agree, four users at the level of agree. From the transcripts it was clearly evident that users had mixed opinions about *WHEATMAN* as an aid in both record keeping and decision-making.

Table 5-2 *WHEATMAN* – interviewee profile

Id	User	Age	Computer-skills	Hectares of wheat	Involved in testing	Rate *WHEATMAN* as easy to use	Rate *WHEATMAN* as useful	Uses/used *WHEATMAN* for decision-making	Uses/used *WHEATMAN* for record-keeping	Why do you not use *WHEATMAN*?
1	Yes	70	Good	700	Yes	StronglyAgree	StonglyAgree	Not really	Yes	NA
2	Yes	61	Good	4700	Yes	StronglyAgree	Agree	Yes	Yes	NA
3	Yes	41	Good	2000	Limited	Agree	StonglyAgree	Yes	Yes	NA
4	Yes	44	Good	2000	Yes	StronglyAgree	Agree	Limited	Yes	NA
5	Yes	50s	Good	1600	No	Agree	Agree	Limited	Yes	NA
6	Yes	56	Good	500	No	Agree	Agree	Limited	Limited	Retired
7	Yes	32	Good	700	No	Agree	Agree	Yes	Limited	NA
8	Yes	46	Good	5000	Limited	Agree	Agree	Limited	Yes	NA
9	Yes	66 - female	Reasonable	171	No	Agree	Agree	Limited	Yes	NA
10	Not now	38	Good	840	No	Agree	Neutral	Problems	Difficult to access data	Not what I was looking for
12	No	38 - female	Good	NA	No	NA	NA	NA	NA	No crops due to weather
12	No	>60	Poor	?	No	NA	NA	NA	NA	Poor computer skills

5.5 Summary

This chapter has looked at the users' view of two intelligent support systems, *AVOMAN* and *WHEATMAN*. *AVOMAN* had extensive user involvement that was consensual in nature. This system was coded as a system where users had a strong influence over system features. Users and non-users of this system held the system in high regard. They had confidence in the output from the system and felt that the system was both useful and easy to use. It met their needs in that it was able to record information about chemical applications, generate reports that were required by quality assurance agencies, and provide advice on levels of chemical applications. Users had a sense of ownership of the product and were confident that their suggestions would be incorporated into the system in future versions.

In contrast, *WHEATMAN* had user involvement that was coded as reasonable to extensive and that was representative in nature. This resulted in the system being coded as a system where users had a moderate degree of influence over system design. Users had a view that they were consulted from time to time and that they were consulted after the system was developed. The developer of the system described user involvement in such a way that it appeared to be representative in nature. It appeared that users were involved through reference groups or testing groups of selected users. This aspect of the development of *WHEATMAN* is discussed further in Chapter 6. After interviewing users, however, the degree of user influence on design features appeared to be weak to moderate. Users had varying opinions in relation to most aspects of the system. Some users found the system useful in decision making whilst others felt that they did not gain much from using it. Some users found it a useful tool for record keeping whilst others were disappointed in the record keeping side of the software. In general, there was a sense that for many users the system did not match their way of thinking in terms of managing their data and making their farming decisions. While the system met some of the farmers' needs, there were aspects of it that were clearly not in line with how some of the farmers thought about their farming process.

This chapter has examined the transcripts of interviews with users in relation to the two intelligent support systems, *AVOMAN* and *WHEATMAN*. Chapter 6 will discuss the results from Chapter 4 and Chapter 5 in relation to the conceptual framework and the propositions arising from the conceptual framework.

Chapter 6

6 Research findings

Reality leaves a lot to the imagination.
John Lennon

6.1 Introduction

Chapter 4 outlined the method of analysis of interviews with individuals involved in the development of intelligent support systems in Australian agriculture. In addition, the results of that analysis were discussed. Chapter 5 presented the results of interviews with farmers who had used one of two targeted intelligent support systems.

This chapter concludes the thesis by presenting an overview of the work as a whole. The chapter discusses in detail the implication of the findings presented in Chapters 4 and 5. The discussion is presented in relation to the conceptual framework and related propositions as well as in relation to prior research.

The chapter proceeds as follows. This section outlines the structure of the chapter and section 6.2 briefly outlines the focus of the study. Section 6.3 examines the findings in relation to adoption levels and reasons for developing the systems. In section 6.4, the findings are examined in relation to user involvement in system development and system outcome.

The fifth section, 6.5, evaluates the research method used with particular reference to Klein and Myers's (1999) set of seven principles for conducting and evaluating interpretive studies in information systems.

Section six, 6.6, discusses the outcomes from this study specifically in terms of contribution to practice and contribution to theory. The limitations of the study are outlined in the seventh section, 6.7, while section 6.8 discusses areas where further research would be useful. Finally, the conclusions from this study are given in section 6.9.

6.2 Focus of the study

Data were collected in relation to 66 intelligent support systems developed for use in the agricultural sector in Australia. In addition, to gain a better understanding of the users' view, data were collected from the users of two systems. The data were analysed using both quantitative and qualitative methods. Information relating to system features of the 66 systems was presented in Chapter 4. These features were related to the type of system that was developed, who developed it, reasons for developing the system, the number of units sold and the like. Discussion on this aspect of the findings is in section 6.3.

Data from 38 systems targeted at or used by farmers were analysed in more detail to determine scenarios that are more likely to lead to system success. The analysis was mainly in terms of involvement of users in system development and the outcomes for those systems. Detailed discussion in relation to these findings is in section 6.4. Interviews were conducted with users of two systems, *WHEATMAN* and *AVOMAN*. The outcomes from this analysis are also discussed in section 6.4.

The following section looks at the results in relation to the data collected on the 66 systems. These findings provide confirmation of previous studies undertaken in relation to the lack of a user pull in the development of many of the systems.

6.3 Findings in relation to all 66 systems studied

Discussion will be firstly around the level of adoption and impact of intelligent support systems in Australian agriculture and the reason why the systems were developed.

It was apparent that despite anecdotal evidence of the limited uptake of intelligent support systems in Australian agriculture, a large number of these types of systems had been developed. One of the aims of this study was to establish if the anecdotal evidence was correct and if indeed the uptake of these systems was low. In addition, it was of interest why developers would continue to develop these types of systems if the uptake was limited. These aspects of the results are now discussed.

6.3.1 Adoption rates

The compilation of intelligent support systems targeted at agriculture identified 128 systems. Of these only 66 had gone beyond the prototype phase and had been placed in the public domain and in recent times had achieved some use. These 66 systems represent the more successful systems. That is, of the 128 systems identified 66 systems (52%) had achieved some prominence in the public domain. Of these 66 systems, 39 systems (59%) were coded as having achieved an impact level of medium to high. Of these, however, only 18 systems (27%) had an impact level of high. Impact was determined, for this study, by examining the adoption levels, market share, and other information that gave some indication of the impact that the system had amongst users. In terms of the 128 systems identified, these 18 successful systems represent just 14% of all the systems identified. However, caution is needed here as some of the 128 systems that were not included in the study were developed as research tools and were never meant for use in the public domain. Nonetheless, despite this cautionary note, a considerable number of systems have been developed with only a limited number achieving success in terms of adoption and impact. One reason for the limited uptake appears to be the fact that many systems were developed for a potentially small market.

6.3.2 Market size and non-competitive development

Many of the 66 systems investigated in this study appear to have been developed with little regard to the size of the target audience or in some instances without a clear understanding of who the target audience was. Forty three systems (65%) had adoption levels of 200 units or less. Twenty seven systems (41%) had adoption levels of 100 units or less. That is, close to half of those systems that had achieved some success had adoption levels of less than 100 units. Fifty six of the 66 systems (85%) were developed in government organisations. This supports the findings of Hilhorst and Manders (1995) study where they concluded that most systems in Dutch agriculture did not appear to have a large market base and were developed in a non-competitive environment, that is, in government organisations. In this current study, in many instances the systems developed by government organisations were not priced to cover costs, rather they were seen as providing a service to farmers. Only 10 systems were developed by private organisations or individuals. These systems had to compete with those that were developed outside the commercial environment.

The dilemma for the agriculture industry is that the privately developed systems were generally more successful than those developed in government organisations and yet these privately developed systems were at a disadvantage in terms of the price that had to be placed on their systems in order to cover costs. This presents problems for government organisations in Australia in that most developers are not conforming to Australian government directive requiring competitive neutrality (Hilmer, 1993).

Competitive neutrality involves removing unfair competitive advantage that government business may experience simply as a result of government ownership.

The results from this study suggest that many developers of agriculture software had little regard for a 'user pull' (Hilhorst & Manders, 1995) for their software, in terms of the target audience, and continued to develop software for limited or even non-existent markets. Of the 66 systems, 28 systems (42%) were identified as being developed solely from a technology transfer perspective. That is, a 'research push' perspective. These developers saw intelligent support systems as a way of transferring information to farmers. Claims by Cox (1996) and Stapper (1992) that it appears that the transfer of technology approach has been used in the development of intelligent support systems are supported for many of the systems studied.

From the developers' perspective, some interviewees saw their system as being at the cutting edge of knowledge and for these individuals uptake was not an issue – rather improvement in understanding was seen as the outcome of their system. The problem is that despite this lack of concern about uptake, some of these systems were still placed in the public domain. Once a system had been developed there appeared to be the temptation to place the system in the public domain even if this was not the original intention when the system was first conceived or even the intention during the development process. When this happened, the newly decided target users, the farmers, might not even have been considered, let alone be involved, in the development of the system.

For those systems that were developed originally for scientists or extension officers, the development perspective was generally from a scientist's or extension staff viewpoint with little understanding of the needs of farmers. These types of systems appeared to be over-engineered in terms of underlying models and so required extensive data input and complex data output. Little thought was given to marketing and maintenance issues. The systems were often sold for a nominal amount meaning that it was not possible to use revenue for maintenance or advertising. Many interviewees raised issues surrounding on-going problems with the marketing of their systems.

6.3.3 Marketing

In relation to the marketing of systems, some systems had been broadly advertised, for example, in newspapers, but generally this was seen as not cost effective. Many developers found that demonstrations at field days were a more effective way of raising the profile of the software. Cox (1996) claimed that market research was usually done after the product had been released and the developers become concerned about the poor uptake. There is evidence from this current study that developers often did not have a clear understanding of who their target audience was and were often not able to put time and money into marketing their product.

Training was also raised by a number of interviewees. Workshops were seen as one way of allowing farmers to interact with the software and also to raise the profile of the software product. Fifteen systems (23%) were incorporated into a workshop situation. Often the software was included in the price of the workshop. However, the time involved in running the workshops was often seen as too time consuming and again some interviewees did not see this as part of their core business.

Four systems were marketed by a professional commercial partner, Horizon[8], that specialised in linking science to productive systems. Of the four intelligent support

[8] Horizon – www.hnz.com.au

systems marketed by this organisation, two were coded as high impact, one as medium, and one as low. The systems were developed by government organisations but marketed and managed by a commercial company. Only one of the systems, *LambAlive*, was targeted at or used by farmers and so only the outcome of this system has been discussed in detail in this thesis. The issues of on-going maintenance and system champions were raised by a number of interviewees.

6.3.4 Maintenance, system champions, and project management

Many systems were developed without regard to the size of the underlying market, how the system would be marketed, and how the system would be maintained. Only rarely was a management group in place to look after the system once it had been finished and placed on the market. Project management consists of a relatively structured process of defining tasks and planning and scheduling those tasks before beginning the project. The progress of completion of the tasks is monitored during the life of the project. Only nineteen systems (29%) had some type of management group during development. This means that 71% of systems appeared to have been developed without any significant management plan. Project management was rarely in terms of information systems project management. This type of management involves a methodical approach to system development involving analysis, planning, development, testing, and maintenance.

However, it could be that the developers of these types of systems do not think in terms specific to information systems development. For example, no interviewees mentioned requirements gathering during the planning phases. Yet some systems clearly evolved out of a need. That is, the developers saw a need and proceeded to develop a system. In some respects this type of development approach has similarities with requirements gathering but with requirements gathered in a much more informal manner. Additional user requirements may also be gathered during the prototyping stages. So whilst most systems were developed without the use of a formal systems development life cycle approach this does not exclude aspects of that approach being incorporated into the development process of some systems. It is just that the process was more informal. However, it is the case that requirements were generally gathered during the testing phase for those systems where user requirements were incorporated.

With regard to systems developed by government organisations, in many instances these systems were not seen as core business by the department. This leads to issues in relation to ongoing maintenance and ownership. The scientist or extension officer would see a DSS or expert system as a good way of demonstrating some concept to farmers. Issues such as maintenance or distribution were not high in the minds of the developers. For them the challenge was either in demonstrating some modelling problem or else in using a DSS as a tool for transferring knowledge to farmers. For many systems the driving force behind development was one individual in a department. If that person became too busy or left the organisation then the system did not have a champion with all the resulting implications in terms of the ongoing success of the system.

Several interviewees raised the issue of systems needing a champion to drive the system in terms of sales, updates, and maintenance issues.

> *Unless someone is driving these products, they will die. Software is moving all the time - operating systems change, authoring systems change. So you need someone to support it and be prepared to ensure changes happen.*

Because of the nature of the application, it could be argued that many DSS have 'use by dates'. Some systems, by their very nature, require continual updating to include more recent knowledge or data (Hearn & Brook, 1989). On the other hand, some systems are developed in relation to a specific problem and once that need has passed the system has served its use. However, because few systems had management plans, it was not clear in the minds of the developers if a system had fulfilled its goals and should be withdrawn. Rather than withdrawing a system, some systems become re-invented in the hope that they would regain their position in the market (Hearn & Brook, 1989). *SIRATAC* is a widely cited example of a system that underwent considerable re-invention but was eventually abandoned (Cox, 1996) although it appears from the interview transcripts that this system has been further re-engineered as *CottonLOGIC*.

The larger more complex system had often attracted large amounts of grant monies and so the tendency was to 'keep these systems going' even if the benefits from these systems were not clear, especially in relation to the extensive maintenance costs.

> *There is a difference between the large tools and the simple tools. The simple tools keep a low profile - an issue is raised, look at the problem, produce an output, system used to solve problem, system dies. The large systems are less effective but have a higher profile. They take all the grant monies.*
>
> *... instead of suggesting that they should stop they keep getting money to try new approaches.*

The above comments were in relation to a particularly large system developed by government organisations in the state of Queensland. The outcome for systems developed by government organisations and non-government organisations differed.

6.3.5 Outcomes – government versus private developers

As indicated, 10 of the 66 systems were developed by non-government organisations. Seven (70%) of these 10 systems were coded as high impact systems. This is in contrast to only 11 (20%) of the 56 systems developed by government organisations being coded as high impact.

These results do not present a favourable picture in terms of success rates of systems developed by government organisations. When the degree of user involvement is also considered, there appears to be considerable problems with the approach taken in development of systems by scientists and extension staff.

Six (60%) of the 10 systems developed by private organisations had user involvement coded as reasonable to extensive. In contrast, 15 (27%) of the 56 systems developed by government organisations had user involvement coded as reasonable to extensive.

The issue of whether it was easier to make contact with developers in government organisations as opposed to private developers was considered. If this were the case, then perhaps only contact was made with the more successful private developers and in this way the results would be biased in favour of the private developer. However, from information collected about all 128 systems (Appendix H) it appears that scientist or extension staff developed most of the systems where contact details were not current. Therefore, the success rate of systems for government organisations may be even lower than the above figures would indicate. It is acknowledged, nonetheless, that information about government developed systems may be more readily available in the public domain.

Most systems were developed in government organisations. More systems were also developed in the state of Queensland than any other state.

6.3.6 Culture of developing decision support systems

More systems (27 ≡ 41%) were built in the state of Queensland than any other state. The next highest number of systems from a state was 16 systems (representing 24%) from New South Wales. Of the 27 systems from Queensland, 25 were developed in government organisations. There appears to be a culture of developing this type of system in relevant departments in this state. Whilst this does not necessarily present a problem, the outcome for these systems is not good. Four (16%) of these systems had an outcome coded as high impact. This was the lowest percentage of high impact systems of any of the other states. Tasmania had the highest percentage of high impact systems (33%) followed by New South Wales (29%). However, it is also the case that some very successful systems were developed by government organisations in Queensland. These systems are: *AVOMAN*, *FeedLotto*, *RainMan*, and *SafeCarryingCapacity* (this system was not targeted at or used directly by farmers).

6.3.7 Summary

The results from this current study indicate that in general developers of intelligent support systems continued to develop systems with little regard to whether users wanted the systems. This finding supports the findings of Hilhorst and Manders (1995) who suggested that knowledge-based systems (KBS) were research driven and many times lacked a user pull. Hilhorst and Manders identified, amongst other factors, the relatively small market segment and the low penetration of PCs at the farm level as responsible for the low uptake of these types of systems. They went on to suggest that this small market segment meant that the development of these systems was not economically viable and most systems were developed in a non-competitive environment.

In addition, this study confirms the work of Barrett *et al.* (1991). They suggested that there had been limited acceptance of these types of systems because of lack of understanding by software developers of the decision-making process of farmers, inadequate user involvement in their development, and improper problem definitions. The beneficiaries of intelligent support systems were, they suggested, primarily the scientists or the programmers. The results from this study support these claims.

Whilst many systems in this study were developed along the lines noted by Barrett *et al.* (1991) some developers have learnt from their mistakes. Some interviewees felt they had learnt that developing these types of systems was just not worth the effort. Other developers commented on their misunderstanding of the users needs and their naïve approach to system development and the corresponding expectations about the systems.

> *We were of the opinion that if you put a package out there then people would use it. We see this as naïve now.*

Unfortunately, the problems surrounding the development of these types of systems in Australian agriculture and the resulting outcomes are not widely available in the public domain. New systems continue to be developed without drawing from the experiences and knowledge gained by prior development efforts. This is partly due to the fact that researchers and developers seldom report failures. Often, even if a system has had limited adoption, publications reporting on the system will focus on the underlying modelling issues or issues surrounding the technical aspect of development. This current study highlights problems with the development of these systems and brings this information more directly to the developers of these systems so that they can learn from the experience of others (Appendix I).

There have been some successes. The following section looks more closely at the impact of user involvement in relation to system success.

6.4 Findings in relation to user involvement and system outcomes

In the 66 systems investigated, 38 were either targeted at or used by farmers. The 38 systems that were targeted at or used by farmers were analysed and discussed in detail in Chapter 4. The remaining 28 systems were aimed at either researchers, extension staff, or were developed for use by industry. These systems fall outside the primary focus of this current study. Nonetheless, some issues arising from these 28 systems were raised in the previous section where discussion was in relation to all 66 systems investigated.

The findings for the 38 systems studied in relation to user involvement and system outcome are now discussed. This discussion is specifically around the research propositions put forward in Chapter 2. These propositions are related to the context-involvement-outcome conceptual framework, shown again for ease of reference in Figure 6-1.

Not all links developed in the framework were examined in this current study. The links that were the main focus of this study are L1, L2, and L3b. That is, this study focused on the outcomes of involving or not involving users in software development in terms of system characteristics (L1) and system uptake (L3b). Furthermore, two systems were investigated in further detail in terms of user involvement and the users' views of the resulting usefulness and ease of use of systems (L2).

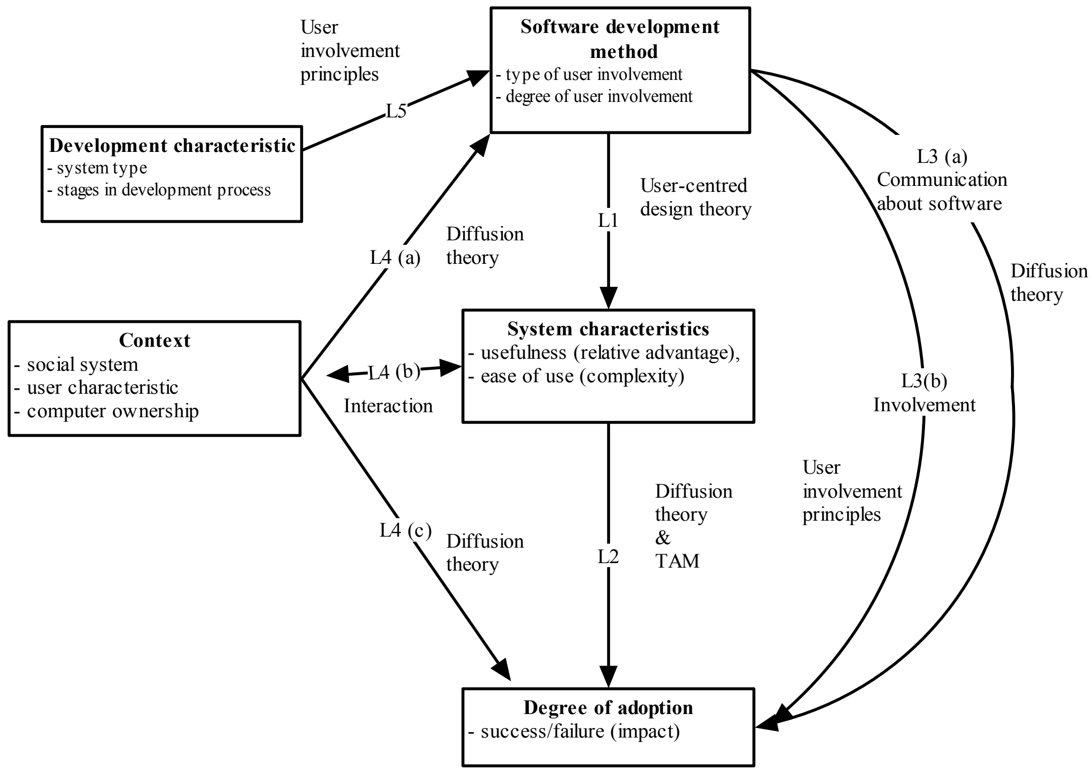

Figure 6-1 Context-involvement-outcome model

Evidence was found to support the individual links L1, L2, and L3b shown in the conceptual framework. These three links can be stated as:

- L1 – user involvement impacts on the usefulness and ease of use of software. In addition, the degree and type of involvement is important.
- L2 – systems that are useful and easy to use are more likely to be adopted.
- L3b – involving users in software development improves the adoption levels.

First, issues surrounding user involvement (L3b) are discussed. Links L1 and L2 are discussed in 6.4.2

6.4.1 User involvement and system outcome

It was argued in Chapter 2 that systems developed without user involvement would be less likely to be adopted than those developed with user involvement. Systems developed without user involvement would be more likely to be developed from the developers' perspective rather than the adopters' perspective and would, therefore, be less likely to meet the needs of users. It was argued that systems developed with user involvement would be more likely to be useful to the user. That is, the system would be fulfilling some need.

It was argued, therefore, that:

- intelligent support systems that are developed with user involvement are more likely to be adopted (Link 3b).

As outlined in Chapter 4, it was determined during the course of this research that it was not user involvement that was of interest but rather the degree of influence that users had over system features. The 'degree of influence' represents information drawn from many aspects of user involvement – degree or depth of involvement (involved in development, testing, incorporate user feedback) and type of involvement.

Table 6-1 details the relationship between degree of influence and system outcome for the systems where the impact was coded as either low impact or high impact. The information in this table was provided in Chapter 4 and is shown here again for ease of reference for the reader. The table explores the relationship between the low and high impact systems and the degree of influence that users had during system development. Table 6-1 presents the data with the names of the systems and numbers of systems that fall into each of the categories.

Table 6-1 Cross tabulation - impact and degree of influence – high and low impact systems

Level of Impact	Degree of influence users had over system design						
	Strong	Moderate to strong	Moderate	Weak to mod-erate	Weak	None	
High	1 AVOMAN	2 CottonLOGIC Rainman	3 Feedmania Herbiguide PYCal		1 FeedLotto		7
Low					5 Beefin WaterSched WeedMaster PastureMaster Sheepo	5 DairyMaster Applethining Littermac Chickbug MilkCool	10
Total	1	2	3	0	6	5	17

As discussed in Chapter 4, the above table demonstrated that a pattern emerges between the degree of user influence in system design and system outcomes. Many factors impact on system outcomes – user involvement and the degree of influence that users have during system development are just two factors. From the propositions proposed for this study, the results support the proposition that user involvement is a contributor to the degree of success of an information system project. The results clearly show the pattern linking user influence and level of system impact.

Of the 38 systems examined in detail, all of the systems identified as having a low impact had little or no user influence. For those systems identified as low impact the developers appear to have built systems that did not meet the needs of their target audience. There was little consideration of maintenance issues and how to reach their target market. That is, developers were focused on their reasons for building the system rather than the needs and requirements of the eventual user. As discussed previously, the target audience was not always clearly articulated at the outset of the development process.

There are some systems, however, where the relationship between user involvement and system success fall outside this pattern. One system, *FeedLotto*, was coded as a high impact system and yet users had only a weak influence over system features. Four, of the 38, systems that had little user influence – ranging from no influence to weak influence - were coded as having achieved a medium impact. According to the propositions put forward in this study these systems should have failed and did not. An examination of these systems allows a better understanding of issues involved to emerge. This is a 'logic of opposition' approach (Robey & Boudreau, 1999). This approach can account for contradictory outcomes of information technology development. These contradictions involve results that run counter to expectations based on the theory guiding the research. By investigating these contradictions understanding may be further deepened, rather than the contradictions being explained away as 'unusual results'.

6.4.1.1 Contradictory results

FeedLotto was coded as a high impact system and yet users had only a weak influence over system features. As discussed in Chapter 4, *FeedLotto* is a very simple system developed because of a perceived need to place a simple program on the market that met the users' skill levels and needs. The success of this system illustrates that the need for user involvement can be contingent on the type of system being developed (Link L5) and the reason why it is developed.

The four systems that achieved a medium impact level but had little user influence were: *Herd-econ, CamDairy, LambAlive, NPDecide*. The interviewee for *Herd-econ* identified the fact that the system was big and complex as the reason for the outcome for this system. So although this system achieved a reasonable level of adoption the interviewee's perception of the reason for its outcome plus reference to the transcripts (see Chapter 4) highlight problems with this system that may well have been overcome with more user involvement. The same is true for *CamDairy* although in this instance the developer saw the system as successful and indicated the reason for its success being due to the fact that it was easy to use. However, this system was initially targeted at farmers but not used by them. In this respect it has not been successful and it is only because advisers used it that it achieved some level of success. The interviewee of *LambAlive* indicated that data input problems were the reason this system did not achieve a higher adoption rate. In fact this system required input data that were not readily available. It is hard to imagine that software would be developed without consideration of this crucial issue. In terms of target audience, again, this software was not taken up by the target audience, the farmers, but rather has been taken up by extension staff and educational institutes. Apart from this respect, this system could also be regarded as unsuccessful. The fourth system, *NPDecide*, was distributed free of charge so the extent of actual installation and use of this system is extremely hard to gauge. There is nothing in the transcript to indicate that this system would have met the needs of the targeted users.

The results from this study support a relationship between user involvement and system success. That relationship however, is 'probabilistic' rather than 'deterministic'. That is, it is not possible to state that 'user involvement' is both necessary and sufficient to lead to adoption of a system. Rather, it is more likely that user involvement in system development will lead to improved adoption of a given system.

The above discussion has been in terms of the approach taken in the development of intelligent support systems in relation to focusing on the needs of the users. The discussion has been in terms of user involvement in system development. In general, systems where users had involvement and influence over system features were more successful than systems where users had little or no involvement or influence. It was anticipated that if users were involved in the development of the systems, then the systems would be expected to be both useful and easy to use. It was also anticipated that systems that are useful and easy to use would be widely adopted.

The following section examines the impact of user involvement on system characteristics and the impact of system characteristics on adoption or impact.

6.4.2 Involvement of users on system characteristics and system outcomes

In addition to the proposition discussed in the previous section, the following propositions were put forward in Chapter 2.

Propositions relating to Link L1.

- intelligent support systems that are developed with user involvement are more likely to meet the users' requirements (that is, they will be useful and easy to use).
- the degree and type of user involvement will impact on the usefulness of the system and so will influence adoption.

Proposition relating to Link L2

- intelligent support systems that are perceived as useful and easy to use are more likely to be adopted than systems perceived as not useful or easy to use.

The aspect of user involvement in software development is now discussed in terms of creating software that is both useful and easy to use. As well, the difference between involvement and influence is also discussed. The discussion is around the links L1 and L2 in the conceptual framework.

The effect of user involvement on the usefulness and ease of use of the software was investigated for two systems, *AVOMAN* and *WHEATMAN*. Interviews with users of these two systems allowed the propositions surrounding Links L1 and L2 in the conceptual framework to be investigated more fully.

6.4.2.1 User involvement and system characteristics

Users of two systems were interviewed. Users had extensive involvement in the development of the system *AVOMAN*. As discussed in Chapter 5, users of this system held the system in high regard. The focus of the system was changed as a result of user involvement from a tool to deliver knowledge to farmers to a system that was a record keeping tool, a reporting tool, and a decision support tool. The focus was on developing a tool that met the farmers' needs. All users rated the system highly in terms of usefulness and ease of use. Even non-users of this system held this system in high regard. For most non-users, the reasons they did not use the system were not because they did not trust the system but were related more to farm size or lack of computer skills. Because users had been involved so extensively in the development of *AVOMAN*, they had a good understanding of how the outputs were derived. In this respect the process of how the system reached its decision was more observable.

The developers of *AVOMAN* initially conceived of developing a DSS to act as a vehicle for technology transfer. As a result of interaction with users the system was changed to be more than a DSS. Users rated its record keeping facilities and reporting facilities as very useful for them in managing their farms. The system is in line with the recommendation of Lewis (1998) in terms of providing users with systems within a continuum of their prior experiences. Many avocado farmers wanted a comprehensive record keeping facility that would allow them to issue reports for quality assurance. *AVOMAN* allowed them to do this. Adding a decision support facility to this record-keeping tool was a practical approach to encouraging farmers to use the records they had already kept to assist them make decisions in relation to chemical applications. The farmers were able to use the one software package for both record keeping and decision-making. Usefulness increased as a result of user participation. This approach overcomes previously reported problems where farmers are required to enter the same data into different software packages. This approach is in line with the findings of Gill (1995) who reported that 'expert systems embedded within conventional systems (ie., enhanced conventional systems) showed significantly higher rates of maximum usage and current development than those of stand-alone systems' (p. 67).

User involvement in *WHEATMAN* was less extensive than that of *AVOMAN*. User involvement was rated reasonable to extensive and representative in nature. Whilst the interviewee involved in the development of the system described user involvement in such a way that it appeared to be representative in nature, users had a view that they were consulted from time to time and that they were consulted after the system was developed. Representative participation, for this study, was defined as involvement through a reference group or a testing group. User involvement in *WHEATMAN* appears to be consultative. Consultative representation was defined as involvement when users are consulted from time to time or after the system is developed.

There appears, therefore, to be a conflict in information provided by the two different sources – the developer and the users. This could be due to the following reasons. Only 12 users were interviewed and of these, only five were involved in testing and two of these indicated their involvement was limited. Therefore, this sample may not be representative of the degree of user involvement. The developers of the system may have believed that the type of testing and involvement was such that users were having an impact on system features when in fact they had little influence. This is not surprising as it is more usual for users not to be involved from the design stages and only to be consulted about the look and feel of systems (McKeen & Guimaraes, 1997).

Users had varying opinions in relation to most aspects of *WHEATMAN*. In comparison to users of *AVOMAN,* users of *WHEATMAN* had lower levels of confidence in *WHEATMAN*. Most users appeared to struggle with some aspect of the system. Users of *WHEATMAN* did not have the same sense of ownership that the users of the *AVOMAN* system had. Users made comments to the effect that the system did not do things the way they would like or that regardless of the recommendation of *WHEATMAN* they were constrained in what farming choices they actually had. They did not have as much trust in the output of the system. Several users commented on the fact that they did not agree with the output.

From the interviews with users of *WHEATMAN* there is evidence that farmers have not adopted *WHEATMAN* for sensible reasons. This data supports the claim made by Vanclay and Lawrence (1994) that extension officers need to consider that farmers may not adopt a technology for logical reasons. Also, Hirschheim and Newman (1988) point out that users may be willing to adopt a system, but not the one that is proposed. Given the fact that some wheat farmers perceive that they have a limited set of options in relation to planting, the benefits of using *WHEATMAN* for these farmers is limited. Also, given that generic information from *WHEATMAN* is available from other sources this would appear to be sufficient for many farmers. As one user stated:

Information on different varieties of wheat and frost risk is provided in a pamphlet that is put out by the Department of Primary Industry each season (based on *WHEATMAN* information). *It is pretty broad and general and for most people this is enough information. But if you want more specific information you would need to use WHEATMAN. Also many farmers just go on what their dad did. Pamphlet would be guiding many farmers especially the older generation who would not want to use a computer.*

Some users of *WHEATMAN* were of the opinion that the use of *WHEATMAN* did not provide sufficient advantage to justify its use. This is in line with the work of Kelleher *et al.* (1992) and Woods *et al.* (1997). As Woods *et al.* point out, for many farmers there are a limited number of decision points for farmers – an 'if it rains, I plant' – approach (p.477).

Users of *AVOMAN* had a higher degree of influence over the features of this system than users had over the system features of *WHEATMAN*. The users of *AVOMAN* found the system to be useful and easy to use and held the system in high regard. *WHEATMAN* did not appear to meet the needs of the users as well as *AVOMAN* met the needs of its users. Comments from users of *AVOMAN* indicated that the system was easy to use. Some users of *WHEATMAN* found it easy to use while others did not. The usefulness and ease of use of *WHEATMAN* was not as clear-cut as that of *AVOMAN*.

It is not appropriate to make too absolute a comparison between the adoption levels of *AVOMAN* and *WHEATMAN*. Certainly *AVOMAN* had a higher adoption level by targeted users (25%) compared with *WHEATMAN* (4%). Many factors influence adoption levels, for example, the availability of generic information generated by the

WHEATMAN package may have impacted on its adoption levels. However, it could be equally argued that if farmers were aware of the value of the information generated by the *WHEATMAN* package, it may raise their awareness of the software and encourage them to use the software. Another reason for not making too direct a comparison between the adoption levels of the two software systems is that there may be different reporting requirements in the two industries – the avocado and wheat industries. Nonetheless, it was apparent from the interviews that users of *AVOMAN* had a high level of trust in this system. This level of trust was not as apparent to the same extent for users of *WHEATMAN*. Cox (1996) argues, in fact, that the criteria for success should not be in terms of units sold but rather to 'the critical insights gained through improved communication of the different perspectives of researcher and farmer' (p.376). If this is the criteria used to gauge success of a system then *AVOMAN* would be considered significantly more successful than *WHEATMAN*.

There appears to be some evidence that the developers of *WHEATMAN* convened the reference groups from, as proposed by Woods *et al.* (1997), a perspective that focused on their purposes rather than to build an enduring relationship with the farmers based on joint purposes. For *AVOMAN* the relationship seems to have been more enduring.

> *Feel it is our (producers) product - because of involvement. It was a team effort. Producers put a lot of effort into it as well. There is joint ownership*

6.4.3 Summary

The results from this study support the propositions that arose from the conceptual framework. There is evidence to support the proposition that systems that are developed with user involvement are more likely to be meet the needs of users in that they are useful and easy to use. This study supports the proposition that systems that are developed with user involvement are more likely to be adopted than systems where users are not involved. This study highlights the importance of focusing on user influence and not only on user involvement – that is, the degree and type of user involvement influences adoption outcomes. In addition, there is evidence to suggest that systems that are useful and easy to use are more likely to be adopted.

Evidence was found to support the individual links L1, L2, and L3b shown in the conceptual framework.

- L1 – user involvement impacts on the usefulness and ease of use of software. From the study of users' views of the two systems, *AVOMAN* and *WHEATMAN*, it was found that *AVOMAN* was seen as more useful and easier to use. Users had a greater influence in the design of system features in *AVOMAN* than users of *WHEATMAN* had over that system.
- L2 – systems that are useful and easy to use are more likely to be adopted. From the study of users' views of the two systems, *AVOMAN* and *WHEATMAN*, it was found that the system that was perceived by users as more useful and easier to use had a higher level of user acceptance.
- L3b – involving users in software development improves the adoption levels. The users of *AVOMAN* were strong advocates of the system. Through their involvement in the development of the system they had a better understanding of how the system worked and held the system in high regard. They were willing to recommend the system to other farmers. In addition, their involvement in the development of the system raised their awareness of the benefits of the system. The outcome of the *WHEATMAN* system was not so evident as farmers had less involvement in the development of that system.

As indicated, results from this study support the propositions put forward. For the results to be of value, however, the method of data collection and analysis needs to be rigorous and clearly documented so that they can be assessed by others, and any limitations recognised. This aspect of the study is now discussed.

6.5 Evaluating the study

In the first phase of this study, data were collected from an individual involved in the development of each of 66 intelligent support systems. The interviews were open-ended in nature and were conducted via the telephone. Because only one person was interviewed for each system and minimal data were collected from other sources, such as from documents, the method used does not neatly fit into the case study research approach. Because the amount and nature of the data collected was not only quantitative, but also rich in detail, the method is clearly not a quantitative survey.

The method chosen for collection of data for this first phase of the study falls, therefore, in between survey methods and case study methods. The method combines elements of both case study methodology and survey methodology. Because of this fact, an evaluation of this research method is appropriate.

For the second phase of the study, data were collected, again through telephone interviews, from users of two targeted intelligent support systems. The systems investigated were *AVOMAN* and *WHEATMAN*. This aspect of the study was more in line with a case study approach.

The research methods used in both phases will be evaluated in terms of Klein and Myers's set of principles for conducting and evaluating interpretive studies in information systems (1999). This is followed by a discussion of the issues surrounding the collection of system specific data from only one individual.

Klein and Myers identified seven principles for evaluating interpretive field research (Table 6-2). The first part of this current study, whilst not a field study nor a case study, is still seen as interpretive in nature. The study 'focuses on the complexity of human sense making as the situation emerges … it attempts to understand phenomena through the meanings that people assign to them' (Klein & Myers, 1999, p.69).

6.5.1 Seven principles for evaluating interpretive field research

A summary of the seven principles identified by Klein and Myers (1999) is outlined in Table 6-2. The seven principles are (1) the hermeneutic circle, (2) contextualization, (3) the interaction between the researchers and the subjects, (4) abstraction and generalization, (5) dialogical reasoning, (6) multiple interpretations, (7) suspicion.

Whilst the seven principles are listed as seven separate principles, there is an interdependence between the principles.

> .. a researcher's deciding on what relevant context(s) should be explored (principle two) depends upon the following: how the researcher "creates data" in interaction with the subjects (principle three); the theory or concepts to which the researcher will be abstracting and generalizing (principle four); the researcher's own intellectual history (principle five); the different version of "the story" the research unearths (principle six); and the aspects of the "reality presented" that he or she questions critically (principle seven) (Klein & Myers, 1999, p.78).

Table 6-2 Summary of principles for interpretive field research

1. The Fundamental Principle of the Hermeneutic Circle This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.
2. The Principle of Contextualization Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
3. The Principle of Interaction between the Researchers and the Subjects Requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants.
4. The Principle of Abstraction and Generalization Requires relating the idiographic details revealed by the data interpretation through the application of Principles 1 and 2 to theoretical, general concepts that describe the nature of human understanding and social action.
5. The Principle of Dialogical Reasoning Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.
6. The Principle of Multiple Interpretations Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.
7. The Principle of Suspicion Requires sensitivity to possible 'biases' and systematic "distortions" in the narratives collected from the participants.

(Klein & Myers, 1999, p.72)

As a result of applying these seven principles, the whole story then becomes greater than the individual parts. The account of the research must not only be interesting but also plausible and convincing (Klein & Myers, 1999).

6.5.1.1 Hermeneutic circle

Hermeneutics is concerned with the process of interpretation and understanding of the world. The idea behind the hermeneutic circle is that through preconceptions about the meaning and interrelationship of smaller parts we come to form an understanding of the complex whole. The movement of understanding is by continual iteration from the whole to the part to the whole until understanding is achieved.

This study continually iterated from the whole to the parts and back to the whole again. This was evident during coding. Each interview was examined many times during the coding process to gain an understanding of the important issues influencing not only system outcomes but also why the system was developed in the first instance. As well as looking at the whole of an interview and then examining its parts, all the interviews formed 'a whole' and an individual interview formed a part. Thus there was iteration between layers of parts. That is, examination of a given interview formed part of the whole study, while examination of the parts of an interview allowed an understanding of the nature of that interview to emerge. Once coded, the interviews were grouped into various categories. Again, there was iteration between the coding of a particular aspect of the data and the whole study.

As part of the structured case approach taken in this study, there was continual reading and re-reading of the interview transcripts at the same time that the researcher was gaining more understanding of the issues through further readings in the literature. In this way new meanings could emerge.

6.5.1.2 Contextualization

Contextualization is ensuring that the reader has some understanding of how the current situation arose so that they are more readily able to place the current research into its historical setting.

The background to this study was clearly presented. However, there was little understanding as to why so many systems continued to be developed when it appeared that few systems were adopted. In fact, one aspect of this study was to explore the reasons behind the development of these types of systems so that a better understanding of the historical reasons behind system development could be documented. Other case studies were examined and the researcher talked to many people and read widely in relation to the topic. Interviews were not too narrow in focus and interviewees could bring up any factors they thought important.

6.5.1.3 Interaction between the researchers and the subjects

This aspect of the evaluation acknowledges 'that the facts are produced as part and parcel of the social interaction of the researchers with the participants' (Klein & Myers, 1999, p.74). The researcher acknowledged a shift in understanding during collection of data for the pilot study. The researcher was aware of the influence that merely talking about the issues of intelligent support system adoption would have on the interviewees as they altered 'their horizons by the appropriation of concepts used' (p.74). It was with this in mind that many of the questions were purposefully not framed in terms of key terminology. The researcher was clearly aware that this study is an interpretation of the interviewees' interpretation of events. The interviewees' perspective is seen as just that – a perspective and not the one and only final truth.

6.5.1.4 Abstraction and generalization

An understanding of the low adoption of these types of systems was presented in terms of Rogers' diffusion theory (Rogers, 1995), the technology acceptance model (Davis, 1993; Davis *et al.*, 1989), and theories relating to user involvement in the development of information systems (DeLone & McLean, 1992; Ives & Olson, 1984). This study has abstracted and generalised the findings on the development of intelligent support systems into the wider field of the development of software in general. The study has focused on the generalization of the impact of user involvement and user influence in information systems development. Broader issues have emerged relating to how to evaluate whether a system is successful or not. The issues of how a system can be seen as a failure from one aspect but a success from another aspect is generalisable to many situations in information system development. The study is more than just an account of anecdotes about the development of intelligent support systems in Australian agriculture. The study was framed around a conceptual framework and the results were examined in relation to this framework and the accompanying propositions that were drawn from that framework. The number of systems investigated and the enduring nature of the pattern of user involvement and system outcome support the generalisation of the results arising from this study.

6.5.1.5 Dialogical reasoning

This study acknowledges that the researcher's perspective clearly influenced the focus of this study. There are many reasons why software fails to be adopted. The focus of this research was clearly on the degree and type of user involvement in software development and the resulting influence users had on system features. A different set of questions may have revealed other reasons for the failure of these systems. The researcher acknowledged her perspective in the pilot study and was continually reminded of it as she interacted with the interviewees and found that their perspective of the outcome of their system was different from her interpretation.

In addition, this study clearly acknowledged the researcher's perspective in relation to what constitutes system success. Initially the researcher assumed that success would be measured in terms of units sold or distributed. It clearly emerged during this study that success and failure are multi-dimensional and that the same system can be seen as both a success and a failure. So whilst the researcher had her own set of prejudices at the start of this study, through the hermeneutic circle, other views were able to emerge.

6.5.1.6 Multiple interpretations

Because only one person was interviewed in relation to most of the systems, this aspect of the principles was not generally performed for the first phase of this study. This lack of multiple viewpoints could be seen as a weakness of the study. The researcher had only one view of the reasons why and how a system was developed and the outcomes of that system.

For two of the systems, *AVOMAN* and *WHEATMAN*, interviews with users allowed multiple interpretations in relation to aspects of system features collected on these systems. By including the comments from users of these two systems, users' views are presented more clearly. Comments are included from individuals involved in system development. This allows readers to construct their own interpretation of the data that may be different from those of this researcher.

6.5.1.7 Principle of suspicion

This principle requires the researcher to be aware of possible biases and distortions in the narratives collected from the participants. The researcher was aware of this problem during data collection. With this in mind, the researcher always tried to have a non-judgmental approach to whatever story the interviewee revealed. That is, there was never any judgement made if the interviewee stated, for example, that there was no user involvement in the development of the system. It would be imagined that generally the interviewee would present a picture about system outcomes that may be 'rosier' than reality. It is also acknowledged that the interviewee may present a 'bleaker' picture of the outcomes of a particular system if there were political motives for doing so. However, for most of the interviews there was a general willingness and openness amongst interviewees. In a few instances, interviewees would make statements to the effect that they should not reveal certain information but proceeded to do so nonetheless. Despite this willingness of some interviewees to share some confidential information, the researcher is aware of the fact that an interviewee may have provided an outcome of events surrounding the development of the system that should have occurred and not what actually occurred.

The study has been evaluated in terms of the seven principles for evaluating interpretive research. A potential problem for this study was the number of individuals interviewed in relation to the development of each of the systems.

6.5.2 In-depth interviews

A concern with the design of this study is that information about each system was obtained from only one individual. In effect this means that there has been minimal confirming information about each system. Gill (1995) used a similar approach in his investigation of 97 commercial expert systems in American. For his study, systems were identified from a catalogue of commercial applications and information about each system was gathered through a telephone survey. Quantitative and qualitative analysis of the data was undertaken.

For the systems investigated in this study, there were often only a few individuals involved in the development of a given system. The principal person involved in development of each system was generally known amongst the extension staff community. The number of people who could be interviewed in relation to development process and the outcome for each of the systems was limited. One individual generally knew this information – and this was the person targeted by this study. There would have been little to gain from conducting interviews with other individuals about many of the systems. As indicated in Chapter 3, if the person who was being interviewed did not have a good understanding of the development process for a system and the outcome for that system, then the interview was terminated and information was sought from some other individual. In addition, interviewees were often very keen to speak about their systems and the outcomes. As indicated in Chapter 4, they often provided insights into why their systems had not been as successful as they had anticipated.

Some additional information about some of the systems was obtained from other interviewees during an interview. In addition, there have been articles published about many of the systems. However, whilst these sources have provided some additional information it is the case that generally the information available from publications only report on the positive aspects of the system and not on problems surrounding system adoption and maintenance.

The study by Gill (1995) supports the validity of the approach used here for the collection of information about these types of systems. Gill collected mainly quantitative information but he also collected some qualitative data. This current study has added to the study of Gill in that it has collected more qualitative data and used a more interpretive approach allowing more complex constructs to emerge during data analysis. In addition, this study has focused on the approach used during development and the reasons behind why the system was developed in the first instance.

6.6 Contributions

The implications of the results from this study to both practice and theory are now outlined.

6.6.1 Contributions to practice

This research has several implications for practice. It has established the level of adoption of intelligent support systems in Australian agriculture. The study supports the anecdotal evidence that, despite the many systems that have been developed, few have been widely adopted. In addition, this study has explored why so many systems were developed. This study confirms previous work in that a significant number of systems were developed because of a research or developer push rather than a user pull. This knowledge is important in that it can guide future development of intelligent support systems in Australian agriculture.

In addition, the study clearly demonstrated that intelligent support systems targeted at farmers are more successful when users are involved in the development process. The study has provided guidelines (Appendix I) for developers of these types of systems on issues to consider when developing systems for farmers. Some developers have indicated that they will take into account the guidelines when developing future software. The following is feedback about the guidelines distributed to developers:

> *<snip> has sent your preliminary findings info around to many DSS developers here. I also used them in my workshop (they were very silent as they read) and in particular the findings rang a lot of bells for some developers of very big models - who now have developed huge models/product – no one wants.*
>
> *After reading your findings - suddenly everyone is interested in evaluation and gathering client opinions on their needs etc.*

One of the intended outcomes of this research was to place into the public domain information concerning the low adoption rates of intelligent support systems (Lynch *et al.*, 2000) and information on scenarios that are more likely to lead to the development of successful systems (Jones & Lynch, 1999; Lynch & Gregor, 2001;

Newman *et al.*, 1999a; Newman *et al.*, 1999b). Further information of the outcomes of this study will be published in publications that developers of these types of systems are likely to read. This is in-line with the call of Benbasat and Zmud (1999) to communicate the implications of information systems research to practitioners in a clear, simple, and concise manner. This thesis is not the mechanism to do this. Neither are many information systems journals.

The outcomes of this study are of interest not only to developers of intelligent support systems in agriculture but also for developers of other types of systems. In particular, the outcomes of this study will be of interest to developers of non-mandatory systems used outside large organisations.

There is currently a move towards placing some intelligent support systems onto the world wide web (Georgiev & Hoogenboom, 1999; Jensen *et al.*, 2000; Zhu & Dale, 2000). The intention is that users will interact with these systems and the underlying data via the web. The outcomes from this study are relevant to the development of intelligent support systems for use over the world wide web. It is still important to capture the needs of users – regardless of how the system will be delivered. In fact, it is important that developers do not continue to develop systems from their perspective. If this happens then users may be ‘turned off’ from using these types of systems over the web – and again, an opportunity is lost.

Developers will also need to consider the number of farmers who are currently users of the world wide web or they may end up, yet again, developing systems for non-existent markets. Of the approximately 147,000 Australian farms, with an estimated value of agricultural operations of $5,000 or more, almost half (49%) owned or used a computer (Australian Bureau of Statistics, 2000). The uptake varied from state to state with the state of Queensland having the lowest proportion for both computer use (45%) and internet use (16%). The Northern Territory had the highest proportion for both computer use (65%) and internet use (31%). Developers of web-based systems should keep in mind the level of internet use by farmers – especially developers based in Queensland.

6.6.2 Contributions to theory

In this section, the implications of this research in relation to theory are discussed. The discussion is in terms of the conceptual framework that brought together work from three areas: Rogers' diffusion theory (Rogers, 1995), the technology acceptance model (Davis, 1993; Davis *et al.*, 1989), and theories relating to user involvement in the development of information systems (DeLone & McLean, 1992; Ives & Olson, 1984). Most prior research in the information systems area has investigated only two of the above three areas in any one study. There appears to be little work on examining the three aspects of involvement, system features, and outcomes in the one study.

Rogers' diffusion theory is concerned with many aspects of adoption, amongst which are communication about the innovation, characteristics of the innovation, and the setting into which the innovation is being introduced. However, Rogers' diffusion theory does not consider user involvement in the development of the innovation. The technology acceptance model draws on some aspects of Rogers' diffusion theory and is concerned with the relationship between two system characteristics in particular, ease of use and usefulness, and system outcome. The technology acceptance model does not focus on how to ensure that systems have the characteristics that improve adoption levels. Work in the area of user involvement and system outcomes has generally not investigated whether user involvement has impacted on the usefulness and ease of use of the software (Cavaye, 1995; Ives & Olson, 1984) and how this may impact on system outcomes.

This current research has brought together these three areas into the one study. This has allowed an explanation, at least in part, of not only the scenarios that are more likely to lead to system success but has given insights into why these systems are more successful.

This study has contributed to the understanding of the complex construct user involvement. The study determined that the degree of influence that users have on system features is the important aspect of involvement. User influence is a complex construct that involves determining the degree of user influence in relation to two aspects of system development. These two aspects are: (i) type of user involvement and (ii) and degree of involvement. These two factors determine degree of influence that users have in system development.

Type of user involvement + Degree of user involvement → Degree of influence

This study has confirmed the view of Myers (1994b) that success is a construct that is open to many interpretations. Implementation success or failure is a matter of interpretation and that interpretation can change over time. This study has shown that the one system could be viewed as both a success (in technical terms) and as a failure (in terms of uptake) at the same time.

In his discussion on the use of dialectical hermeneutics as a framework for evaluating information systems implementation Myers (1994b) provides the following definition of information systems success (from a hermeneutic dialectic perspective):

> Information systems success is achieved when an information system is perceived to be successful by the stakeholders and other observers (Myers, 1994b, p. 65).

Myers suggests that this definition allows for differing opinions within and outside of an organisation. A given system can be seen as being both a success and a failure. Myers is critical of the meta-analysis of Alavi and Joachimsthaler (1992). He suggests that in their quantitative analysis of 33 studies, they:

> 'gloss over the fact that their main dependent variable, 'implementation success' is taken for granted. The assumption is made that implementation success is a static phenomenon and that it was defined consistently both within and between all 33 articles.' (Myers, 1994b, p. 66).

The view that a system can be seen as both a success and a failure was supported in this study. Systems were seen as failures in terms of number of units adopted but successful in terms of technical outcomes. Technical outcome relates to the impact that development of the system had on the understanding of the issues surrounding the original problem. This attribute arose during analysis of the data. That is, it became apparent that there were a number of ways developers judged their systems – adoption level was one aspect of success while technical outcome was another. The target users may not have adopted a system, but through the process of developing and using the system, the researchers' or developers' knowledge and understanding of issues relating to the problem may have improved. The fact that developers had more than one way of judging the outcome of their software confirms Myers' (1994a) view that success is a construct open to many interpretations. Systems can be seen as successful at first and later classed as no longer successful. Lyytinen (1988) makes the point that failure is not all or nothing. There are differing degrees of failures. He provides the following:

> IS failure is a gap between stakeholders' expectations expressed in some ideal or standard and the actual IS performance. (Lyytinen, 1988, p.62).

The problem for information systems researchers is that in most instances the ideal or standard is not recorded at the start of the project and so can be modified by the developer to match more closely the actual information system performance.

This study has extended work on user involvement and system outcomes. As stated previously, this study has drawn together three separate areas of information systems research. These areas are user involvement, system characteristics (the ease of use and usefulness of software identified in diffusion theory and the technology acceptance model), and adoption levels. This study has focused on the issue of user involvement in software development and the resulting outcome for these systems. Systems that have user involvement are more likely to be successful. From the investigation of the system *AVOMAN*, it is apparent that when users have a strong influence over system features then the system will truly be easy to use, but more importantly will truly be more useful to users. It is not a perception of ease of use or usefulness – the system is truly useful. Few studies have previously focused clearly on the relationship between involvement, usefulness and ease of use, and adoption levels.

6.7 Limitations

This study has the limitations and strengths of qualitative methods. For this study, a conceptual framework was developed to highlight plausible relationships proposed in relation to propositions and scenarios. The study has allowed participants to tell their own stories and through the presentation of the results has allowed their voice to be heard, although inevitably this has been through the interpretation of the researcher – a limitation of interpretive research.

There were limitations specific to this study. This study focused on the development of intelligent support systems in Australian agriculture. Some aspects of this study may, therefore, only be relevant to Australian developers and funding bodies in this field of study. The study considered, in-depth, only those systems targeted at farmers. Outcomes may be different for different target groups, for example, extension staff.

For the systems investigated in phase one of the study only one person per system was interviewed. Thus, only one viewpoint of each system was gained. The collection of data on each of the systems relied on the interviewee's recollection of events, that is, it is a retrospective study.

However, the study has described in detail the methods and procedures used to collect and code data. The sequence of how the data were collected, processed, and transformed have been clearly articulated. The conclusions that have been drawn are clearly linked to the condensed data. Personal assumptions have been stated and biases and values examined.

6.8 Further research

In this research, the importance of user influence, as opposed to user involvement, has been explored. The study has successfully used an in-depth survey approach to data collection. The study has used a qualitative approach to measuring complex constructs such as user involvement, level of impact, user influence. The results from this study are promising in that they advance understanding of the construct system success and the impact of user influence on system success.

Further studies, using this qualitative approach, to examine user influence on system outcomes would be useful. Work on those systems that are currently being developed that are drawing on the outcomes from this current study would provide an opportunity to examine the developers' and users' opinions of their involvement during the development process rather than after the event.

Two aspects of system success were discussed in this study – impact levels and technical outcomes. However, it is problematic to actually determine the impact levels of systems. Further work in the area of determining what constitutes system success and what constitutes failure would be useful. A study that encouraged developers to articulate how they would gauge not only the success of their system but also the criteria by which it would be a failure would be useful for both developers as well as for the researchers in that it would articulate clearly differing aspects of success and failure. Cox (1996) urged the development of distinctive criteria for evaluating success in the construction and use for both process models and DSS in agriculture.

Further work is needed to re-examine the aspects of the complex constructs user influence and system impact, especially in relation to eliciting this information from users in a way that does not influence their responses but at the same time allows for collection of data that can be meaningful in terms of other studies.

Longitudinal studies on the impact of usefulness and ease of use on actual adoption behaviour are rare (Rawstorne *et al.*, 2000). A re-examination of users' views of *AVOMAN* and *WHEATMAN* at a later date would provide important information on the long-term benefit of user influence on system design. There would be benefit in examining, in more detail, those systems where the outcome was not as predicted and clarification was not forthcoming through re-examination of the transcripts.

6.9 Conclusions about the research problem

This chapter has presented the findings and conclusions of the research. In addition, the study has been evaluated in terms of Klein and Myers' (1999) seven principles for evaluating interpretive research. The study has been evaluated in terms of the contribution it has made to both practice and theory. The chapter discussed the implications of the research from both a practical and theoretical aspect. The limitations of the research were also discussed. Suggestions for future research were detailed.

This research has contributed to knowledge in the following ways. First, it has presented a conceptual framework for explaining the relationship between user involvement, system outcome, and the context in which the system is developed. This framework is broader than those used in previous studies in that it draws together work from three areas: Rogers' diffusion theory, the technology acceptance model, and user involvement in system outcome.

Second, the study has validated the conceptual framework and the resulting propositions that were examined. This study has highlighted the importance of user influence on system outcome, as opposed to user involvement. In addition, the study has made a contribution in the area of the differing degrees and types of user involvement and the impact that this has on system outcomes. The study has highlighted the complexity of determining whether a system is successful or not. The study has used a qualitative approach that has allowed factors to emerge from the data.

Finally, the research has contributed more specifically by providing information on the low level of adoption of intelligent support systems in Australian agriculture and the reasons why the systems were developed.

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Appendices

Appendix A - Survey Questionnaire for Pilot Study

Adoption of Intelligent Support Systems in Agriculture

Questionnaire used as a guide

Name of software ____

- How many units have been sold in total? ____________
  this year ____________
  last year ____________

  ie have sales peaked? If so, when? ____________

- How long has the system been on the market?
- Who are the main purchasers of this product?
  for example:
  farmers/producers
  extension staff
  agri-advisers
  researchers
  educational
  other

- What is the main purpose of this system?

- What is the version and date of the current version?

- Operating system?

  Language/Shell

- Cost to purchaser?

  Has this changed recently?

- Do you have any user feedback of the system?

  Types of comments

- Who initiated the development of the system?
  for example:
  researcher
  consultant
  extension staff
  farmers/producers

- Why did they initiate development of the system?

11. Who was the intended target audience?
  for example:
  farmers/producers
  agri-advisers
  researchers
  educationalists

- Has the system been widely marketed?
  Where ie paper, conferences, field days, web etc.

- Current status of system?

- What is your role with regard to this system?
  for example:
  developer
  researcher
  distributor
  publicity officer
  other

- Does the system have a web presence?

- Did the system receive industry or government funding?

- Underlying model

- Extent of data input required by user?

- Was there project management? How long did it take to develop system? Lines of code?

Before finishing ask participant:

What information they do not want published.

Thank you for participating. I will forward a transcript of our conversation to you for your approval.

As well a report of this research will be sent to you at a later date.

Appendix B - Survey Information & Consent Form

Adoption of Intelligent Support Systems in Agriculture

For use with participants in phone survey

The following was read before the interview commenced.

Information section:

I am Teresa Lynch from Central Queensland University. I am doing a PhD in the area of the adoption of intelligent support systems within agriculture and the reasons behind adoption and non-adoption.

As part of my studies I am collecting information on the number of sales of particular decision support system or expert systems packages currently available within Australia. I have identified the product, ____________________, as a decision support system/expert system.

Do you agree that it is a decision support system/expert system?
[If yes, proceed, otherwise terminate interview.]

Would you be able to spare some time (approximately 15 to 20 minutes) to provide me with information about this product.

[If agree and time is suitable - then proceed, - read following consent information - otherwise thank them for their time or arrange interview for a more suitable time.]

Consent section:

Before taking part in the survey you are requested to indicate your consent to be interviewed. The conversation is not taped.

During the survey you will be asked questions about the adoption and use of a decision support system. The notes of the interview will not be shared with anyone outside the research team and no responses will be identifiable with any participants in any subsequent reports or publication. At the end of this interview I will establish what details, concerning the product, can be published, for example - the name of the software product.

You are free to refuse to answer any specific question and may withdraw from the interview at any time.

At the completion of this research written documents will be stored in a locked room in the Faculty of Informatics and Communication, Central Queensland University

THIS IS TO CERTIFY THAT THE PARTICIPANT HAS AGREED TO PARTICIPATE AS A VOLUNTEER IN THE ABOVE NAMED RESEARCH

(Participant's name -please print)

---------------------------------------	---------------------------------------
(Researcher's name)	(Date)

Appendix C – Developers' Survey Questionnaire

Adoption of Intelligent Support Systems in Agriculture

Questionnaire used as a guide

Name of software ____

1. How many units have been sold in total? ____________
   this year ____________
   last year ____________

   ie have sales peaked? If so, when? ____________

2. How long has the system been on the market?

3. Who are the main purchasers of this product?
   for example:
   farmers/producers
   extension staff
   agri-advisers
   researchers
   educational
   other

4. What is the main purpose of this system?

5. What is the version and date of the current version?

6. Operating system?

   Language/Shell

7. Cost to purchaser?

   Has this changed recently?

8. Do you have any user feedback of the system?

   Types of comments

9. Who initiated the development of the system?
   for example:
   researcher
   consultant
   extension staff
   farmers/producers

10. Why did they develop the system?
    ie what problem were they trying to overcome

11. How was the system developed?

    Who was involved? (organisations, knowledge experts, users, programming experts, money(?)

    Was testing and/or prototyping carried out?

12. Who was the intended target audience?
    for example:
    farmers/producers
    agri-advisers
    researchers
    educationalists

13. Has the system been widely marketed?
    Where ie paper, conferences, field days, web etc.

14. Current status of system?

15. When you think back on what you hoped to achieve with the system and you reflect on what has been achieved how what you describe the outcomes for this system?

16. And what do you consider the main reasons for this outcome?

17. What is your role with regard to this system?
    for example:
    developer
    researcher
    distributor
    publicity officer
    other

18. Does the system have a web presence?

19. Did the system receive industry or government funding?

20. Underlying model

21. How much data input is required by the user?

22. Was there project management? How long did it take to develop system? Lines of code?

23. Complexity of interface (and output data)?

Before finishing ask participant:

What information they do not want published.

Thank you for participating. I will forward a transcript of our conversation to you for your approval.

As well a report of this research will be sent to you at a later date.

Appendix D – Users' Survey Questionnaire

General Survey Questions

Questionnaire used as a guide

The same questionnaire was used for the two systems – *AVOMAN* and *WHEATMAN*. The system name was changed when interviewing users.

1 Tell me about *AVOMAN* and how you use it
- Purpose of the system
- Data input
- Complexity of output

2 Tell me about how if effects your decision-making

3 The impact that *AVOMAN* has had on your farming operations
- Cost/benefit

4 Tell me about your involvement in the development of *AVOMAN*
- influence
- communications with developers
- participation in development

5 What made you decide to use *AVOMAN*
- Perceived benefits
  - Direct saving (money/business operations)
  - Indirect - tactical & competitive advantage
- Organisational readiness
  - Financial
  - Technological resources
- External pressures
  - Competitive pressure
  - Imposition ie QA

6 Do you differ to other avocado growers in any way?
- Farm size

Usefulness, Ease of Use, and Compatibility Survey Questions

AVOMAN

The following also indicates the scoring of usefulness, ease of use, and compatibility of AVOMAN. A * indicates a response by user.

Strongly Agree		**Neutral**		**Strongly Disagree**
1	2	3	4	5

Usefulness

Using *AVOMAN* improves the quality of the work I do

1 - *	2 - ****	3 - *	4 - *	5

Using *AVOMAN* gives me greater control over my work

1 - ***	2 - ***	3 - *	4	5

Accomplish tasks more quickly

1 - ** *	2	3 - ***	4 -**	5

Increases my productivity

1	2 - ***	3 - *	4 - **	5

Improves job performance

1	2 - **	3 - ****	4 - *	5

Find it useful

1 - *****	2 - **	3	4	5

Advantages of using it outweigh disadvantages

1 - *****	2 - **	3	4	5

Ease of use

Cumbersome to use

1	2	3	4 - *	5 - ******

Learning to use was easy for me

1 - ****	2 - *	3	4 - **	5

Often frustrating

1	2	3	4 - ***	5 - ****

Rigid and inflexible

1	2 - **	3	4 - **	5 - **

One not sure

Easy to remember how to perform tasks

1 - **** *	2 - **	3	4	5

Requires a lot of mental effort

1	2	3	4 - *****	5 - **

Overall it is easy to use

1 - ***** *	2 - *	3	4	5

Compatibility

Fits well with the way I like to work

1 - ****	2 - ***	3	4	5

Does things in a way that makes sense to me

1 - ****	2 - ***	3	4	5

Usefulness, Ease of Use, and Compatibility Survey Questions

WHEATMAN

The following also indicates the scoring of usefulness, ease of use, and compatibility of WHEATMAN. A * indicates a response by user.

Strongly Agree		**Neutral**		**Strongly Disagree**
1	2	3	4	5

Usefulness

Using *WHEATMAN* improves the quality of the work I do

1 - *	2 - **** * *	3 - ***	4 -	5

Using *WHEATMAN* gives me greater control over my work

1 - *	2 - ***	3 - *****	4 - *	5

Accomplish tasks more quickly

1 - **	2 - **	3 - *****	4 -*	5

Increases my productivity

1 - *	2 - *****	3 - ***	4 - *	5

Improves job performance

1 - *	2 - ******	3 - **	4 - *	5

Find it useful

1 - **	2 - ******	3 - **	4	5

Advantages of using it outweigh disadvantages

1 - ****	2 - *****	3 - *	4	5

Ease of use

Cumbersome to use

1 - *	2 - **	3	4 - ****	5 - ***

Learning to use was easy for me

1 - *	2 - ********	3	4 - *	5

Often frustrating

1- *	2 - **	3	4 - *******	5 -

Rigid and inflexible

1- *	2 - ***	3 - ***	4 - ***	5 -

Easy to remember how to perform tasks

1 - *	2 - ******	3 - *	4 - **	5

Requires a lot of mental effort

1	2 - *	3 - *	4 - ********	5 -

Overall it is easy to use

1 - ***	2 - *******	3	4	5

Compatibility

Fits well with the way I like to work

1 - ***	2 - ****	3 - *	4 - *	5 - *

Does things in a way that makes sense to me

1 - **	2 - *******	3 - *	4	5

Appendix E - Issues/categories arising during the coding process

amateur
auto data entry
award
champion
collaboration
confidential
conflict - output
cost
data entry
developer focus
different needs
easy to use
evolved
expert knowledge
gender
hobby
inspire confidence
learning
maintenance problems
modelling tool
needs based
niche market
no real need
not commercially viable
not supported
outcome-could be better
over engineered
personal interaction
problems
recording tool
research focus
saw need
software development methodology
service
success factors
survey
technology transfer
training
use by date
useful
user demand
user friendly
user involvement
user support
whole systems

Appendix F - Attributes arising from data analysis

Name of system

Adoption outcome

Cost of unit

Current status

Level of data input

Demo disk available *

Development method *

Developed by

Domain

Domain type

Feedback incorporated

Funded

Impact system

Degree of user influence

Interviewee's role in system

Type of user involvement

Language used *

Last updated *

Lines of code *

Main user

Marketed

Percent market share

Time on market *

Operating system

Outcome

Complexity of output

Project management

Reason for outcome

Secondary users *

Number of units sold

State where developed

Target users

Technical outcome

Technical problems *

Time to develop *

Training/workshops

Type system

Underlying model *

User involvement

User testing

Version *

Web presence

Who initiated

Why developed

* Data collected in relation to these attributes have not been discussed in this thesis

Appendix G - Additional systems data

The following data relates to all 66 systems.

The web can be a useful tool for delivering information about software updates and downloading demo versions. However, only 23 systems (35%) used the web for delivering information about the software. Not all of these have demonstration versions available for downloading.

Web presence	Frequency	Percent
No	43	65.2
Yes	23	34.8

Over 60% of the systems have Windows as the operating system.

Operating system	Frequency	Percent
DOS	19	28.8
DOS & Mac	1	1.5
DOS to Windows soon	4	6.1
Unknown	1	1.5
Windows	38	57.6
Windows &Mac	2	3.0
MainFrame	1	1.5

The application domain of the systems was many and varied. However, Livestock management had the most systems with 12 (18%) systems identified as belonging to this domain. The next most popular type of system was related to diet formulation. A total of 8 (12%) of systems were targeted at this area. This was followed by five (8%) of systems developed for the domain of weed control.

Domain of interest	Frequency	Percent
Breeding	4	6.1
BusinessAnalysis	1	1.5
ChemicalApplication-Fertiliser	3	4.5
ChemicalApplication	2	3.0
DietFormulation	8	12.1
Erosion	1	1.5
FeedLot	1	1.5
FodderProduction	1	1.5
GrainProduction	2	3.0
Irrigation	2	3.0
Lambing	1	1.5
LandForm	2	3.0
Management-Horticultural	2	3.0
Management-Livestock	12	18.2
Management - general	2	3.0
PastureProduction	3	4.5
PestId&Control	3	4.5
PlantNutrition	1	1.5
Refrigeration	1	1.5
SoilNutrients	3	4.5
SoilWater	1	1.5
StockingRate	1	1.5
WeatherData	3	4.5
WeedControl	5	7.6
WholeFarmModelling	1	1.5

Many systems (n=17, 26%) were applicable to the whole farm – for example herbicide or fertiliser applications. The next most popular domain type was beef – eight (12%) systems were targeted at beef enterprises.

Domain type	Frequency	Percent
Apples	1	1.5
Avo	1	1.5
Beef	8	12.1
Beef&Sheep	2	3.0
Cereal	1	1.5
Chick Peas	1	1.5
Cotton	1	1.5
Dairy	7	10.6
Farm	17	25.8
Feedlots	1	1.5
Grain	3	4.5
Grapes	1	1.5
Grazing	2	3.0
Land units	1	1.5
Pastures	2	3.0
Pastures&Crops	1	1.5
Pig	5	7.6
Pig&Poultry	1	1.5
Potato	2	3.0
Sheep	2	3.0
VariousAnimals	3	4.5
VariousCrops	2	3.0
unclear	1	1.5

Thirty four of the systems (52%) had been updated within the last 12 months. This may have been influenced by the need to update software to make it year 2000 compliant. However, it may also indicate that developers are aware of the need to keep their systems up-to-date.

Last updated	Frequency	Percent
<1	34	51.5
>=1<2	8	12.1
>=2<3	2	3.0
>=3<4	5	7.6
>=4	10	15.2
NA	7	10.6

Thirty seven systems (56%) had targeted marketing. That is, the systems were advertised in departmental brochures or were part of displays at field festivals. Many participants felt that there was not much benefit gained from marketing systems.

Others felt that this was one area where they did not have enough expertise and that the systems would have done better if they had a better marketing strategy. Marketing is a big issue for many developers.

Marketed	Frequency	Percent
Unclear	2	3.0
NA	2	3.0
No	18	27.3
Yes - targeted	37	56.1
Yes	7	10.6
Total	66	100.0

Ten systems (15%) had been developed within the last two years. Thirty nine systems (59%) were developed over five years ago. Two systems were released over 20 years ago – *Compute-a-grade* is currently under revision and *NPDecide* was described as dormant. *Compute-a-grade* was one of a small number of systems developed by a private individual.

Time since released	Frequency	Percent
<2	10	15.2
>=2<5	13	19.7
>=5<10	24	36.4
>=10<20	15	22.7
>=20	2	3.0
Beta stage	2	3.0
Total	66	100.0

Appendix H – List of identified systems

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Agrisource	interviewed	1	1	0				
AppleThinning	interviewed	1	1	0				
APSIM	interviewed	1	1	0				
AusPig	interviewed	1	1	0				
AusVit	interviewed	1	1	0				
AvocadoRootRot	no upto date contact details			0		1		1
AvoMan	interviewed	1	1	0				
Banks	interviewed	1		1	1			
BB-Safe	did not return email - DSS?			0		1		1
BeefFeed	DSS?			0		1		1
Beefin	interviewed	1	1	0				
BeefLotFeeding	no upto date contact details			0		1		1
Bovision	no upto date contact details			0		1		1

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
BreedCow & Dynama	interviewed	1	1	0				
BreedEwe & BreedCow	contacted - very brief discussion - didn't get to be a standalone product	1		1	1			
BreedBull	interviewed	1	1	0				
BreedPlan	interviewed	1	1	0				
Bugchecker	did not get beyond prototype phase	1		1	1			
Cambeef	interviewed	1	1	0				
CamDairy	interviewed	1	1	0				
Catmark	interviewed	1		1	1			
Chickbug	interviewed	1	1	0				
Compute-a-Grade	interviewed	1	1	0				
CottonLOGIC	interviewed	1	1	0				
CropPlan	no upto date contact details			0		1		1
CropTest	interviewed	1	1	0				

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
DairyFeed	interviewed	1	1	0				
DairyMan/DairyWin	not return emails or calls			0		1		1
DairyMaster	interviewed	1	1	0				
DairyPro	interviewed	1	1	0				
DecideBaseSeries	no upto date contact details			0		1		1
Decision Support for Farm Managers	interviewed	1	1	0				
Drains	interviewed	1		1	1			
DSSonCropRotation	interviewed	1		1	1			
Farm & FarmChoice	no upto date contact details			0		1		1
FarmCare	no upto date contact details			0		1		1
Farmula	interviewed	1		1	1			
FarmWise	no upto date contact details			0		1		1
FeedBal	not is use			0		1	1	

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
FeedLotto	interviewed	1	1	0				
Feedman	interviewed	1	1	0				
FeedMania	interviewed	1	1	0				
FertiliserAdviceforCrops	interviewed	1	1	0				
FertiliserAdv to DairyFarmers	interviewed	1	1	0				
FodderPak	interviewed	1		1	not enough info -			
Forecaster	interviewed	1		1	1			
Goats	no upto date contact details			0		1		1
GrainStore	no upto date contact details			0		1		1
Grasp	no upto date contact details			0		1		1
GrassGro	interviewed	1	1	0				
GrassMan	interviewed	1	1	0				
GrazeOn	interviewed	1	1	0				
Grazfeed	interviewed	1	1	0				
Herbicide Advisor	not is use			0		1	1	

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Herbiguide	interviewed	1	1	0				
Herd-econ	interviewed	1	1	0				
HotCross	interviewed	1	1	0				
HowMuch	interviewed	1	1	0				
HowOften?	interviewed	1	1	0				
HowWet?	interviewed	1	1	0				
Id in Subclover Varieties	not is use			0		1	1	
Interp. of Biochemical Analysis	prototype, not in use			0		1	1	
Jumbuck	interviewed	1		1	in house use			
LambAlive	interviewed	1	1	0				
Land-Lev	interviewed	1	removed	1	personal use			
LandPlan	no upto date contact details			0		1		1
LCDP - Least Cost Diet Program	interviewed	1	1	0				
littermac	interviewed	1	1	0				

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
LucVar	not is use			0		1	1	
Matchup	did not get beyond prototype phase	1		1	1			
Melon	prototype, not in use			0		1	1	
MetAccess	interviewed	1	1	0				
Midas	interviewed	1	removed	1	in house use			
Milkcool	interviewed	1	1	0				
MIPS software	no upto date contact details			0		1		1
Mudas	interviewed	1		1	1			
NPDecide	interviewed	1	1	0				
NutrientAdvantage	interviewed	1	1	0				
NutSpots	no upto date contact details			0		1		1
OptLime	interviewed	1		1	1			
PAM	interviewed	1	1	0				
Pastor and PastorC	interviewed	1		1	1			

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Pasture Supply and Demand	no upto date contact details DSS?			0		1		1
PastureMasture	interviewed	1	1	0				
PasturPak	interviewed	1	1	0				
PaturePestPak	interviewed	1	1	0				
Perfect	interviewed	1		1	1			
PestKey	not is use			0		1	1	
PestMan	in use			0		1		1
Pia				0		1		1
Pig-E	no upto date contact details			0		1		1
PigPulse	interviewed	1	1	0				
Plantcal	did not get beyond prototype phase	1		1	1			
PotentialYieldCalculator	interviewed	1	1	0				
Profitprobe	surveyed	1	1	0				
Profitpork	interviewed	1	1	0				
ProPlus	interviewed	1	1	0				

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Rainman	interviewed	1	1	0				
Rationing Program	no upto date contact details			0		1		1
RiskFarm	no upto date contact details			0		1		1
Rural Loans Assessment	prototype, not in use			0		1	1	
RuralTradingSystems	no upto date contact details			0		1		1
Sadi	interviewed	1		1	1			
Safe Carrying Capacity	interviewed	1	1	0				
SaltPlan	interviewed	1		1	1			
Sheepo	interviewed	1	1	0				
SheepWorms	interviewed	1		1	1			
SoilCarbonManager	no upto date contact details			0		1		1
Soiloss	interviewed	1	1	0				
Sowtel	interviewed	1	1	0				
Splat	interviewed	1		1	1			

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Stockman	interviewed	1		1	1			
Swagman-WhatIf	interviewed	1	1	0				
Tact	interviewed	1		1	1			
TakeAway	interviewed	1	1	0				
Tomato Adviser	prototype, marginal use only			0		1	1	
TopStud	no upto date contact details			0		1		1
WADairyFarmModel	interviewed	1		1	1			
Watersched	interviewed	1	1	0				
Weed Advisor	not is use			0		1	1	
WeedMaster	interviewed	1	1	0				
WeedWatch	interviewed	1	1	0				
Wheatman	interviewed	1	1	0				
WheatVarietyAdvisor	prototype, not in use			0		1	1	
WhopperCropper	interviewed	1	1	0				
Woody Weed Advisor	interviewed	1	1	0				
Xbreed	interviewed	1	1	0				

DSS Package		Interviewed	Included in study	Not included	Not beyond prototype phase or In house	Not contacted	Available info suggests not in use	Status unknown
Zack/Jumbuck	interviewed	1	1	0				
		total interviewed	included	not included	interviewed - but not beyond prototype stage + 3 inhouse use + 1 not enough info	not contacted	think not in use	status unknown
	count	**91**	**66**	**25**	**21**	**37**	**11**	**26**
	total systems	128						

Appendix I - Guidelines for developers

Preliminary findings:

A study of the adoption and use of decision support systems and expert system within Australian agriculture

Author: Teresa Lynch
22nd August 2000

[Notes distributed at a workshop for modellers and developers of decision support systems held in Toowoomba, Queensland on the 6th September 2000]

- Systems must be useful to the anticipated user – it doesn't matter how flash the system is in terms of what it does - if it is not useful to the intended user then they will not use it.

- The system should match the decision-making style of the intended user – not the decision-making style of the researcher or developer.

- You may think you know what the users want – but you probably do not. Over 40% of information systems fail. Don't assume that you know what the users want – ask them and then listen to what they say.

- To determine what your potential users wants generally requires a need to involve them otherwise you will build a system that you want – not one that the user wants. They may not want a decision support system at all – will you still go ahead and develop a system if the users do not appear keen?

- Involving users towards the end of the development process will not ensure success. By then you have already decided what the system will do. User involvement at this stage will not do much to ensure that your system is a success.

- Resist the temptation to convert your model into a decision support system – you should develop decision support systems because users want them – not because you have this really good model that you want to share with users. Research models and decision support systems are two distinct products. One does not always have to lead to the other.

- Developing systems is a lot of work. Ensure that you have the time and resources.

- The target of many decision support systems should be extension and/or advisory staff – not farmers. Many farmers are not interested in decision support systems (at this moment). If extension staff are the intended users make sure they are involved in the development – from the conceptual stage – not the user testing phase.

- Remember where the user is currently at in terms of computer skills and decision-making. If users are not adopting decision support systems then is it primarily because the systems are not perceived as being useful to them.

- If a user does not keep records manually they are unlikely to be interested in using a decision support systems – sad but true.

- Many farmers are looking for good recording keeping tools. A good approach is to give them a good record-keeping tool that also assists them in their decision-making. These appear to be the most successful systems.

- Simple systems are often very useful. Farmers I have interviewed have commented that there are a lot of good little spreadsheet packages that the Department of Primary Industry and the Department of Natural Resources have developed but that they do not seem to advertise.

- Check that someone else has not already developed the system you are thinking about developing – there are a lot of systems already developed.

- A software application is never finished. Software continually needs updating – will there be enough resources to do this? Is this your core business? If it is not, then how will it be funded?

- Many developers commented to me that it is one thing to develop a system but an entirely different matter to advertise and promote it. There appears to be a lot of unresolved problems in relation to marketing software.

- You should determine why you want to build the system. How will you determine if it is successful? Most developers had no goal in mind in terms of gauging system success. Often they were unaware of the potential market for their product.

- Will your system enable farmers to make 'better' decisions? How will you know?

- It is important to understand that not all innovations have advantages. Some innovations do not appear to afford the user any advantage. Many decision support systems currently fall into this category because they did not take into account users' needs.

- Remember that an adoption/rejection is always right in the eyes of the individual who makes the decision to adopt/reject. If farmers or extension staff are not using decision support systems then you should not wonder what is wrong with them but what is wrong with your software.

- There are some success stories. Simple programs have been successful. Record keeping tools with a decision support component have been successful. Make sure that the record keeping aspect of the software is the primary focus during development. The most innovative of farmers told me that what they were really looking for was a good record keeping tool – and they couldn't find one! Systems developed and used by industry to assist farmers and their advisers have been successful. The companies have strong ownership of these products.