Factors affecting farmer adoption and use of computerised information systems: a case study of Florida, Uruguay, dairy farming

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Abstract

With the objective of collecting data for assessing research hypotheses about information management, a survey was carried out on Florida-Uruguay dairy farmers between October and November of 2000. A total of 61 farmers were interviewed and asked to fill a survey questionnaire and three psychological test forms. While more than a quarter of the farmers own a computer, 17% are using computerised systems to manage farm information. Livestock management was the most common use of computers with 15% of the farmers using them in this way, followed by the finance area with 5%, while no farmers were using software to support their feed management. Farmers using computerised systems were more educated, and more "success in farming" oriented than non-users. This group managed bigger farms, and they spent more time doing office work. Unwillingness to use computerised systems can be explained according to the farmer's computer technology alienation feelings ("knowledge gap"), incompatible information management skills, and poor economic benefit perceptions. The first two factors may reflect farmers' learning and problem solving styles being incompatible with computerised systems, which may originate from the interaction of basic personality traits and the educational and life process (family and community environment). Given certain learning and problem solving styles, farmers may form positive or negative economic benefit perceptions. The size of the farm, among other farm variables, clearly influences this perception through both the economies of scale of software use, and the scale of the management work. The lack of (computer) operational skills can delay software adoption, but can be removed through training if the above factors support a positive attitude toward computerised system use. If feasible, actions promoting information technology change should focus on building farmer information management skills, and in making available knowledge relevant to developing positive economic benefit perceptions, assuming they exist. Advisors can play a significant role in this process. An additional strategy, particularly where non-users not considering the use of computerised systems represent important segments in the farming community, is the development of information management tools more compatible with these farmers' current information systems.

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1. Introduction

As part of a PhD thesis[1] a survey of Florida (Uruguay) dairy farmers was carried out. The purpose of the survey was to collect data needed to assess some research hypotheses related to farmer adoption, and the usefulness of computerised information systems.

On a daily basis farmers manage many classes of information concerning different aspects of the dairy business. For this research, these different classes of information have been grouped into three main areas: finance, feed and pasture, and livestock. Within each of these areas, farmers have available different types of procedures to manage the information. The main research objective was to develop a comprehensive understanding of the factors that promote or otherwise delay computerised information system use as an on-farm procedure for managing information.

The data collection was performed using three survey procedures. Firstly, a questionnaire was developed to collect data about farmers' information management and other related characteristics. Secondly, a two-hour interview through which farmers were asked about their management practices to find out their information management skills and their personal reasons for using or not using a computer to perform this task. Finally, farmers did three psychological tests to find out their goals, personality traits and learning styles.

The first aim of this paper is to present what was found through the use of these survey procedures in describing Florida dairy farmers' information management. By using different statistical techniques, relationships between software use and a set of explanatory variables were researched and quantified. The second aim is to present these results in an attempt to discover the factors that are promoting this technology.

In the first section the research hypotheses will be stated. Then the sampling procedure used for data collection will be explained. A third section will contain a characterisation of the surveyed farmers in term of the variables related to information management. A fourth section will provide evidence from the statistical techniques used to test the relevant relationships between software use and the research hypotheses. Finally these results will be discussed and final comments made. A brief description of the Uruguayan dairy industry is presented in Appendix A.1.

2. The research hypotheses

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

[1] Research project: A study of factors affecting the adoption and usefulness of information system innovations: the case of Canterbury and Uruguayan dairy farmers

2.1 Software adoption

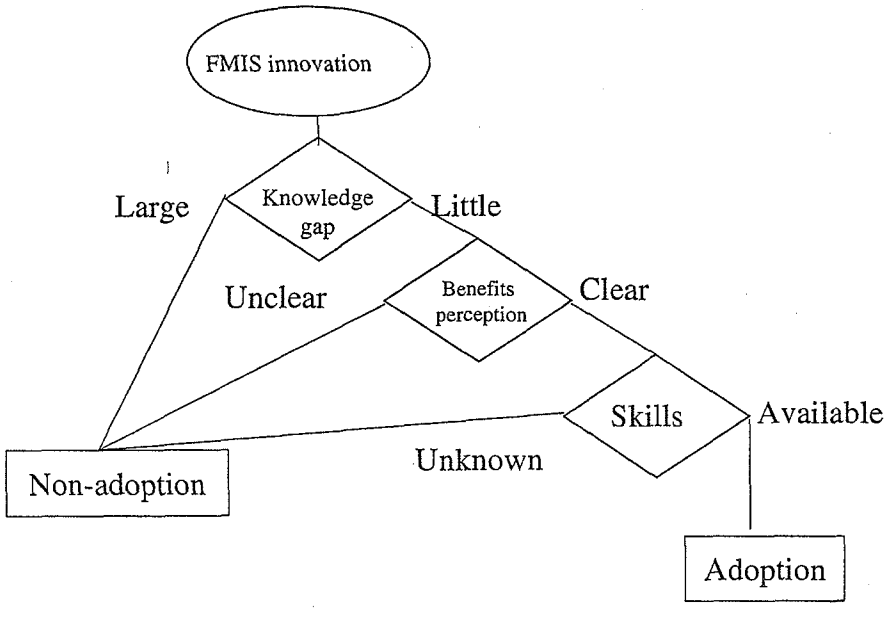
Given that information innovation adoption is not due to either government or similar edict (e.g. from a bank lender), nor due to technological necessity, the research hypothesis is that information innovation adoption depends on the concurrent presence of three factors. These are listed below and diagrammatically demonstrated in figure 2.1.

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

- The second factor is the extent of a farmer's perception of the economic benefits and ease of management derived from the adoption of an information innovation. A clearly perceived benefit will reinforce adoption behaviour, otherwise adoption will not occur. The first and second factors are related.

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

Figure 2.1: Information innovation adoption framework



Note: FMIS means "farm management information system".

2.2 Software usefulness

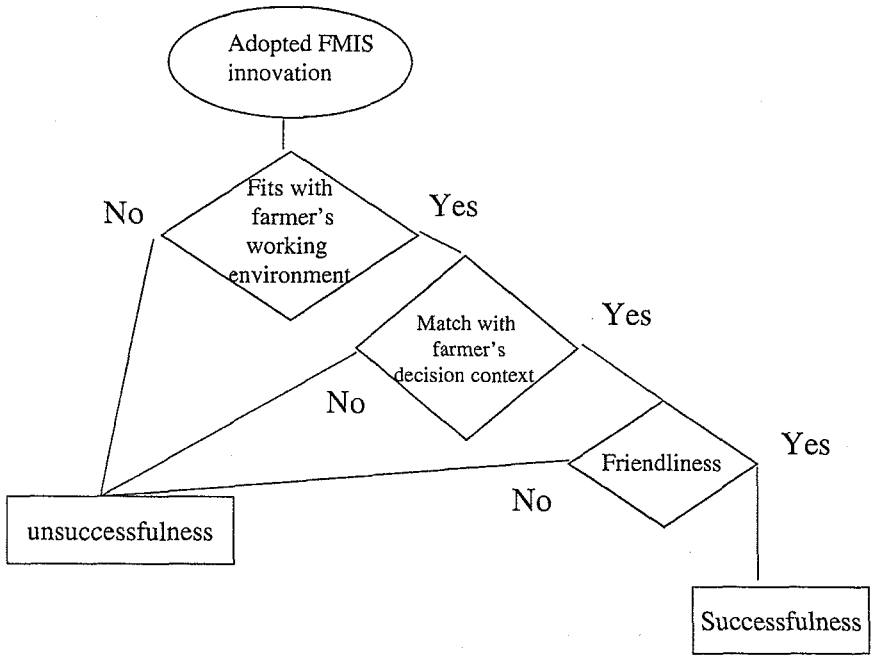
Adoption is not sufficient to guarantee the successful use by farmers (See Figure 2.2). The second general hypothesis is that successful use depends on the following three factors:

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

- The matching of the information innovation capability with the farmer's decision context. The more flexible the system to accommodate the farmer's requirements, the more successful the system will be.

- Suitable system facilities such as the introduction of inputs, interface design, output type and design, and integration with other applications. These aspects define the level of application friendliness. The greater the friendliness, the more likely the application will be successful.

Figure 2.2: A framework for the successfulness of an innovation



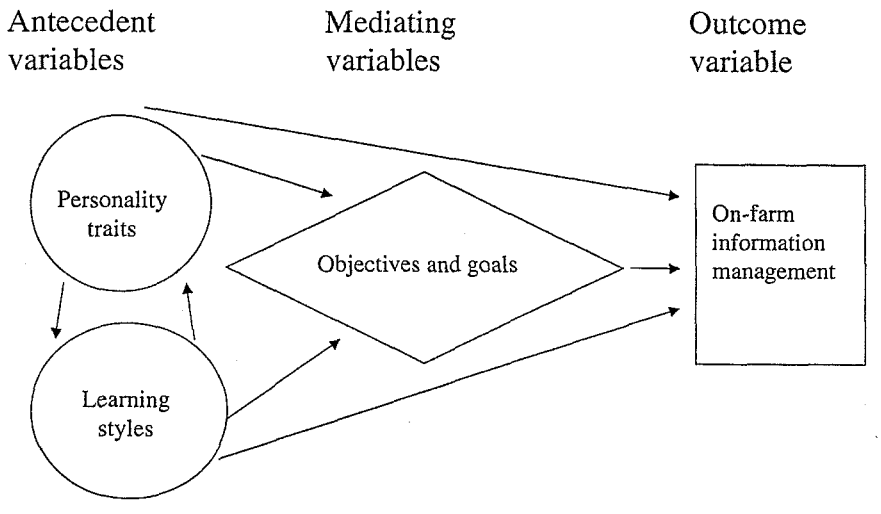
2.3 Behaviour model

Behavioural modelling using mediating variables was used to assess the relationships. This approach produces a transactional model of behaviour (Willock et al, 1999), which includes three types of variables. The first group includes antecedent variables, such as personality traits, the second includes mediating variables, such as coping styles, appraisals, objectives, and goals. The last group includes behaviour outcome variables such as, for example, the use of on-farm computerised information systems.

A transactional model allows considering both direct and indirect relationships between antecedent variables –farmer's personality traits and learning styles, and information management behaviour.

Figure 2.3 Transactional model

Transactional model representing on-farm information management behaviour



3. Sample selection

The research procedure involved randomly selecting 41 farmers for completing a questionnaire, the psychological tests, and for having a 2 hour interview relative to their information management strategies. These 41 farmers were selected from a 408 farmer list provided by the Asociacion Nacional de Productores de Leche[2] (ANPL), which included its Florida membership. This list included 71% of the regional dairy farms[3].

[2] Dairy Farmer National Association, which is the most important Uruguayan dairy farmer organisation.
[3] There were 581 Florida dairy supplier numbers on June of 2000 (Echerverria, 2000), however several dairy farmers own more than one supplier number, while each farmer has only one membership to the association; so Florida ANPL members are likely to represent more than 71%.

The ANPL list provided the farmer's name and address. This data was complemented by asking regional advisors[4] about the farmer's age, formal education, herd size and whether the farmer owned a computer or not. Using this procedure it was possible to complete data for 342 farmers of the ANPL list, who represented 60% of the regional dairy farmer population.

From these 342 farmers, 229 had a telephone, which was used to make interview arrangements for the random sample (41 farmers). This was selected to reflect the main characteristics (age, formal education, herd size and computer ownership) of the 342 identified farmers among those who had a telephone.

Another 20 farmers (not randomly selected) were interviewed to complement information about computer use, as it was known they owned a computer or they had better information management than the average.

The next four tables present the farmers' age, formal education, herd size and computer ownership characteristics for the 342 farmers and the survey sample.

Table 3.1 Farmers' age distribution

	Percentage of farmers in the 342 list	Percentage of farmers in the survey sample
Less than 35 years	12.5%	4.88%
From 36 to 47 years	40%	36.59%
From 48 to 59 years	31%	51.22%
More than 60 years	16.5%	7.32%

Chi-square: 9.41, p<1% (independent test)

Table 3.2 Farmers' formal education

	Percentage of farmers in the 342 list	Percentage of farmers in the survey sample
Primary or less	35%	48.78%
Secondary. Equal or less than 4 years	43%	26.83%
Secondary. More than 4 years	9.5%	12.20%
Tertiary	12.5%	12.20%

Chi-square: 5.23, 5%>p<10%, for 5% require 5.99 (independent test)

Table 3.3 Herd size distribution

	Percentage of farmers in the 342 list	Percentage of farmers in the survey sample
Less than 50 cows	16%	17.07%
From 51 to 150 cows	49%	46.34%
From 151 to 300 cows	25%	26.83%
From 301 to 498 cows	9%	9.76%
More than 499 cows	1%	0%

Chi-square: 0.53, p<95% (independent test)

Table 3.4 Computer ownership

	Percentage of farmers in the 342 list	Percentage of farmers in the survey sample
With computer	26%	26.83%
Without computer	74%	73.17%

Chi-square: 0.03, p<95% (independent test)

[4] Daniel Zorrilla, Daniel Delgado, Fernanda Perez, Jorge Arrieta, Sergio Vaz and Carlos Cladera.

The contrast between the 342 farmer list and the survey sample (independent tests) showed that the sample increased the representation of older and less educated farmers.

4. Survey data results

Three procedures were implemented to collect data: a questionnaire with 24 questions, three psychological tests each involving a form to be filled, and an interview combining open and close questions. This was recorded using a tape (for taking farmers explanations) and some written records using standard forms.

4.1 Questionnaire results

The questionnaire is presented in appendix A.2. The data is presented following the original order.

4.1.1 The average farm

Table 4.1 presents a group of statistics that describe the average Florida dairy farm.

Table 4.1 Average Florida dairy farm

	Effective area (hectares)	Cows (head)	Heifers (head)	Calves (head)
Average	166	142	63	63
Std Dev.	127	105	54	75
Median	150	120	48	34
Mode	150	120	50	30
Maximum	530	460	211	350
Minimum	35	32	6	5

The farm effective area provides pasture resources for grazing as the largest component of dairy cow intake. At certain times at the year grazing is complemented with reserves (usually farm produced) and concentrates. Because the season 1999-2000 (the previous season to the survey) was extremely dry, farmers used an unusual amount of concentrates and in many cases they also needed to purchase reserves.

The majority of farmers (63%) complement the farm effective area with additional land resources. This complementary land can be either owned or rented. This is usually used for young stock and dry cows.

Table 4.2 presents the percentages of farms that used additional land resources, and the areas involved.

Table 4.2 Additional land

	Percentage of farmers	Average amount/farm*
Owned	27%	139 hectares
Rented	39%	119 hectares

* The averages were calculated using only the farms that used the extra-land resource.

4.1.2 Dairy farming experience and age

Farmers were asked how long they have been dairy farming. Table 4.3 contains the details.

Table 4.3 Farmers' dairy farming experience

	Dairy farming experience (years)	Farmer age (years)
Mean	25	48
Std Dev.	11.4	8.4
Median	25	48
Mode	30	39
Maximum	58	66
Minimum	1	31

4.1.3 Tenancy

Twenty percent of farmers were renting their farms. This group seemed to be younger than other categories, and managing larger herds, but these were not statistically significant differences.

Table 4.4 Tenancy, age and herd size

Tenancy	Percentage of farmers	Average age (years)	Average herd (head)
Owner	26.83%	48	144
Owner/Rentee	43.90%	49	137
Rentee	19.51%	43	182
Colono*	9.76%	53	90

Notes: * A colono is a farmer who had accessed land through a governmental institute that is rearranging land tenure.

4.1.4 Education

Farmers were asked their formal education background in five categories: primary or less, equal or less than 4 years of secondary, more than 4 years of secondary, equal or less than 2 years of tertiary, and more than 2 years of tertiary. Table 4.5 gives the details.

Almost 50% of the dairy farmers have primary, or lower, level of education, while more than 10% have tertiary education. There were non-statistically significant correlations (Spearman coefficient) between education and age, and education and herd size. However, farmers with tertiary education were statistically significant younger than primary or less educated farmers.

Table 4.5 Education

Education level	Number of farmers	Percentage	Average age	Average herd size (head)
Primary or less	20	48.78%	49a	133
Secondary. Equal or less than 4 years	11	26.83%	49	182
Secondary. More than 4 years	5	12.20%	45	98
Tertiary. Equal or less than 2 years	1	2.44%	45	45
Tertiary. More than 2 years	4	9.76%	42a	64

Notes: a) there is a statistically significant difference (SSD) between age of farmers with primary or less education, and farmers with tertiary (more that 2 years) education, t-test=1.717 p=10%.

4.1.5 The management team

Farmers were asked to describe whether management responsibilities were ssumed personally, or whether they were shared within the family group. The next table shows that 24% of respondents stated that they carried out the management job personally. Those who shared their management work with the whole family are in the majority (more than 41%). The other 34% of farmers said that they together with their spouses (couple) carried out the management work. Farmers who managed their farms themselves were younger and seemed to have a smaller herd.

Table 4.6 Management team and age

Management team	Percentage of farmers	Average farmer age	Average herd size (head)
1-Myself	24.39%	43a	117
2-Couple	34.15%	47	156
3-Father/Mother and Sons/Daughters (F/M and S/D)	41.46%	51a	148

Notes: (a):the "Myself" average age is statistically different from the Father/Mother and Sons/Daughters (t-test=-2.448 p=2.2%) category

Table 4.7 combines the structure of the management team and the farmers' level of education. Farmers who were managing by themselves seemed to be more educated than other management team arrangements. However, the differences were not statistically significant.

Table 4.7 Management team and education –percentage for each column

	1-Myself	2-Couple	3-Father/Mother and Sons/Daughters (F/M and S/D)
Primary or less	30.00%	57.14%	52.94%
Secondary. Equal or less than 4 years	30.00%	21.43%	29.41%
Secondary. More than 4 years	20.00%	7.14%	11.76%
Tertiary. Equal or less than 2 years	0.00%	7.14%	0.00%
Tertiary. More than 2 years	20.00%	7.14%	5.88%

4.1.6 Non-family people who give a reasonable input into farm decision making

Farmers were asked whether they involved non-family people through asking for ideas or suggestions as input into their farm decision making. Four "adviser" types were suggested: advisers (farm consultants), accountants, lawyers, and friends/neighbours. Four levels of involvement were suggested: none, a little, quite a lot and heavy involvement. Table 4.8 contains the results.

Table 4.8 Management involvement by non-family members

	Percentage who are involved			
	None	A little	Quite a lot	Heavy
Adviser	48.78%	21.95%	21.95%	7.32%
Accountant	100%	0%	0%	0%
Lawyer	100%	0%	0%	0%
Friend/neighbour	95%	2.5%	2.5%	0%

Advisers were the main farm decision making contributors. Neither accountants nor lawyers were involved. This question had an open category. Table 4.9 shows these responses. After advisers, the second group of non-family members was veterinarians, and in a few cases employed staff.

Table 4.9 Management involvement by non-family "others"

	Percentage who are involved			
	None	A little	Quite a lot	Heavy
Veterinarian		5%	14%	2.5%
Staff			8%	2.5%
Total	69%	5%	22%	5%

4.1.7 Farm information management

4.1.7.1 Financial recording system (FRS)

Farmers were asked to describe which type of FRS they were using. Five alternatives were suggested: an informal system (such as memory, informal writing (such as notes on calendars), and off-farm printed reports (for example, bank statements) as backup information), a manual FRS (such as a cash book), a computerised FRS (software), a combination of manual and computerised FRS, and a system based on a service that might be provided by an accountant. The farmer was allowed to tick one or more alternatives. To process this variable the responses were coded in the following order:

a) If a computerised FRS was involved, the farmer was classified into this group.

b) For the remaining farmers, it they used a "service system", they were classified into the "service system" group.

c) For those not classified above, if a manual system was used, they were put into this group.

d) The remaining farmers were put into the "informal FRS" group.

Table 4.10 presents the results. A large majority of Florida dairy farmers used an informal information system. A quarter of the farmers used a service system, 15% a manual system and only 5% managed financial information through computers.

Table 4.10 Financial recording systems used by farmers

Financial recording system (FRS)	Number of farmers	Percentage of Total
Computerised FRS	2	4.88%
Service FRS	11	26.83%
Manual FRS	6	14.63%
Informal FRS	22	53.66%
Total	41	100.00%

Farmers who were using computerised FRS were asked to identify which software package they were using. One was using a spread sheet and the other a commercial package.

4.1.7.2 Feed (pasture) recording and management system (Feed RS)

Farmers were asked to describe their Feed RS. Five alternatives were provided. Systems based on: (i) farmer memory, (ii) notes on calendars, (iii) a manual system based on pocket notebooks, farm diary, field record books, or similar, (iv) a computerised recording scheme, and finally, (v) on an off-farm service. Farmers could tick one or more alternatives. The answers were coded following a similar procedure that was described above for the FRS.

Table 4.11 Feed recording and management system used by the farmers

Categories*	Number of farmers	Percentage of Total
Computerised Feed RS	0	0%
Service	11	26.83%
Book	7	17.07%
Calendar	9	21.95%
Memory	14	35.15%
Grand Total	41	100.00%

* See text for an explanation of the categories

Table 4.11 shows the results. Almost 40% of farmers were using a manual device, such as a book or similar, or a calendar. The second largest group are those who solely relied on their human capacities. A quarter of the farmers used an off-farm service. None of the interviewed farmers were using software.

4.1.7.3 Livestock recording and management system (LSRS)

Farmers were also asked to describe their LSRS. The same five alternatives as offered for Feed RS were given. The next two tables show the results.

Table 4.12 Livestock recording and management systems used by the farmers

	Number of farmers	Percentage of Total
Computerised LSRS	6	14.63%
Service	8	19.51%
Book	24	58.54%
Calendar	3	7.32%
Memory	0	0%
Grand Total	41	100.00%

The majority of farmers used a manual system. The next group are those managing their livestock information through an off-farm service. Finally, a third group used computerised LSRS.

Farmers who used computerised LSRS were asked to identify the software used. Table 4.13 shows the results. The majority of these farmers (66%) used one commercial product.

Table 4.13 Range of computerised livestock recording and management systems

	Software name	Number of users
	Brand 1	4
	Brand 2	1
	Spread sheet	1
Total		6

4.1.7.4 Fiscal requirements

Farmers were asked who carried out the fiscal requirements[5]. Table 4.14 presents the results.

Very few farmers relied on themselves for the fiscal requirements. This activity was performed mainly by farmer organisations, and other service providers.

Table 4.14 Fiscal requirements

	Number of farmers	Percentage of Total
Accountant	5	12.20%
Myself	3	7.32%
Spouse/Partner	1	2.44%
Service (operated by a farmer organisation)	25	60.98%
Other services	5	12.20%
Other	2	4.88%
Total	41	

4.1.8 The farm office

4.1.8.1 Office work

Farmers were asked the proportion of their total work devoted to management tasks and how many hours they spent doing office work per week. Table 4.15 shows the results.

On average farmers spent a quarter of their time on management work. This appears to represent 9 hours per week. Notice however, that some farmers did not perform any formal management work and others stated that their jobs were largely all a farm management operation.

Table 4.15 Office work

	Management work (% of total work time)	Farm office work (hours per week)
Mean	26.3%	9.0
Stdev.	21.0%	9.18%
Median	20%	6
Mode	20%	6
Maximum	80%	40
Minimum	0%	0

[5] Fiscal requirements involve income taxes (for large farms) and social security expenditure (for all farms)

4.1.8.2 Office equipment

Farmers were asked to identify which equipment they used for helping their management and office work. Table 4.16 presents the results.

Table 4.16 Office equipment

Equipment type	% Owning
Fax machine	2.44%
Telephone answering machine	4.88%
Cellular phone	39.02%
Photocopier	2.44%
Computer	26.83%

While almost 40% of Florida farmers have a cellular phone, a quarter own an on-farm computer. Other equipment types are rarely owned.

4.1.9 Computer use

Because the random sample had only 27% of computer users, this section and sections 4.1.10 and 4.1.12 also include data from the non-random sample. Including both groups the total number of computer users was 20.

Farmers were asked to identify the person who was the main user of the farm computer. The results are presented in the next table. The main groups of users are the farmers and their sons and/or daughters, and secondly farmers' spouses or partners.

Table 4.17 Main computer user

Computer user	Number of farmers	Percentage of computer users
Spouse	4	20%
Farmer	8	40%
Other family member	8	40%
Hired personnel	0	0%
Other	0	0%
Total	20	

Table 4.18 shows how long the farmers have had a computer, the main uses of the machine, and the average time per day that the computer is in use.

Table 4.18 Computer users' experience, types and hours of use

	Computer user experience (years)	Farm business	Learning and education	Leisure/personal	Communication	Off farm business	Average computer use time (hours/day)
		% of total use					
Mean	6.0	71.6%	5.6%	1.6%	7.25%	13.9%	1.0
Std	4.0	35%	15%	3.7%	8.8%	34.1%	1.0
Median	5.5	85%	0%	0%	0%	0%	1.0
Mode	10.0	100%	0%	0%	0%	0%	1.0
Maximum	15.0	100%	60%	10%	20%	100%	4.0
Minimum	0.4	0%	0%	0%	0%	0%	0.0

Farmers were also asked to identify their computer use routine. Seven alternatives were given to answer this question (see appendix A.2 question 17). Table 4.19 presents the results.

Table 4.19 Computer use routine

	Total
On rainy days	10.0%
A regular period each week during daytime	20.0%
A regular period each week during evenings	20.0%
In irregularly available spare time	25.0%
Exactly when need arises	5.0%
Other (or non identified)	15.0%
Total	100.00%

4.1.10 Software utilisation

Farmers were asked to identify the types of software used and the time per month spent on each type. Table 4.20 shows the results.

Table 4.20 Types of software used

Software category	Percentage of users/computer owners	Average time per month (hours)*
Word-processor	30%	2.4
Financial and accounting recording system	50%	7.3
Pasture and crop record system	5%	1.0
Livestock record system	80%	20.0
Feed budgeting,	25%	2.4
Herd testing,	15%	8.3
Integrated farm management package	0%	0.0
Other spreadsheet use	10%	3.5
Other database use,	0%	0.0
Internet	50%	4.0
E-mail	25%	1.7

* The average was calculated among those who declared some use.

4.1.11 Information sources

Farmers were asked to identify which information sources are used on their farms. Nine sources were suggested (see appendix A.2 question 18). Respondents were asked to use a 1 to 3 scale where 1 means that this source is not used at all, 2 means a little and 3 means an important use. Table 4.21 contains the results.

Table 4.21 Information sources

Information source	An important use	A little use	Not used	No-response
Daily newspaper	4.88%	21.95%	70.73%	2.44%
Farm publications	53.66%	36.59%	7.32%	2.44%
Breed journals	7.32%	19.51%	65.85%	7.32%
Electronic news	4.88%	2.44%	17.07%	75.61%
Daily farm reports on radio or television	87.80%	4.88%	4.88%	2.44%
MGAP[6] reports	4.88%	0.00%	68.29%	24.39%
CONAPROLE[7] advisory service publications	87.80%	7.32%	2.44%	2.44%
Field days/seminars	48.78%	26.83%	21.95%	2.44%
Neighbours/local contacts	63.41%	19.51%	9.76%	7.32%

The main sources of information seems to be the CONAPROLE advisory service publications and daily farm reports on radio or television. Secondly, farmers get information from neighbours or local contacts and farm publications.

Eleven farmers (27%) stated that their discussion group was a very important source of information.

4.1.12 Internet

Farmers were asked to identify which types of information or service they obtained from the internet. Ten types of information were suggested (see appendix A.2 question 19), and respondents were asked to use a 1 to 3 scale where 1 means that this type of information or service is used very occasionally, 2 means occasionally and 3 means frequently. The next table presents the results.

The internet is mainly used for receiving company news, and electronic mail, although significant use is made for news and weather information and the latest research results. Other kinds of information or services show little use.

[6] MGAP means Ministry of Livestock, Agriculture and Fisheries
[7] CONAPROLE means Dairy Farmers National Cooperative

Table 4.22 Internet use

Type of information or service from the internet	Frequently	Occasionally	Very occasionally	No-response
E-mail	33.33%	5.56%	16.67%	44.44%
News and weather information	16.67%	22.22%	11.11%	50.00%
Market information	16.67%	5.56%	27.78%	50.00%
Technical information	5.56%	16.67%	27.78%	50.00%
Economic information	5.56%	5.56%	27.78%	61.11%
Updates on changes to agricultural legislation	0.00%	0.00%	38.89%	61.11%
Latest research results	11.11%	0.00%	27.78%	61.11%
Entertainment and fun	0.00%	5.56%	33.33%	61.11%
Ordering equipment and supplies	0.00%	5.56%	33.33%	61.11%
Dairy company news	55.56%	5.56%	0.00%	38.89%

4.1.13 Farmer opinions about their information management

The final three questions were open asking farmers their ideas or suggestions about what is wrong, if anything, with their current information system (question 22); what new/better information/decision system they would like (question 23); and what new things they have done in the last 3 years for improving their information management (question 24; also see questions 22, 23 and 24 in appendix A.2).

Tables 4.23, 4.24 and 4.25 present the results.

Table 4.23 Answers to the question "Any ideas or suggestions about what is wrong with your current information/decision system?" (41 respondents)

	Percentage of respondents	
		Subtotals
No suggestions –"it is alright"	34.15%	34.15%
Farmer related difficulties		
Lack of time	4.88%	
Lack of motivation	7.32%	
Lack of information management skills	2.44%	14.64%
No-response		51.22%
Total		100.00%

Only half answered question 22. Farmers who thought that there was nothing wrong with their current information systems represented 34.15%. It is guessed this percentage is higher as some farmers who did not answer this question may feel satisfied with their current information systems. The other responses were related to farmer difficulties.

Table 4.24 presents the results from question 23. This question was answered by 56% of the respondents. Some responses involve more than one idea/suggestion. Each of these was analysed separately. Answers were grouped into four categories, (i) those that have solutions

from on-farm tools, (ii) those that involve developing new sources of information, (iii) those that involve improving farmer information management, and (iv) those that asked for better information. Each category received 25%, 11.11%, 8.34% and 55.56% of the responses respectively. Possibly because the way that question 24 was asked (it is not immediately evident that the farmer is part of the farm information system), no farmers focused change on themselves.

Within the first category (solutions using on-farm tools), more than 14% of the responses focused on using a computer to improve information management. The use of the internet was also suggested. Other farmers focused on the need for better software. Those who proposed new information sources suggested discussion groups and field days. The need for making improvements in information management was recognised in record keeping, forecasting trends and financial analysis. Finally, farmers suggested eight topics for watching better information would be useful (mainly dairy farming areas).

Table 4.24 Answers to the question "Any ideas or suggestions as to what new/better information/decision system you would like?" (36 respondents)

	Percentage of respondents	
		Sub-totals
On farm tools		
Use of computer	13.89%	
Use of internet	8.33%	
Better software	2.78%	25.00%
Information sources		
Field days	2.78%	
Discussion groups	8.33%	11.11%
Information management		
Record keeping	2.78%	
Finance information	2.78%	
Forecast trends	2.78%	8.34%
Better information		
Farm inputs and suppliers	2.78%	
Technical information	16.67%	
Direct drilling	11.11%	
Animal nutrition	8.33%	
Soil analysis	2.78%	
Feed analysis	2.78%	
Pasture	8.33%	
Animal genetics	2.78%	55.56%
Total		100.00%

Table 4.25 presents the results from question 24. This question was answered by more than a third of the respondents. Like the former question, some farmers gave multiple examples of things carried out during the last 3 years to improve their information systems. Each action was treated separately.

Answers were grouped into three categories, (i) those that focused on introducing computerisation (20.00%), (ii) those that made improvements in information management (5.00%), and (iii) those that involved a change in their information sources (75.00%).

A fifth of the respondents stated that they started using a computer as a way to improve their information management. One respondent stated that s/he focused on improving the data recording system, but most farmers employed advisers and/or improved their management skills as ways to improve their information management.

Table 4.25 Answers to the question "What new things, if any, have you done in the last 3 years to improve the information you have for making decisions?" (20 respondents)

	Percentage of respondents	
		Sub-totals
Computerisation		
Computer purchase/update/upgrate/use	20.00%	20.00%
Information management		
Improve recording	5.00%	5.00%
Information sources		
Employ farm consultant/specialist	45.00%	
Field days/seminars/training	30.00%	75.00%
Total		100.00%

4.2 Psychological test results

4.2.1 Farmers' goals

The interviewed farmers were asked to express whether they agree with a list of 29 goals using a 1 to 5 scale (1, meaning complete agreement, to 5, meaning totally disagreement). Most goals were taken from the Edinburgh farm objective scale (Willock et al, 1999). The form is presented in appendix A.3. Table 4.26 presents the results.

The analysis of each item can be enhanced by developing an index that scores "strong agreement" with 2, "moderate agreement" with 1, "neither agreement nor disagreement" with 0, "moderate disagreement" with –1, and "strong disagreement" with –2 and is summed across all the sample farmers. This data is presented in table 4.27.

As a group, the farmers showed strong agreement (average index value greater than 1.50) with statements 3, 7, 14, 15, 16, 18, 23, 24, 25, 26, and 27. Statements 7,14,24,25,26, and 27 could be related to success in farming. Statements 15, 16, and 18 are related to quality of life and family enjoyment. Statement 3 reflects farming status, and 23 is related to conservation awareness. However, both may also reflect aims for farming success.

Table 4.26 Edinburgh farm objective scale: percentage of farmers in each "ranking" category

Objective statement	Strongly agree	Moderatel y agree	Neither agree nor disagree	Moderately disagree	Strongly disagree	No response
1. It is important to pass the farm to a member of family	51.22%	17.07%	21.95%	2.44%	4.88%	2.44%
2. It is important to stay in farming whatever happens	48.78%	19.51%	12.20%	7.32%	9.76%	2.44%
3. It is important to have the respect of other farmers in the community	73.17%	9.76%	12.20%	0.00%	2.44%	2.44%
4. It is important to enter and win in shows	21.95%	17.07%	41.46%	2.44%	9.76%	7.32%
5. In adopting new ideas it is important to lead rather than follow.	17.07%	34.15%	14.63%	4.88%	24.39%	4.88%
6. Making a comfortable living is all that is important.	26.83%	17.07%	29.27%	14.63%	9.76%	2.44%
7. Being fully productive is important.	75.61%	12.20%	2.44%	0.00%	0.00%	9.76%
8. It is important to plan for retirement.	60.98%	12.20%	14.63%	2.44%	7.32%	2.44%
9. It is important to keep debt as low as possible.	70.73%	14.63%	4.88%	7.32%	0.00%	2.44%
10. Having interests outside of farming is important.	31.71%	17.07%	14.63%	7.32%	26.83%	2.44%
11. There is too much emphasis put on preventing pollution.	4.88%	4.88%	12.20%	4.88%	68.29%	4.88%
12. It is important to use chemicals sparingly.	51.22%	17.07%	24.39%	2.44%	2.44%	2.44%
13. Having a successfully diversified farm is important.	70.73%	7.32%	4.88%	7.32%	7.32%	2.44%
14. Improving the quality of the farm generally is important.	90.24%	7.32%	0.00%	0.00%	0.00%	2.44%
15. Improving the quality of my life is important.	87.80%	9.76%	0.00%	0.00%	0.00%	2.44%
16. Improving the living standards of family life is important.	90.24%	7.32%	0.00%	0.00%	0.00%	2.44%
17. It is important just to operate on a day to day basis.	7.32%	2.44%	12.20%	14.63%	60.98%	2.44%
18. It is important to spend time with the family.	90.24%	7.32%	0.00%	0.00%	0.00%	2.44%
19. It is important to plan for holidays off the farm.	63.41%	7.32%	17.07%	0.00%	9.76%	2.44%
20. It is important to minimise risk in farming.	58.54%	14.63%	12.20%	4.88%	7.32%	2.44%
21. It is important not to overproduce, on the farm.	41.46%	19.51%	14.63%	9.76%	9.76%	4.88%
22. It is important to encourage wildlife on the farm.	48.78%	19.51%	14.63%	4.88%	7.32%	4.88%
23. It is important to leave the land in as good a state as one received it.	78.05%	7.32%	4.88%	2.44%	4.88%	2.44%
24. Having up-to-date machinery/equipment is important	87.80%	4.88%	4.88%	0.00%	0.00%	2.44%

Table 4.26 (Cont.) Objective statement	Strongly agree	Moderately agree	Neither agree nor disagree	Moderately disagree	Strongly disagree	Non response
25. It is important to have the best possible livestock/pasture.	90.24%	4.88%	2.44%	0.00%	0.00%	2.44%
26. It is important to make the largest possible profit.	87.80%	7.32%	2.44%	0.00%	0.00%	2.44%
27. It is important to fully utilise all your resources.	75.61%	17.07%	2.44%	2.44%	0.00%	2.44%
28. It is important to increase the size of the farm.	51.22%	29.27%	14.63%	2.44%	0.00%	2.44%
29. Financial commitment should be taken over a long term.	63.41%	9.76%	19.51%	4.88%	0.00%	2.44%

With index values between 1.50 and 1.00 a second group reflects different ideas that can be associated with minimising the risk of the business, such as statements 9, 20 and 29. In this band of moderate agreement other statements reflect quality of life, such as statements 8, and 19; farming status such as statement 1, farming success in statement 28 and environmental awareness such as statements 12 and 11 (which was asked inverting the 1 to 5 scale).

Table 4.27 Edinburgh farm objective scale index –Average values (see text)

Objective statement	Index
1. It is important to pass the farm to a member of family	1.07
2. It is important to stay in farming whatever happens	0.90
3. It is important to have the respect of other farmers in the community	1.51
4. It is important to enter and win in shows	0.39
5. In adopting new ideas it is important to lead rather than follow.	0.15
6. Making a comfortable living is all that is important.	0.37
7. Being fully productive is important.	1.63
8. It is important to plan for retirement.	1.17
9. It is important to keep debt as low as possible.	1.49
10. Having interests outside of farming is important.	0.20
11. There is too much emphasis put on preventing pollution.	-1.27
12. It is important to use chemicals sparingly.	1.12
13. Having a successfully diversified farm is important.	1.27
14. Improving the quality of the farm generally is important.	1.88
15. Improving the quality of my life is important.	1.85
16. Improving the living standards of family life is important.	1.88
17. It is important just to operate on a day to day basis.	-1.20
18. It is important to spend time with the family.	1.88
19. It is important to plan for holidays off the farm.	1.15
20. It is important to minimise risk in farming.	1.12
21. It is important not to overproduce, on the farm.	0.73
22. It is important to encourage wildlife on the farm.	0.98
23. It is important to leave the land in as good a state as one received it.	1.51
24. Having up-to-date machinery/equipment is important	1.80
25. It is important to have the best possible livestock/pasture.	1.85
26. It is important to make the largest possible profit.	1.83
27. It is important to fully utilise all your resources.	1.66
28. It is important to increase the size of the farm.	1.29
29. Financial commitment should be taken over a long term.	1.32

The next step, index values between 1.00 and 0.50 (little agreement), has three statements, 2, 21, 22. The first is related to farming status and the other two are related to sustainable practices. Between 0.50 and –0.50, which means neither agreement nor disagreement, there are four statements, 4, 5, 6,and 10, which are again related to farming status, being innovative, life quality and having off-farm interests respectively. Finally, on the band of moderate disagreement, there is one statement related to management style –statement 17.

Due to the small number of farmers interviewed it was not possible to use principal component analysis to reduce the farmer goal data into a small number of underlying factors.

4.2.3 Farmers' personality traits

Many psychologists (see, for example, Matthews and Deary, 1998) believe a person's basic psyche is made up of two main factors –their intelligence level and their personality (though some believe motivation is also a basic trait). Thus, it is important to explore whether personality is related to information practices. It was not possible to include intelligence in this work.

Appendix A.4 shows the form used to collect personality trait data. The scale was developed following a psychological framework that defines human personality based on five main traits: openness, conscientiousness, extroversion, agreeableness and neuroticism (see Matthews and Deary (1998) for their definition). From the total 25 questions, there are five groups of five questions each one of which is theoretically associated with each trait. Appendix A.6 shows these five groups of questions.

Factor analysis was used to test both the number of basic personality traits and whether the relationships between the questions occurred as expected. This technique required 5 or more observations (farmers) for each variable considered (25 questions) (Hair et al, 1998). The interviewee sample has 86 observations (in some cases the personality test was answered by other family members, besides the farmer) provided enough observations to use factor analysis.

Table 4.28 shows the seven factors obtained from the factor analysis of the 86 responses collected through the survey. The method used was principal component analysis from the correlation matrix. Six questions were eliminated due to their low measures of sampling adequacy (Hair, 1998). These were questions 5, 6, 7, 17, 20 and 21. The criterion to determine the number of factors was to keep those with eigenvalues greater than one. Collectively, these seven factors explain 64% of the total variation, which is a significant amount. Loading values were obtained using a varimax rotation.

Table 4.28 Factor loadings of variables describing farmer's personality traits*

	F1	F2	F3	F4	F5	F6	F7
Q1	0.22	**0.80**	-0.09	-0.09	0.06	-0.12	0.14
Q2	-0.01	-0.14	-0.12	0.16	-0.04	**-0.75**	0.03
Q3	-0.13	0.04	0.04	**0.75**	0.13	-0.25	0.12
Q4	0.17	0.25	-0.01	0.37	-0.34	**0.46**	0.38
Q8	0.09	**0.41**	-0.05	**0.54**	0.25	0.01	-0.13
Q9	-0.06	0.09	0.18	0.29	**0.67**	0.13	-0.15
Q10	0.00	0.04	0.13	0.00	0.05	-0.08	**0.78**
Q11	0.14	0.02	**0.74**	-0.08	0.06	0.09	0.04
Q12	0.28	**0.63**	0.21	0.16	-0.18	0.13	0.09
Q13	-0.03	-0.08	-0.06	0.08	**0.78**	-0.13	0.09
Q14	-0.14	0.01	**0.73**	0.12	-0.02	-0.10	0.21
Q15	0.16	0.06	**0.74**	0.06	0.04	0.15	-0.13
Q16	0.24	-0.15	0.08	-0.29	**0.53**	0.29	0.30
Q18	**0.78**	-0.03	0.14	0.22	0.01	0.17	-0.09
Q19	**0.40**	-0.03	-0.16	-0.08	0.03	0.38	**0.49**
Q22	**-0.60**	-0.25	0.18	-0.01	0.21	**0.42**	-0.18
Q23	0.28	-0.19	0.09	**0.77**	-0.02	0.04	-0.09
Q24	-0.18	**0.62**	0.05	-0.02	-0.08	0.28	-0.16
Q25	**0.67**	0.34	0.22	-0.05	0.08	-0.02	0.17

Note: * see appendix A.3 for the questions Q1-Q25.

Factor 2 is closely aligned to one of the five theoretical personality traits. Factor 2 measures conscientiousness with the high loadings of questions 1, 8, 12 and 24, where the last three were originally developed to measure this trait, and question 1 can be rethought in this direction.

Factor 3 may measure openness with high loadings on questions 11, 14 and 15, where question 11 was developed to measure this trait, and the other two can be rethought in this direction. Similarly, Factor 4 may measure extroversion due to the high loadings on questions 3, 8 and 23, where question 23 was developed for this trait.

Factor 1 (questions 18, 19, 22, and 25) combines high loadings on questions that are related to management functions (19 and 25), staff/contractors control (22) and farmer organisation enjoyment (18). Relating the first two components it is possible to identify a trait that describes a style which emphasises the control function.

Factor 5 (questions 9, 13, and 16) describes farmers who admire financial logic (9), who worry about what other farmers think of their methods (13), and who feel pain when something well established needs to be changed (16). The last two questions were originally developed for measuring neuroticism.

Factor 6 (questions 2, 4, and 22) combines high loadings on question related to interpersonal relationships. This trait may describe a preference to interact with known persons (family members or staff), but they do not find it easy to communicate with strangers. This trait can be called "familiar style".

Finally, factor 7 describes farmers who think carefully and intensively about their decision making. This style can be called "precautionary".

Using the factor analysis results, seven new variables were developed, each one representing the above personality trait factors. Each variable receives the contributions of the 21 original question scores. The original questions that have higher loadings on each factor make the important contributions. The new variables have mean 0, and a variance equal to the squared multiple correlation between the estimated factor scores and the true factor values. The new variables may be correlated, even when the factors are orthogonal (SPSS 10.1, 1999).

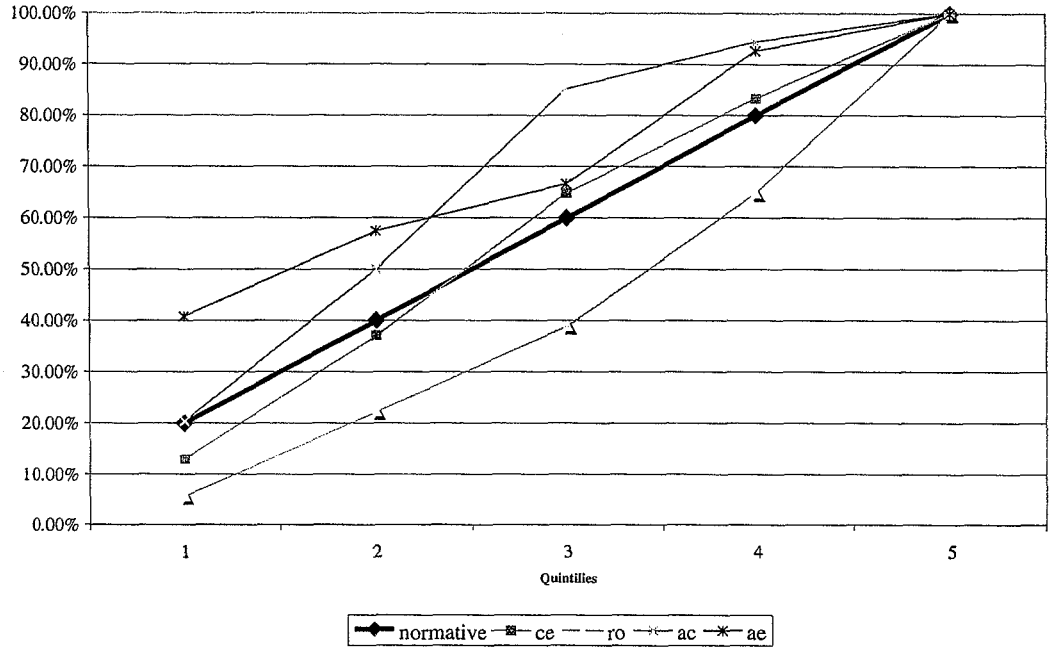
4.2.3 Farmers' learning styles

Measurements of farmer's learning styles were carried out using the well-recognised Kolb learning style inventory test (Kolb, 1984). The form used is shown in appendix A.5. For each interviewed farmer four learning (modes) dimensions were elicited, concrete experience (ce), reflective observation (ro), abstract conceptualisation (ac), and active experimentation (ae). These modes were described by Kolb as:

- Concrete experience: learning from specific experiences, relating to people, sensitivity to feelings and people.
- Reflective observation: careful observation before making judgements; viewing things from different perspectives, looking for the meaning of things.
- Abstract conceptualisation: logical analysis of ideas, systematic planning, acting on an intellectual understanding of a situation.
- Active experimentation: ability to get things done, risk taking, influencing people and events through acting.

These measurements are compared with standards provided by Kolb in figure 4.1.

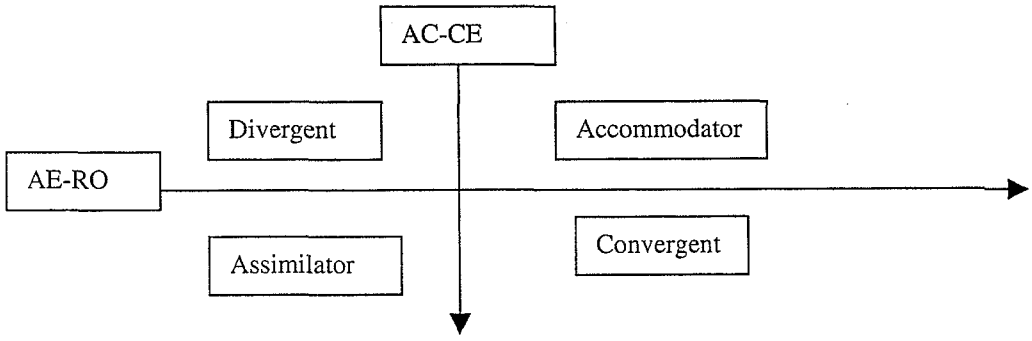
Figure 4.1 Kolb's learning modes of Florida dairy farmers



The comparison with the norm (developed from 1933 adults ranging from 18 to 60 years of age, Kolb, (1984)) shows that large percentages of Florida (Uruguay) farmers have higher values on one learning mode, reflective observation (ro). Conversely, it shows farmers having lower values on abstract conceptualisation (ac) and active experimentation. In the other learning mode, concrete experience, the contrast shows similar standard distribution values.

The four learning modes were combined into two scores that resulted from combining concrete experience and abstract conceptualisation (ac-ce), and combining reflective observation and active experimentation (ae-ro). Parameter (ac-ce) measures to what extent a person emphasises abstractness over concreteness while parameter (ae-ro) measures the relative "action over reflection" emphasis. By combining both parameters, a two-dimension space is developed and four learning styles are defined: (a) convergent, which emphasises abstract conceptualisation and active experimentation; (b) divergent, which emphasises concrete experience and reflective observation; (c) assimilation, which emphasises abstract conceptualisation and reflective observation; and (d) accommodative, which emphasises concrete experience and active experimentation.

This situation can be portrayed through the following diagram:



The 61 interviewed farmers were categorised into their corresponding learning styles as shown in Table 4.29. The percentage distribution differed from standard norm (chi-square test= 8.55, p<5%). Among Florida farmers it seems to be larger percentages of assimilator and divergent learning styles and a smaller percentage of convergent learning style than in the Kolb norm.

Table 4.29 Interviewed farmers' learning styles

Learning style	Interviewed farmers
Accommodator	24.49%
Assimilator	32.65%
Convergent	8.16%
Divergent	34.69%

4.3 Interview results

4.3.1 The interview procedure

The interviews were performed on the farms and took, on average, 2 hours. Two guidelines were developed, one for farmers who are users of computerised systems, and another for the rest.

Once the research objectives were introduced, farmers were asked to list 3 to 5 areas that they closely control as they regard them as very important to the success of the business. With respect to each of these areas, farmers were asked to state how frequently they updated information, how they processed this information, and how they recognised they were facing a problem and how it was dealt with. This part of the interview was designed to assess farmer information management skills.

Farmers who were using computerised information systems were asked to evaluate the overall usefulness of each software package used, using a simple scale from 1, unsuccessful, to 5, highly successful.

One or two software packages were then selected (when the farmer used more than one) to talk about the advantages and disadvantages of their use. This started by asking the farmer which were the usual information management functions that were carried out with the selected software. The farmer was also invited to make a comparison with the pre-computer procedures used to record and analyse the data. At this stage, s/he was asked to summarise the advantages of using the computerised system relative to the original methods.

Some respondents identified economic benefits as a direct reason for adopting computerised systems. If this was not the case, the farmer was invited to make a cost-benefit analysis of her/his decision to use the software.

Finally the interviewees were asked to rank the software using two scales. One related to how well the software meshed with the work environment and the second related to how well the software matched with the farmer's decision making system.

Farmers who were not using computerised information systems were asked to explain their decision for non-use. Some stated that they are going to use a computer soon, others not. The first group was asked to explain their reasons for supporting the proposed change.

The data was collected using forms, a notebook and a recorder. There were technical problems in recording one interview. Total reliance on the notes was necessary in this case.

Data from interviews will be presented later as qualitative analysis results (section 5.2).

5. Analysis results

This research is concerned with farmer use of computers and computerised information systems (CIS) to manage farm information. According to the data collected, as noted earlier 26.83% of the farmers have a farm computer and 17.07% use at least one kind of computerised information system.

It will be recalled that farmers' information systems were divided into three areas: finance, feed and pasture, and livestock. None of the survey farmers were using Feed-CIS, 4.88% were using Finance-CIS, and 14.63% were using Livestock-CIS. Only 2.44% of respondents were using computerised information systems in more than one area.

While it is necessary to own a computer to use any CIS, the reverse it is not true. Almost 10% have computers but they use non-computerised systems for their information management.

In order to investigate which circumstances promote or delay on-farm software use four classes of variables were collected from the farmers surveyed. These are variables related to the farm, variables that reflect farmers' characteristic, variables that describe management styles and farmers' opinion about software use. The first three classes are suitable for quantitative analysis, involving both a explorative one-to-one analysis technique, and a regression analysis attempting to quantify the relationships. Due to the large number of potential explanatory variables, once these were identified, a data reduction technique was employed to simplify the variable numbers using principal component analysis.

Farmers' opinions (qualitative data) were processed by developing different farmers groups, such as those using software, those expressing their willingness to use, and those not considering this possibility.

Collected data will be also used to test the research hypotheses and to develop two behavioural models, one representing farmers using software, and another representing farmers considering using CIS.

5.1 Quantitative analysis

5.1.1 Factors associated with farmers' computer uptake and computerised information system (CIS) use: simple one-to-one relationships

The analysis of the relationship between computer ownership, CIS use and farmer related factors was carried out using the random sample (41 farmers) and data from 20 additional farmers selected to increase the number of CIS users.

5.1.1.1 Herd size, computer uptake and CIS use

Table 5.1 presents the relationship between the size of the herd (as a farm size measure), farmer computer adoption, and the use of at least one CIS. There is a clear association between these variables, the larger the herd the higher the percentage of computer uptake, and the higher the percentage of CIS use.

There are at least two possible explanations that support this positive association between herd size and CIS use. Firstly, the extra income from using computer technology increases with the scale of the dairy operation, particularly where the technology is not easily divisible, as is the case with computer and software. This fact may be related to the second explanation that there is a minimum critical time input needed to take advantage of a computer system. Large farms may have farmers more management oriented and therefore prepared to devote time to computer use (see section 5.1.1.5).

Table 5.1 Herd size , computer ownership and CIS use

Herd size (cows)	% with computer*	% that use at least one CIS**
Less than 60	11.11%	0.00%
60-119	15.38%	15.38%
120-179	35.71%	28.57%
180-239	50.00%	50.00%
240-359	62.50%	37.50%
More than 359	76.92%	69.23%

*t-test=-3.790, p=0.1%; **t-test=-3.418, p=0.2%

5.1.1.2 Farmer age, computer uptake and CIS use

For analysis purposes the farmers' ages were grouped into seven classes. The next table shows the age classes, the number of farmers that each includes and the percentage over the total in the expanded sample (non random).

Table 5.2 Farmers' age distribution

Farmer's age (years)	Average age (years)	Number of farmers	Percentage
Less than 30		0	0%
Between 30 to 34	32	3	4.92%
Between 35 to 39	38	9	14.75%
Between 40 to 44	43	6	9.84%
Between 45 to 49	47	11	18.03%
Between 50 to 59	54	24	39.34%
More than 59	63	8	13.11%
Total		61	100.00%

Table 5.3 shows the relationship between the farmer's age, computer uptake and CIS use.

Table 5.3 Farmers' age, computer uptake and CIS use

Farmer's age (years)	% with computer	% that use at least one CIS*
Less than 30	0.00%	0.00%
Between 30 to 34	33.33%	33.33%
Between 35 to 39	66.67%	66.67%
Between 40 to 44	16.67%	16.67%
Between 45 to 49	45.45%	27.27%
Between 50 to 59	41.67%	29.17%
More than 59	25.00%	25.00%

There is neither a relationship between farmer age and computer ownership, nor between farmer age and CIS. The t-tests were not significant.

5.1.1.3 Education, computer uptake and CIS use

As was discussed earlier, there is no relationship between farmer age and education (see section 4.1.4). The next table presents the relationship between farmer age classes and education levels in the expanded sample (non random). An independence test also shows the lack of a relationship.

Table 5.4 Age and education

	Education level (percentage within each age class)					
Farmer age (years)	Primary or less	Secondary <=4yrs	Secondary >4yrs	Tertiary <=2yrs	Tertiary >2yrs	Total
Less than 30	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Between 30 to 34	33.33%	0.00%	33.33%	0.00%	33.33%	100.00%
Between 35 to 39	22.22%	33.33%	11.11%	0.00%	33.33%	100.00%
Between 40 to 44	50.00%	0.00%	33.33%	0.00%	16.67%	100.00%
Between 45 to 49	36.36%	18.18%	9.09%	9.09%	27.27%	100.00%
Between 50 to 59	41.67%	29.17%	12.50%	4.17%	12.50%	100.00%
More than 59	87.50%	12.50%	0.00%	0.00%	0.00%	100.00%
Total of each education level	44.26%	21.31%	13.11%	3.28%	18.03%	100.00%

Chi-square=18.252, p=57.1%

The next table shows the relationship between farmer education and computer uptake and CIS use. Education shows a strong relationship with computer ownership, and with CIS use.

Table 5.5 Farmer education, computer uptake and CIS use

Education level	% with computer* (farmer)	% that use at least one CIS (farmer)**
Primary or less	22.22%	18.52%
Secondary. Equal or less than 4 years	38.46%	30.77%
Secondary. More than 4 years	37.50%	25.00%
Tertiary. Equal or less than 2 years	50.00%	0.00%
Tertiary. More than 2 years	90.91%	81.82%

*Mann-Whitney U-test=-3.440 p=0.1%;**Mann-Whitney U-test=-2.906 p=0.4%,

Education, especially tertiary education, reduces the knowledge gap that may exist between farmers and information technology developers. Educated farmers may tend to see and think about their farm management problems and their solutions in a similar way to scientists and CIS developers.

5.1.1.4 Involvement of non-family people, computer ownership and CIS use

5.1.1.4.1 Adviser

The next table shows the relationship between adviser involvement, computer uptake and CIS use.

Table 5.6 Adviser involvement, computer ownership and CIS use

Adviser involvement	% with computer	% that use at least one CIS
0-No involvement	25.00%	15.00%
1-A little	11.11%	0.00%
2-Quite a lot	44.44%	44.44%
3-Heavy involvement	33.33%	0.00%

Adviser involvement is not related with both computer ownership and CIS use.
Both Mann-Whitney U-tests were not significant.

5.1.1.5 Management work, computer use and CIS use

Both variables used to measure management work (percentage of total work and weekly hours) showed strong relationships with computer ownership and CIS use. The results are shown in table 5.7. Compared to non-computer users, computer owners and CIS users assigned more time to management activities.

Table 5.7 Management work, computer ownership and CIS use

	Computer owners	Non-computer owners	CIS users	CIS non-users
Percentage of total work assigned to management	48.4%a	20.83%	48%c	24.39%
Hours per week assigned to management	17.52b	7.49	19.15d	7.91

(a): t-test=-4.415, p<0.1%; (b): t-test=-3.270, p=0.2%; (c): t-test=-3.618, p=0.1%; (d): t-test=-3.179, p=0.4%.

Pearson correlation coefficients show that there are strong positive associations between both measures of management work (r=0.717, p<0.1%), and with the size of the herd (percentage of total work assigned to management-herd size r=0.435, p<0.1%; and hours per week assigned to management-herd size r=0.676, p<0.1%). The bigger the farm the more requirement for management attention.

5.1.1.6 Information sources, computer ownership and CIS use

From the 9 sources of information, only 2 had statistically significant (Mann-Whitney U-tests) relationships with computer ownership. These were Breed journals (MWU-test= -1.907, p=5.7%) and electronic news (MWU-test=-3.055, p=0.2%). With CIS use only this last source of information, electronic news (MWU-test=-4.371, p<0.1%), was significant.

5.1.1.7 Goals, computer ownership and CIS use

Farmers owning computers showed differences (statistically significant) in goal statements 4, 9, 12, 14, 24 and 28 compared to farmers not owning computers (MWU-test=-2.959, p=0.3%; MWU-test=-1.798, p=7.2%; MWU-test=-1.651, p=9.9%; MWU-test=-2.573, p=1%; MWU-test=-2.386, p=1.7%; MWU-test=-2.079, p=3.8% respectively). Goal statements 14, 24 and 28 are related to farming success, goal 4 with farming status, and goals 9 and 14 referred to risk and environmental management.

Relative to non-users, farmers using a CIS showed differences (statistically significant) in goals 4, 9, 11 (disagreement), 14, 24 and 25 (MWU-test=-2.512, p=1.2%; MWU-test=-1.696, p=9%; MWU-test=-2.260, p=2.4%; MWU-test=-3.070, p=0.2%; MWU-test=-2.961, p=0.3%; MWU-test=-1.789, p=7.4% respectively). The results are quite similar to those shown by computer owners.

5.1.1.8 Personality traits, computer ownership and CIS use

Both computer owners and software users showed differences in personality (factor) traits 1, 6 and 7. While factor 1 describes a management style that put emphasis on control, factor 6 describes another management style that shows preference to "familiar" relationships, and factor 7 shows emphasis on precautionary thinking. Farmers who neither own computers, nor use on-farm software show these personality traits more strongly compared to owners (Owners against non-owners factor 1: t-test= -3.728, p<0.1%; factor 6: t-test= -2.720, p=0.9%; factor 7: t-test= -1.903, p=6.3%, and CIS-users against non-CIS-users factor 1: t-test= -2.650, p=1.1%; factor 6: t-test= -1.807, p=7.7%; factor 7: t-test= -1.457, p=15.1%).

5.1.1.9 Learning modes, computer ownership and CIS use

Both computer owners and software users showed differences in abstract conceptualisation and in active experimentation learning modes. Both farmers owning computers or using software have a strong abstract learning mode while show weaknesses in using an experimental learning mode, compared with those not owning computers or not using software (Owners against non-owners abstract conceptualisation: t-test= -1.963, p=5.5%; active experimentation: t-test= 1.618, p=11.2%, and CIS-users against non-CIS-users abstract conceptualisation: t-test= -3.056, p=0.4%; active experimentation: t-test= 1.530, p=13.2%).

5.1.2 Computer uptake and CIS use: a summary of one-to-one relationships

Table 5.8 summarises the statistical results. There are 18 variables related to computer uptake and 17 variables related to CIS use. The two groups of variables are almost the same. This comes from the fact that it is necessary to earlier have a computer to use farm management software, but it was noted earlier there are approximately 10% of farmers who owned computers but did not use them for managing farm information.

Computer uptake and CIS use are more likely on large farms (large herd and large effective area), and it seems to be related to farmers' education (positively), disagreement in entering and winning in shows, keeping debts as low as possible, having less concern about environmental issues, and believing "improving the quality of the farm and its resources" as not being important. In addition, farmers who spend more time doing office work, and obtain

information from breed journals and electronic news, are more likely to own a computer and use farm management software.

Focussing on CIS use, factor analysis was used to simplify the number of variables related to on-farm software use and to start understanding the intra-relationships. The original list of 17 variables (table 4.8) was reduced by removing off the "use of electronic news" (which is more a consequence of having a computer than a cause), and reducing the number of clearly related variables, such as herd size and area, and management work and office time. This gives a reduced group of 14 variables.

Because factor analysis requires at least 5 observations per variable (Hair et al, 1999), data from the 61 farmers was used. This analysis shows the degree of linear correlation among variables which allows identifying a set of underlying factors. These factors are unobserved variables that are highly correlated with the observed ones. The method used to perform factor analysis was principal component analysis from the correlation matrix. The criterion to determine the number of factors was those with eigenvalues greater than one. The analysis identified four factors once goal 11 was eliminated because of its low measures of sampling adequacy (Hair et al, 1999). These four factors collectively explain 61.7% of the cumulative variance. Table 5.9 presents the factor loadings of each variable within each factor after the original factors were rotated using the varimax rotation method.

Table 5.8 Statistical test values for factors affecting computer uptake and CIS use

	Computer uptake	Computerised information system use
Farm		
Herd size	-3.790 (t-test) p=0.1%	-3.418 (t-test) p=0.2%
Effective area	-4.667 (t-test) p<0.1%	-3.866 (t-test) p<0.1%
Tenancy	+	
Farmer		
Age	+	
Education	-3.440 (M-W-test) p=0.1%	-2.906 (M-W-test) p=0.4%
Goals	It is important to enter and win in shows, -2.959 (M-W-test) p=0.3% It is important to keep debt as low as possible, -1.798 (M-W-test) p=7.2% It is important to use chemicals sparingly, -1.651 (M-W-test) p=9.9% Improving the quality of the farm generally is important, -2.573 (M-W-test) p=1% Having up-to-date machinery/equipment is important, -2.386 (M-W-test) p=1.7% It is important to increase the size of the farm, -2.079 (M-W-test) p=3.8%	It is important to enter and win in shows, -2.512 (M-W-test) p=1.2% It is important to keep debt as low as possible, -1.696 (M-W-test) p=9% There is too much emphasis put on preventing pollution, -2.260 (M-W-test) p=2.4% Improving the quality of the farm generally is important, -3.070 (M-W-test) p=0.2% Having up-to-date machinery/equipment is important, -2.961 (M-W-test) p=0.3% It is important to have the best possible livestock/pasture, -1.789 (M-W-test) p=7.4%

Table 5.8 cont.		
Personality traits	Factor 1 Controlling management style -3.728 (t-test) p<0.1% Factor 6 Familiar management style -2.720(t-test) p=0.9% Factor 7 Precautionary -1.903(t-test) p=6.3%	Factor 1 Controlling management style -2.650 (t-test) p=1.1% Factor 6 Familiar management style -1.807 (t-test) p=7.7% Factor 7 Precautionary -1.457 (t-test) p=15.1%
Learning modes	Abstract conceptualisation -1.963 (t-test) p=5.5% Active experimentation 1.618 (t-test) p=11.2%	Abstract conceptualisation -3.056 (t-test) p=0.4% Active experimentation 1.530 (t-test) p=13.2%
Time dairy farming	+	
Management		
Management team structure	+	
Adviser involvement	+	
Management work	-4.415 (t-test), p<0.1%	-3.618 (t-test), p=0.1%
Office time	-3.270 (t-test), p=0.2%	-3.179 (t-test) p=0.4%
Information sources	Breed journal: -1.907 (M-W-test) p=5.7% Electronic news -3.055 (M-W-test) p=0.2%	Electronic news -4.371 (M-W-test) p<0.1%

+ a blank cell represents a non significant relationship

Table 5.9 Factor loadings of variables describing farmers' characteristics associated with CIS use

	1	2	3	4
Abstract conceptualisation	0.20	**0.64**	0.27	-0.06
Active experimentation	-0.30	**-0.61**	-0.30	0.06
It is important to enter and win in shows (goal 4).	**0.59**	0.24	0.04	**0.56**
It is important to keep debt as low as possible (goal 9).	**0.56**	0.07	-0.01	0.01
Improving the quality of the farm generally is important (goal 14).	0.13	**0.54**	0.09	**0.46**
Having up-to-date machinery/equipment is important (goal 24).	0.14	**0.80**	-0.17	0.14
It is important to have the best possible livestock/pasture (goal 25).	-0.08	**0.65**	-0.23	0.07
Herd size (head)	0.02	-0.09	**0.87**	0.14
Education	**0.77**	0.18	0.15	0.27
Factor 1 Controlling management style	**0.83**	0.15	-0.04	0.02
Factor 6 Familiar management style	**0.55**	0.01	0.07	-0.13
Factor 7 Precautionary	-0.07	0.00	0.17	**0.89**
Office time (hours)	0.06	0.09	**0.90**	0.09

Factor 3 could be called "farm size". Herd size and office work show high loadings in this factor. As the farms increase their sizes, farmers need to spend a larger percentage of their time doing management and office work.

The other 3 factors show a more complex pattern resulting from the combination of farmers' goals, personality traits, learning modes and education.

Factor 1 combines high loadings on education, personality traits 1 and 6 and farmers opinions about goals 4 and 9. More educated farmers seem to worry less about exercising a "controlling and familiar relationship" management style, and show disagreement with taking part in shows and keeping debts lower. Factor 2 combines both learning modes and goals related to farm and farm resource improvement. Farmers who show an emphasis on using an abstract conceptualisation learning mode, in opposition to active experimentation, worry less about improving farm and farm resources. Finally, factor 4 combines goals 4 and 14 and personality trait 7. Farmers who worry less about behaving with precaution, show disagreement with taking part in shows and making improvement in the quality of the farm.

5.1.3 Regression analysis

The above analysis identified a set of variables which are related to farm information management systems. Each variable was tested separately and the relationships among them idenfied using factor analysis. However specific relationships with computerised system use was not quantified. This was obtained using a logistic regression analysis on these variables. The criteria for including variables in the equation were statistical significance and the factor analysis results. From the factor analysis four variables were identified. One alternative was to use factor scores as new variables. However, this alternative has the problem that these new variables are non-observable (underlying factors). Another alternative was to choose for each factor a meaningful variable-representative. Using this second approach, education, herd size, abstract conceptualisation (AC) and goal 14[8] ranking were selected to represent these four variables. Table 5.10 presents regression results.

The equation enables predicting the probability of using a computerised system relative to the probability of non use. Equations 1 and 2 show this relationship.

Equation 1:

$$\ln\left(\frac{\Pr ob(CIS)}{1-\Pr ob(CIS)}\right) = -11.443 + 0.756 Education + 0.008 Herdsize + 0.297 AC + 1.885 Goal14$$

Equation 2:

$$\Pr ob(CIS) = \frac{Exp(-11.443 + 0.756 Education + 0.008 Herdsize + 0.297 AC + 1.885 Goal14)}{1 + Exp(-11.443 + 0.756 Education + 0.008 Herdsize + 0.297 AC + 1.885 Goal14)}$$

Equation note: AC means abstract conceptualisation score.

[8] Goal 14 was selected due to the better estimation that it produced in contrast to personality trait 7 and goal 4.

Table 5.10 Logistic regression for predicting the use of any computerised information system (61 farmer sample)

Variables in the Equation		B	Statistical significance	Exp(B)
Education (score)		0.756	1.04%	2.13
Abstract conceptualisation (score)		0.297	13.04%	1.35
Herd size (cows)		0.008	0.79%	1.01
Improving the quality of the farm generally is important (score).		1.885	16.68%	6.59
Constant		-11.443	0.19%	0.00
Classification Table		Predicted		
		Dependent variable		Percentage Correct
Observed		0	1	
Dependent variable	0	31	2	94%
	1	4	16	80%
Overall Percentage				89%

Using equation 2 and assigning values to the independent variables it is possible to visualise the quantitative effect over the dependent variable. Such an exercise is shown in table 5.11.

It is clear that herd size has the greatest influence on the likelihood of using a computerised system, followed by the level of education. However, farmers' learning modes (abstract conceptualisation) and objectives (goal 14) also make a contribution to explain farmers' software adoption. Although no personality trait was included in the equation, these variables are also related with those included.

5.2 Qualitative analysis

Qualitative analysis was performed using the interview transcriptions. In the random sample, from the 41 farmers interviewed, 7 (17.1%) were using computerised systems, and 34 were non users when the interview took place. Within this last group, farmers were split in two categories; those who were thinking of using computerised systems, and those who were not. Each group had 22 (53.7%) and 12 (29.3%) farmers respectively.

Data provided by the random sample was complemented with data from the additional 20 (non-randomly selected) farmers. This group had 13 computer users, five who were thinking of using computerised systems, and two who were not.

Table 5.11 Some probabilities of using a computerised system predicted from the logistic equation 2

Education	Herd size (head)	Abstract conceptua-lisation	Improving the quality of the farm generally is important.	Probability
1	144*	15.88*	1.08*	6.03%
2	144	15.88	1.08	12.02%
3	144	15.88	1.08	22.53%
4	144	15.88	1.08	38.24%
5	144	15.88	1.08	56.86%
2.03*	32	15.88	1.08	5.28%
2.03	100	15.88	1.08	8.88%
2.03	144	15.88	1.08	12.26%
2.03	300	15.88	1.08	33.46%
2.03	460	15.88	1.08	65.15%
2.03	144	10	1.08	2.37%
2.03	144	13	1.08	5.60%
2.03	144	16	1.08	12.65%
2.03	144	18	1.08	20.80%
2.03	144	20	1.08	32.25%
2.03	144	15.88	1	10.73%
2.03	144	15.88	1.2	14.91%
2.03	144	15.88	1.4	20.35%
2.03	144	15.88	1.6	27.14%
2.03	144	15.88	2	44.20%

Notes: * random sample average for each variable.

Thus 3 categories of farmers were used to answer the following questions:

Why have they changed to a computerised system?
Why have they not changed to a computerised system but are thinking of doing so?
Why are they not intending to change?

5.2.1 Responses from farmers who were using computerised information systems

From the 20 farmers of this group (7 from the random sample plus 13 from the non-random group), 17 were using a computerised system for managing their livestock information. From these, 9 were also using software in the finance area, and only 3 were also managing their pasture and feed information through computers. From the 3 remaining, 2 were using a computerised system in the pasture and feed area, and one for finance information (see table 5.12).

Table 5.12 Types of information systems used by computerised farmers

Livestock	Finance	Pasture and feed	Number of farmers
Computerised	Computerised	Computerised	3
Computerised	Computerised	Not computerised	6
Computerised	Not computerised	Not computerised	8
Not computerised	Not computerised	Computerised	2
Not computerised	Computerised	Not computerised	1

In total, 16 farmers talked about livestock software, 9 about finance software and 4 made comments related to feed and pasture software. Several farmers provided information for more than one package. Interviewed farmers were using several commercial packages in all information areas as well as spread sheets.

5.2.1.1 Computerised financial information system users

Six of the nine farmers who were using software to manage financial information had changed from a non computerised procedure, which was mainly manual. These farmers provided two main explanations for this change. Firstly, they stated that by using a computerised procedure they achieved a more structured (organised) information management. Two advantages of computerised systems were repetitively identified, data availability and data retrieval. One farmer explained *"That is because someone can keep all the financial records, every expenditure, every income. And as I told you, from the package we get, we can get, everything detailed, every enterprise can be taken separately. So we have every data. It is important to have it updated, on a day-to-day basis. And then, as I told you, there (by using the package) is where someone realises on what items the expenses were made."*

The second advantage refers to management procedures. Computerised systems allow farmers to improve their management methods and decision making. One farmer stated *"For having better data management, and knowing the (farm) results. And by keeping records, we want to see the business results, since we never measure them, and the only way to have a measurement is by using the package. Additionally, since the other members of the Crea*[9] *farmer group also use the package, we meet, and we make comparisons between each other, so we can identify what are our weaknesses and our strengths, and then, we can take ideas and practices that have been successful on other farms into ours (farm). The package is a great tool for this purpose".*

5.2.1.2 Computerised livestock information system users

Fifteen of the seventeen farmers that were using software to manage livestock information had changed from a non computerised procedure, 12 from manual and 3 from service procedures. These farmers have supported their decisions with three main reasons. Two reasons are similar to those provided by farmers adopting financial software, that is being able use a more structured information system, and achieving better management. The third reason was a time saving.

[9] Uruguayan farmer organisation that promotes discussion group methodology among its members.

Farmers highlighted that by using a computerised procedure they were able to operate a more structured and organised information system. Three advantages of computerised systems were repetitively identified, data availability, data retrieval, and error control. One farmer stated *"if you want to retrieve any data it is easy to do it from there (the computer), and it is easy to identify any error such as having used twice an identification number"*. Another added *"when I enter a wrong date or any wrong data, the machine (the package) immediately displays an error message, preventing me entering the incorrect data"*. Finally, a third farmer noted the impact of herd size, *"before using the software, I managed 100 cows. Now I am managing 400 cows, so the amount of paper has increased four times, it would be hard and difficult to operate a manual system"*.

Several examples were also provided to illustrate the possibility of improving decision making. One farmer stated *"related to the important decision, it (the package) has the criteria that I have defined, (such as) bringing back the cows that are yielding less that certain production per month, those that have been pregnant a certain time, and those that have a certain lactation time. Then, when I do the herd testing, I enter these data, and I ask for a cow list, and based on this I am able to decide about each cow, whether I keep it or I take off from the herd. What cow should be mated, what cow should be culled"*. Another farmer said *"this (the package) makes the work easier, once you have entered the data, since every day you have to pay attention to something, such as knowing which cows are going to calve in a two months period, and should be dried off, making culling decisions, when the vet comes to check the herd, entering the mating, the calving, making selection decisions. Your work is easier because everything is in the package, and in minutes you have the data wanted"*. A third farmer noted *"I use the package for organising the herd information related to livestock management, specially focusing on reproduction management. I also use it for genetic improvement, such as bull selection and culling decisions. It also supports the drying off decisions"*.

The time saving was also clearly reflected in the farmers' opinions. One farmer said *"it (the package) gives you back complete information, the data is easily available; before you needed to work lots of hours with the books to be able to retrieve some data and now you just press a button and you have all the data that you want, (for example) you have a list of the cows that are going to calve soon. Before (using the computerised system) you needed to do everything manually, and now we have an important tool. We are using it (the package) very little, but we have the updated information, we try always to have updated records"*. Another stated *"if I want to know, if I had a certain pregnancy rate, what was wrong, which category had failed, and then based on this knowledge, how can I improve the performance, without needing to look at each individual record. And there is also the objective of saving time, since manual indexes are too time consuming to calculate. And you can easily break down the information, without needing to look up each individual cow record, forming age groups on a manual basis, look at certain categories on a record-to record base, this takes too much time"*.

5.2.1.3 Computerised pasture and feed information system users

Farmers stated that they were using nutritional software to improve feed management. One farmer stated that the software helps him to *"look for cheaper dry matter feed-stuffs and its nutritional components. And trying to select those feed-stuffs with higher starch content, or those that are better according to the season or the pasture state. Trying to find the best complement to the pasture"*. Similarly, another farmer said *"... the software helps us to*

adjust, to adjust closer. Someone can make a coarse adjustment, but for a fine adjustment you need the computer. In the computer you can also easily change things. Besides this, I can make projections, to see what I could obtain if I used more concentrate, or if I used other feed-stuffs, or if the milk price was higher".

5.2.2 Farmers who have not used computerised information systems

This group represented the vast majority (83%) of the dairy farmers in the random sample. However, almost two thirds of them were considering using computer technology to improve their information management.

5.2.2.1 Farmers considering the use of computerised information systems

This group had 27 farmers, with 4 owning computers for non-business from both the random sample and purposely selected groups. These farmers had a positive feeling about computer technology and they provided different reasons for not having yet adopted computerised farm information systems. Three were the typical explanations. Almost half stated that they needed more information/knowledge and/or training before making a decision. A quarter of these farmers explained that the lack of time was the key factor delaying the adoption of CIS. The remaining farmers focused on other priorities rather than introducing the use of computers.

At the same time that the survey was carried out, CONAPROLE was asking its farmers to express their intentions on purchasing computers. The dairy cooperative's idea in promoting computer and communication technology among its dairy suppliers, was to negotiate lower computer prices through volume sales. Within the 22 farmer group (random sample), 12 had expressed an interest, while only 4 stated they were not interested.

Seven farmers belonging to this group clearly stated that they would not be the computer operators. In almost all these cases the computers would be operated by the farmer's offspring meaning the computer technology would be a catalyst in involving family members in the dairy business.

5.2.2.2 Farmers who are not considering the use of computerised information systems

This group had 12 farmers, 2 of them owning computers, plus two other farmers from the non-random sample. These farmers provided four groups of responses to support their decision of not adopting computerised systems.

Firstly, some farmers were facing a near bankruptcy financial situation due to an extreme drought and severe drop in 1999-2000 season farm milk prices (see appendix A.1). This situation involved 5 farmers, more than 10% of the random sample. These farmers, though still operating their farms, were considering neither new investments, nor any use of non-essential expenditure.

The second reason was that farmers considered computerised systems a very low priority level investment. Farmers provided three explanations to support this viewpoint. Some farmers stated that there were other investments or business aspects that more urgently

required the farmer's financial resources and attention, while others said that their current information (non-computerised) systems were working well. The others considered that the impact of computerisation was expected to be small due to the small size of the business, and/or the need to develop computer operation skills.

The third explanation came from farmers who did not have children or those that were not interested in continuing the family farm business.

Finally, there were two farmers in the random sample who were selling the business.

5.3 Analysis of the research hypotheses

5.3.1 Adoption of computerised systems

The group of non-users provides data to directly assess the first set of three hypotheses related to computerised systems adoption.

5.3.1.1 The knowledge gap

The farmer's "knowledge gap" was measured using two approaches. The first uses the level of formal education received by the farmer, as education is one of the main developers of knowledge, and effectively reduces people's relative "knowledge gap". However, computer information technology only started to become a common part of school environments by the nineties, whereas in universities this was in the second half of the eighties. It is possible to have a well-educated farmer who finished her/his formal education at the beginning of the eighties without having any exposure to computer technology. As was above shown (see sections 5.1.1.3 and 5.1.3) formal education is a major "cause" in explaining farmer CIS use.

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

Non-users were split in two subgroups according to their willingness to use software in the future. Seven cases of the twelve non-computerised farmers fall into the group of people who think information management can not be helped with computer technology (a large "knowledge gap" relative to software developers who clearly believe a computer system will be useful). Two of these farmers were leaving the dairy business, while the remaining farmers noted that they were happy with their current information systems, and because of this, they did not think that using a computer was going to make a difference.

5.3.1.2 Perception of economic benefits

Farmers' perception of the economic benefits of using computerised systems was discussed at the interviews. Both groups of farmers, users and non-users, were asked to explain the reasons behind their decisions. Users were asked to describe what were the advantages and disadvantages of a specific piece of software which had been previously identified. Non-

users, after asking them if they had information about farm computerised systems, were asked to explain why they were not using the technology. After the respondents had given two or three arguments, if the economic issue had not been mentioned, directly or indirectly, an explicit question addressing this matter was brought up. The respondent was invited to make a hypothetical comparison between the costs (computer and software purchasing, training and time cost) and the benefits (whatever that the farmer considered might be possible) of using the computer technology.

Two non-users who were not considering using a computer expressed their belief that they would not recover the investment on computer technology, while five stated their uncertainty about the economic rewards from the use of software. The other five did not give their opinions.

The perceptions of non-users who were currently considering the use of a computer were more positive. From 22, only seven farmers were doubtful.

Almost all users (18 in 20) have a positive perception of the economic benefits. Some perceptions were extremely concrete, others were more vague, and were usually associated with the possibility of saving working time.

5.3.1.3 Skill levels

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

Only one of the twelve farmers who were non-users not considering using computerised systems stated that s/he had computer operational skills. In the second group, farmers considering CIS use, 9 stated that they had some operational skills, while eleven recognised their lack of PC skills.

Farmer information management skills were evaluated through a specific question. Before the interviewees were asked about software advantages or disadvantages, or reasons for not using software to manage their farm information, everyone was asked to identify five main areas that they controlled very closely as they believed these were essential for the success of the whole operation. The farmers were asked to state how frequently they updated information, how they processed the information, how they usually recognised a problem in this area, and how they dealt with such a problem. The form used to record the answers is given below.

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

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

Farmers may use different approaches to find usable solutions. For each farmer the most effective approach is one that produced a feasible solution, given farmer capabilities and farm circumstances. There is not a standard best approach. However, some approaches could be more compatible with computerised system use than others. Table 5.13 presents a farmer's information management skill scale.

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

Using the above farmer's information management skill scale each control area answer was processed and each interviewed farmer given an information management skill score for each of problem definition and solution search, data collection and processing, and problem recognition (see table 5.13 for scale definition).

Table 5.13 Farmer's information management skill scale

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

Table 5.14 Group average values for information management skills in the random sample

	Problem definition and solution search	Data collection and processing	Problem recognition-control system
Non users (not thinking of using)	1.99	1.18	1.04
Non users (thinking of using)	2.11a	1.52a	1.37a
Users	2.19b	2.12bc	1.60b

Problem definition and solution search: a) statistically significant difference (SSD) between non-users (not thinking of using) and non-users (thinking of using), t-test= -2.476, p=1.9%; b) SSD between non-users (not thinking of using) and users, t-test= -3.733, p=0.2%.
Data collection and processing: a) SSD between non-users (not thinking of using) and non-users (thinking of using), t-test= -2.670, p=1.2%; b) SSD between non-users (not thinking of using) and users, t-test= -4.641, p<0.1%; c) SSD between non-users (thinking of using) and users, t-test= -3.345, p=0.2%.
Problem recognition: a) SSD between non-users (not thinking of using) and non-users (thinking of using), t-test= -3.158, p=0.4%; b) SSD between non-users (not thinking of using) and users, t-test= -4.140, p=0.4%.

On average users had the largest scores in the three information management skills measured, followed by non-users who were thinking of using software. Non-users who were not thinking of using computerised systems showed the smallest values. Differences were statistically significant between this last group and both users and non-users who were thinking of using computerised systems in all information management abilities. Only on data collection and processing was there a statistically significant difference between users and farmers considering CIS use. This may be due to current use of computerised systems. While lack of information management skills may be considered as an adoption barrier for farmers not considering CIS use, this may not be the case for farmers considering CIS use.

5.3.2 Usefulness of computerised systems

The second set of three hypotheses related to the usefulness of computerised systems was assessed using data collected from experienced users. From a total of 20 interviews, 10 of them focussed on financial packages, 14 on livestock packages and 5 on software packages for managing feed and pasture information. Several farmers evaluated more than one software package. Each farmer was asked to rank the software using a five point scale of 1-not successful through to 5-highly successful.

Two software packages received the highest score (1 to a financial package, and 1 to a feed and pasture package); 11 received a 4 score (4 to financial packages, and 7 to livestock packages), and 16 received a 3 score (6 to a financial package, 8 to livestock packages, and 2 to a feed and pasture packages). These results were related to the factor scores discussed below (sections 5.3.21, 5.3.2.2, and 5.3.2.3), and results are presented in a separate section (see section 5.3.2.4).

5.3.2.1 Fitting with the farmer's work environment

Data related to this hypothesis was collected using the following scale

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

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

5.3.2.2 Matching with the farmer's current decision approach

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

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

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

5.3.2.3 Software user-friendliness

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

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

5.3.2.4 Results

Table 5.15 summarises farmer opinions about factors affecting software successfulness. Factor scores were averaged for each successful value.

Table 5.15 Average values of software factors with respect to different "success" levels

Successfulness level	Fitting with farmer work environment	Matching with farmer's decision system	Software user-friendliness
3	3.36	3.85	4.85
4	3.78	4.00	5.00
5	4.00	5.00	5.00

No statistically significant differences (10% level) were found.

5.4 Farmer behaviour represented through transactional model

Two situations were represented through transactional modelling (see section 2.3). Firstly, the farmers who were using at least one on-farm computerised system for information management (involved 7 farmers from the random sample plus 13 farmers from the non-random group) formed the first group or situation. Secondly, the farmers who were not using computerised systems were divided into farmers who are considering the use of a computer relative to farmers who were not.

For each of these two situations, farmer behaviour was represented as a binary variable with "1" meaning that the farmer exhibits the particular behaviour, and "0" meaning that s/he does not (CIS-users against non-users; and non-users who were thinking of using relative to non-users who were not considering this possibility). Pearson correlation coefficients were used to show whether the behavioural variables were correlated with the farmer's goals, personality traits and learning styles. The same statistic was used to find relationships among mediating and antecedent variables.

5.4.1 Users of on-farm computerised systems

Table 5.16 presents mediating and antecedent variables that show statistically significant correlations (less than 10% probability) with the on-farm computerised system use binary variable (1= using one or more computerised systems, 0= not using).

Because of the binary nature of the behavioural variable, for each positive or negative correlation between any variable and "using one or more computerised systems", the same correlation exists, with the inverse sign, with the "not using a computerised system" variable.

Farmers who were using one or more computerised systems showed disagreement with the goals 'entering and winning in shows', 'keeping debt as low as possible', 'improving the quality of the farm', and 'having up-to-date machinery/equipment', and showed agreement that there is too much emphasis put on preventing pollution. They were also less 'controlling' and rely less on 'familiar relationship' management styles, and showed more emphasis on abstract conceptualisation and less on active experimentation as learning modes and problem solving approaches than farmers who were not using computerised systems.

Table 5.16 Variables related to the use of computerised information systems

Variable	Pearson correlation coefficient	Probability level of statistical significance
Goals (Edinburgh scale) (1)		
4. It is important to enter and win in shows	0.32	1.5%
9. It is important to keep debt as low as possible.	0.24	7%
11. There is too much emphasis put on preventing pollution.	-0.28	3.5%
14. Improving the quality of the farm generally is important.	0.38	0.3%
24. Having up-to-date machinery/equipment is important	0.29	2.5%
Personality traits* (2)		
Factor 1 (controlling style)	0.35	1.1%
Factor 6 (familiar style)	0.24	7.7%
Learning modes** (3)		
Abstract conceptualisation	0.39	0.4%
Active experimentation	-0.21	13.2%

Notes: * see section 4 for description of the personality trait factors, ** see section 5 for description of the learning modes. (1) a positive correlation means that farmers with the expected behaviour considered that goal less important; a negative correlation means that farmers with the expected behaviour considered that goal more important. (2) a positive correlation means that farmers with the expected behaviour weakly showed the personality trait describes by the factor. (3) a positive correlation means that farmers with the expected behaviour have a greater score in that learning mode; a negative correlation means that farmers with the expected behaviour have a lower score in that learning mode.

The next step was to investigate the relationship between mediating and antecedent variables relevant to explaining the studied behaviour. Table 5.17 shows the statistically significant correlation among mediating and antecedent variables.

Four additional personality trait factors appear relevant to explain CIS-use behaviour. Besides factors 1 and 6, which have shown a direct relationship with CIS-use, the correlation analysis showed indirect relationships with factors 1, 2, 3, 5, and 7. Factor 1 showed both direct and indirect relationships.

Table 5.17 Relationships between CIS-use related variables and personality factors

Variable	Personality trait factors*				
	Controlling (1)	Conscientiousness (2)	Openness (3)	Neuroticism (5)	Precautionary (7)
Goals (Edinburgh scale) (1)					
4. It is important to enter and win in shows	0.49 (0.1%)				0.29 (3.7%)
9. It is important to keep debt as low as possible.	0.41 (0.2%)				
11. There is too much emphasis put on preventing pollution.		-0.35 (1.1%)			
14. Improving the quality of the farm generally is important.					0.29 (3.6%)
24. Having up-to-date machinery/equipment is important			0.27 (5.3%)	-0.26 (5.5%)	
Learning modes* (2)					
Abstract conceptualisation	0.30 (3.6%)	-0.29 (4.5%)			
Active experimentation	-0.32 (2.9%)				

Notes: * see section 5 for description of the learning modes. (1) a positive correlation means that farmers who scored the goal highly (showing disagreement) showed weakly the personality trait described by the factor; a negative correlation means that farmers who scored the goals lower (showing agreement) showed strongly the personality trait described by the factor. (2) a positive correlation means that farmers who relied heavily on that learning mode (high score) weakly showed the personality trait described by the factor; a negative correlation means that farmers who relied slightly on that learning mode strongly showed the personality trait described by the factor. The figures in brackets show the statistical significance level for each Pearson correlation coefficient (percentage of accepting the null hypothesis "r = 0").

Factor 1, which measures a 'controlling' management style, showed a positive correlation with goals 4 and 9. Those who showed this trait less markedly did not agree with entering and wining in shows, and keeping debt as low as possible. Similarly, these farmers based much on the abstract conceptualisation learning mode and less on active experimentation.

The relationship between the trait and the learning modes may suggest that the personality trait describes an empirical and "concrete" control management style instead of an analytical control approach. This viewpoint may help to understand the direct relationship between the trait and the behaviour. Those who have a strong preference for exercising this type of control do not necessarily see a computer as a controlling devise that may help them to perform that function.

Factor 2, which measures conscientiousness, showed a negative correlation with goal 11 ("There is too much emphasis put on preventing pollution") and the abstract conceptualisation learning mode. While the first relationship suggests that farmers who agreed that "there is too much emphasis put on preventing pollution" show this personality trait only weakly, the second relationship suggests that conscientiousness and abstract conceptualisation are positively related.

Factor 3 showed a positive correlation with goal 24. Farmers who showed less openness did not worry about having up-to-date machinery/equipment. Conversely, factor 5 (neuroticism) showed a negative correlation with goal 24, which means that neurotic farmers showed a tendency to consider 'having up-to-date machinery/equipment' important.

Finally, goals 4 and 14 showed a positive correlation with factor 7 (precautionary). This means that farmers who did not show a precautionary trait tend to rank higher (showing disagreement) entering and winning in shows and improving the quality of the farm.

Table 5.18 shows personality factor values for users and non-users. As expected, the only factors that show statistically significant differences are factor 1 and 6 -this is the controlling and familiar management style factors respectively. Users seem to be less precautionary and more conscientious than non-users, however, the difference is not statistically significant.

Table 5.18 Personality factors of users and non-users

	Users of computerised systems	Non-users of computerised systems	Probability of similarity
Factor 1	0.5079a	-0.2360	1.1%
Factor 2	-0.1262	0.2228	28.8%
Factor 3	-0.2155	-0.0807	60.9%
Factor 4	-0.0600	0.0400	73.0%
Factor 5	-0.1976	0.0258	47.6%
Factor 6	0.4264b	-0.0968	7.7%
Factor 7	0.2519	-0.1836	15.1%

Notes: a: t-test shows a statistically significant difference (SSD) between users and non-users in factor 1, t=-2.650, p=1.1%; b: SSD between users and non-users in factor 6, t=-1.807, p=7.7%.

Table 5.19 presents the learning mode scores for users and non-users. Again, as expected, the only learning modes that show statistically significant differences are abstract conceptualisation and active experimentation. While users base on abstract conceptualisation learning mode, non-users base more on an active experimentation learning mode than users. Users use a theoretical rather than an empirical approach, compared to non-users.

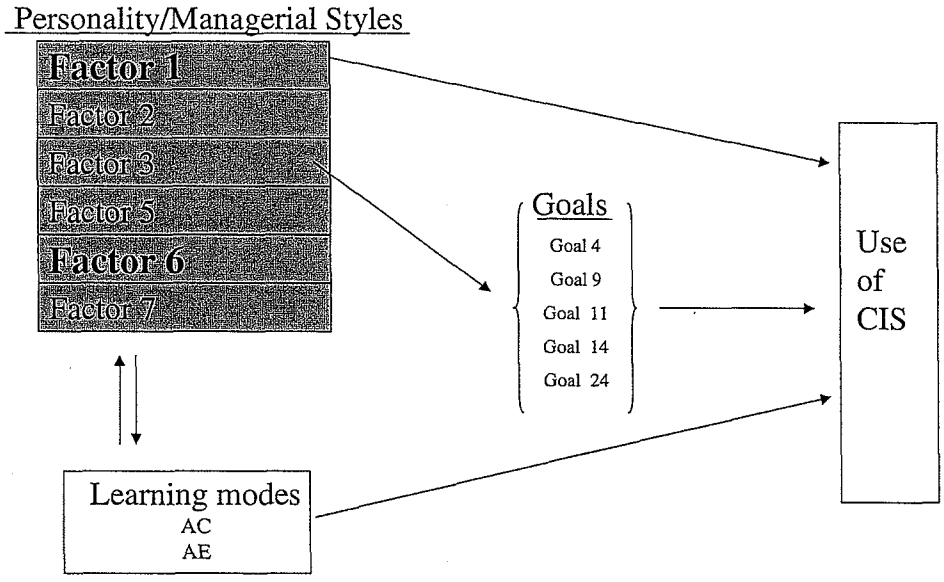
Table 5.19 Scores of Kolb's learning modes -users and non-users

	Average	Users of computerised systems	Non-users of computerised systems	Probability of similarity
Concrete experience	14.49	14.60	14.42	83.7%
Reflective observation	15.26	15.25	15.27	97.9%
Abstract conceptualisation	16.32	17.60a	15.55	0.4%
Active experimentation	14.75	13.95b	15.24	13.2%

Notes: a: t-test shows a statistically significant difference (SSD) between users and none-users in abstract conceptualisation, t=-3.056, p=0.4% b: SSD between users and non-users in active experimentation.

Given the analysis presented the following composite transactional model is proposed.

Figure 5.1 Transactional model for CIS-use



5.4.2 Non-users who were considering using computerised systems

These farmers represent 54% of the interviewed farmers, while farmers not considering CIS use represent 29% (random sample). Table 5.20 presents mediating and antecedent variables that show a statistically significant correlation (less than 10% probability of being the same) with farmers who were still not using CIS, but they were thinking of doing so soon (represented as a binary variable (1= non-users who were considering, 0= non-users who were not considering)).

Farmers considering using computerised systems were less concerned about improving the quality of their life, disagreed in operating their farms on a day to day basis, and showed environmental awareness; further they tended to be extrovert but preferring a familiar management style, and they were less precautionary than farmers not considering using CIS systems.

Table 5.21 shows the second level of relationships between goals relevant to the behaviour under consideration and personality trait factors. There are 5 personality trait factors that appear relevant in explaining "non-use considering using" behaviour (willingness). Besides factors 4 and 7, which both showed a direct relationship with considering CIS-use, factors 1, 2, and 3 showed indirect relationships. Factor 6 that showed a direct relationship, was not related to any of the related goals.

Table 5.20 Characteristics of farmers considering the use of computerised information systems

Characteristic	Pearson correlation coefficient	Probability level of statistical significance
Goals (Edinburgh scale) (1)		
15. Improving the quality of my life is important.	0.28	8.8%
17- It is important just to operate on a day to day basis.	0.27	10.5%
21. It is important not to overproduce, on the farm.	-0.28	9.9%
Personality traits * (2)		
Factor 4 (Extrovertion)	-0.51	0.2%
Factor 6 (Familiar style)	-0.30	7.3%
Factor 7 (Precautionary)	0.28	10.3%

Notes: * see section 4 for description of the personality trait factors. (1) a positive correlation means that farmers with the expected behaviour considered that goal less important; a negative correlation means that farmers with the expected behaviour considered that goal more important. (2) a positive correlation means that farmers with the expected behaviour weakly showed the personality trait described by the factor, a negative correlation means that farmers with the expected behaviour strongly showed the personality trait described by the factor.

Table 5.21 The relationships between the characteristics of farmers considering using CIS and their personality factors – Pearson correlations

	Personality trait factors*				
	Controll-ing (1)	Cons-cientious -ness (2)	Open-ness (3)	Extrover-tion (4)	Precau-tionary (7)
Goals (Edinburgh scale) (1)					
15. Improving the quality of my life is important.					0.24 (8.7%)
17- It is important just to operate on a day to day basis.	0.25 (7.1%)				
21. It is important not to overproduce, on the farm.		0.25 (6.9%)	0.33 (1.7%)	0.30 (2.9%)	

Notes: * see section 4 for description of the personality trait factors. (1) a positive correlation means that farmers who scored the goals highly (showing disagreement) exhibited less strongly the personality trait describes by the factor, or those who scored the goals lower (showing agreement) exhibited strongly the personality describes by the factor. The figures in brackets show the statistical significance level for each Pearson correlation coefficient (percentage of accepting the null hypothesis "r = 0").

Factor 7, which measures the precautionary characteristic, shows a positive correlation with goal 15. Less precautionary farmers tend to give less importance to improving their personal lives.

Factor 1, which measures the controlling characteristic, shows a positive correlation with goal 17. In this case, less controlling farmers do not think that a farm should be operated on a day to day basis.

Finally, goal 21 shows a positive correlation with factors 2, 3 and 4. More conscientious, open and extrovert farmers tend to be environmentally aware.

Table 5.22 shows personality factor values for these two groups of non-users. As expected, the only factors that show statistically significant differences are factor 4, 6 and 7.

Table 5.22 Personality factors of non-users considering computer use relative to farmers not considering use

	Non-users of computerised systems	Non-users thinking of using	Non-users not thinking of using	Probability of similarity
Factor 1	-0.2360	-0.2379	-0.2322	98.7%
Factor 2	0.2228	0.0066	0.6552	26.0%
Factor 3	-0.0807	-0.1531	0.0641	57.9%
Factor 4	0.0400	-0.3204a	0.7607	1.3%
Factor 5	0.0258	0.0556	-0.0339	81.7%
Factor 6	-0.0968	-0.3255b	0.3607	7.3%
Factor 7	-0.1836	0.0105c	-0.5717	10.3%

Notes: a: t-test shows a statistically significant difference (SSD) between the two groups of non-users in factor 4, t=2.847, p=1.3%; b: SSD between the two groups of non-users in factor 6, t=1.849, p=7.3%; c: SSD between the two groups of non-users in factor 7, t=-1.675, p=10.3%.

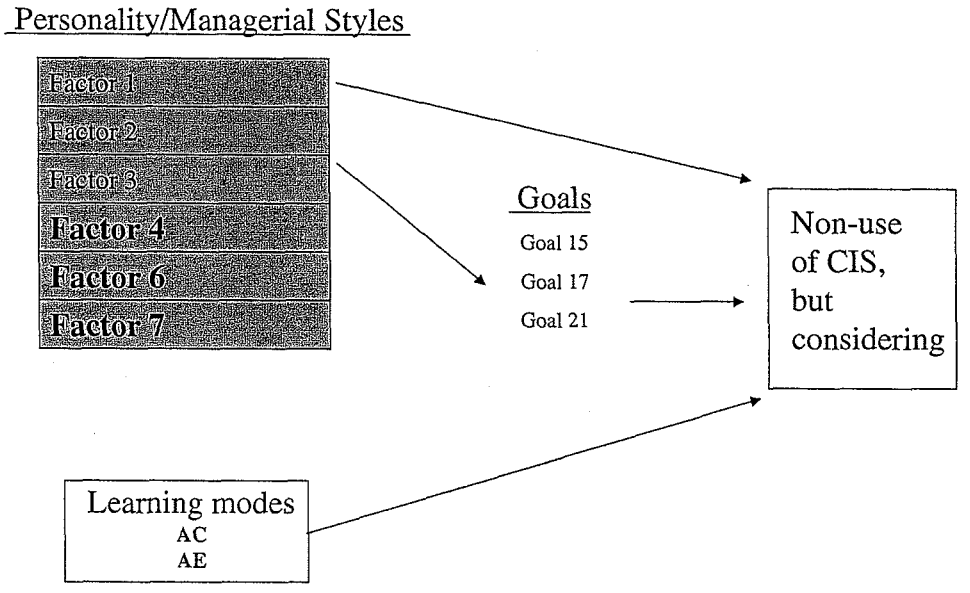
Table 5.23 Kolb's learning modes-scores for non-users considering computer use relative to farmers not considering use

	Average score	Non-users of computerised systems	Non-users considering use	Non-users not considering use	Probability of similarity
Concrete experience	14.49	14.42	14.46	14.33	91.9%
Reflective observation	15.26	15.27	15.38	15.00	75.7%
Abstract conceptualisation	16.32	15.55	15.88	14.67	19.5%
Active experimentation	14.75	15.24	14.83	16.33	24.1%

Table 5.23 shows that, relative to each group, non-users considering using computerised systems tend to learn through abstract conceptualisation, non-users not considering CIS use tend towards the active experimentation approach. Like in the first contrast (users against non-users, see table 6.4), in both non-user groups the other two learning modes do not show any differences.

These relationships give rise to the transactional model portrayed in figure 5.2.

Figure 5.2 Transactional model for non-users



6. Discussion

6.1 Factors affecting computerised system adoption

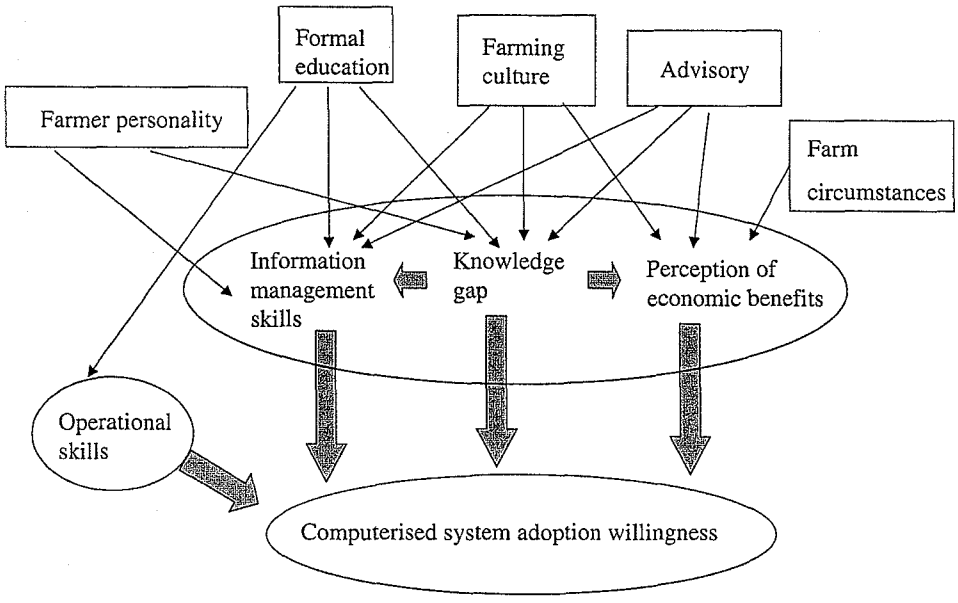
Results from the above analysis provide strong evidence to support the set of hypotheses proposed to explain farmer adoption willingness of computerised systems (see section 2.1). However, these results also suggest the necessity to refine the proposed hypothetical model.

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

While most farmers in both groups shared a lack of operational skills required for using computerised systems, a larger percentage of those considering CIS have started to learn how to use a computer themselves, or were going to use other members of family. This lack of operational skill may delay computerised system adoption, but it could be more easily removed than the other barriers. Conversely, the other three barriers, the knowledge gap, perception of economic benefit, and information management skills, seem to be more permanent factors that may interact with each other.

Survey questionnaire and psychological data showed statistically significant relationships between some farmer characters and computerised system use. Some of these farmer characteristics can be related to those included in the hypotheses as shown in figure 6.1.

Figure 6.1 A model of computerised system adoption



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

Formal education, as was noted earlier, is one of the main developers of knowledge so it is a direct contributor in reducing the farmers' "knowledge gap". Results from the survey questionnaire showed a positive relationship between education and computerised system use. This relationship was quantified using a logistic regression (see section 5.1.3). At the same time, formal education also builds students' information management skills by providing problem solving frameworks and information searching strategies. Finally, formal education offers training opportunities for computer operational skills. However, this is only relevant for farmers who finished their tertiary education towards the end of the eighties and beyond, and those who have finished their secondary education by the second half of the nineties and beyond.

Given a small "knowledge gap", some farmers may think about a problem and its solution somewhat differently relative to other farmers. This has been described as "an attitude toward change", a factor, which may be used to distinguish early adopters from late adopters (Rogers, 1983). Similarly, personality features may be related to information management skills. For instance, Kolb (1984) developed a classification scheme according to a person's predominant learning style and method of dealing with problems. Using this test, farmers' learning modes were measured. It was found that farmers who showed an abstract conceptualisation learning mode were more likely to use computerised systems. Conversely, farmers who showed an active experimentation learning mode were unlikely to use CIS.

These results show a clear relationship between personal learning and problem solving approach and whether or not software is seen as a useful tool to manage information.

Similar to formal education, farming culture is another main developer of farmer knowledge. Farming culture involves values, ideas, and principles that are shared by the farming community where farmers were children and developed their thinking. Farmers usually belong to complex networks that involve family members, friends, neighbours, and colleagues. Part of this knowledge involves the usual procedures to deal with and solve problems. In this context, information management skills usually exist as validated "rules of thumb". In this way other farmer opinions and experiences may become key components in a particular farmer's perception of economic benefits of using computer technology. Through the survey questionnaire there was found to be a statistically significant relationship between five farmers' goals (from a wide range) and CIS use. Using principal component analysis it was found that a complex relationship among goals, education, learning modes and personality traits (see section 5.1.2 and 5.4) existed.

It was found that farmers who showed high agreement with ideas such as "it is important to enter and win in shows", and "it is important to keep debt as low as possible" were less educated and preferred to exercise a more controlling and 'familiar' based management style. Similarly, farmers who showed high agreement with ideas such as "improving the quality of the farm generally is important", "having up-to-date machinery/equipment is important" and "it is important to have the best possible livestock/pasture" were more abstract thinking oriented as opposite to experimental learners. A third relationship (underlying factor) was found in farmers who showed high agreement with ideas such as "it is important to enter and win in shows", and "improving the quality of the farm generally is important" related to a preference for using a precautionary management approach. Clearly, education and personality are related to learning and problem solving styles, and at the same time are reflecting certain values within the farming cultural community. The relationship between these values and the studied behaviour is less clear.

Results from the survey questionnaire did not show a statistically significant relationship between the level of advisor involvement in decision making and the use of computerised systems. However, when farmers were split into users, non-users considering CIS use, and non-users not considering CIS use, this last group showed less adviser involvement than other farmers. Table 6.1 presents the figures.

Table 6.1 Adviser involvement

	Adviser involvement *
Non users (not thinking of using)	0.21
Non users (thinking of using)	0.96a
Users	0.75

* These were measured using a scale 0=none, 1=a little, 2=quite a lot and 3=heavily involvement.
Adviser involvment: a) statistically significant different between non-user not thinking of using and non-users thinking of using, Mann-Whitney-test=2.341, p=1.9%.

While not being as important as formal education and farming culture, the farmer-advisor relationship does, however, contribute to the build up of farmer knowledge, information management skills, and to provide ideas for formulating the economic perception of technological changes. This factor seemed to be important for developing CIS use willingness among non-user farmers.

Other factors can potentially impact on the view of the economic benefit. The size of the herd is one factor. A positive relationship was in fact found between herd size and computerised system use in the mail questionnaire data. This relationship was also quantified through a logistic regression (section 5.1.3). Another factor is the farm financial status. Even though the financial situation was not measured, from the interviews it was clear that some farmers were facing extremely difficult cash shortages. Their priorities were directed at immediate survival, not at improving their information management. A third factor is the level of "time scarcity". This factor also determines priorities, and may impact on the opportunity cost of any learning time, thus affecting a farmer's perception of economic benefit particularly when significant training is required. Finally, the availability of family members (partner, son, or daughter) with the required operational skills and a positive attitude to computerised systems may also affect the economic benefit perception. As was noted in section 5.2.2.1, some potential users had already identified family members as PC operators. Similarly, other farmers justified their decision to not consider CIS use on the grounds of not having children.

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

6.2 Factors affecting software value

The proposed factors explained very little of the variation in the "successfulness" ranking assigned by farmers to their software packages. This result shows some improvement when only commercial software is considered. However, these results suggest that the model should be reviewed.

7. Conclusion

Unwillingness to use computerised systems can be explained according to three related factors. These are the farmer's computer technology alienation feelings ("knowledge gap"), incompatible information management skills, and poor economic benefit perceptions. The first two factors may reflect farmers' learning and problem solving styles being incompatible with computerised systems. For each individual farmer, this learning and problem solving approach results from the interaction of basic personality traits and the educational and life process (family and community environment).

Given certain learning and problem solving styles, farmers may form positive or negative economic benefit perceptions. The size of the farm, among other farm variables, clearly influences this perception through both the economies of scale of software use, and the scale of the management work. Big farms with large herds usually demand the type and amount of management work that can take a clear advantage from using computerised procedures. The benefit perception can also be related to the farmer's time perception of the opportunity cost

of her/his time. Some farmers, for different circumstances (lack of staff, specific urgencies, age, lack of education), may see their time as too expensive relative to the potential gains that may be obtained from computer use. Availability of a PC operator, generally from within the farmer family, may overcome this restriction and change the farmer's economic benefit perception.

The lack of (computer) operational skills can delay software adoption, but can be removed through training if the above factors support a positive attitude toward computerised system use.

If feasible, actions promoting information technology change should focus on building farmer information management skills, and in making available knowledge relevant to developing positive economic benefit perceptions, assuming they exist. Advisors can play a significant role in this process.

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

The proposed model for explaining software successfulness failed, suggesting that more research is needed to clarify farmers' perceptions of software use. However, the small sample size may be a factor here.

8. References

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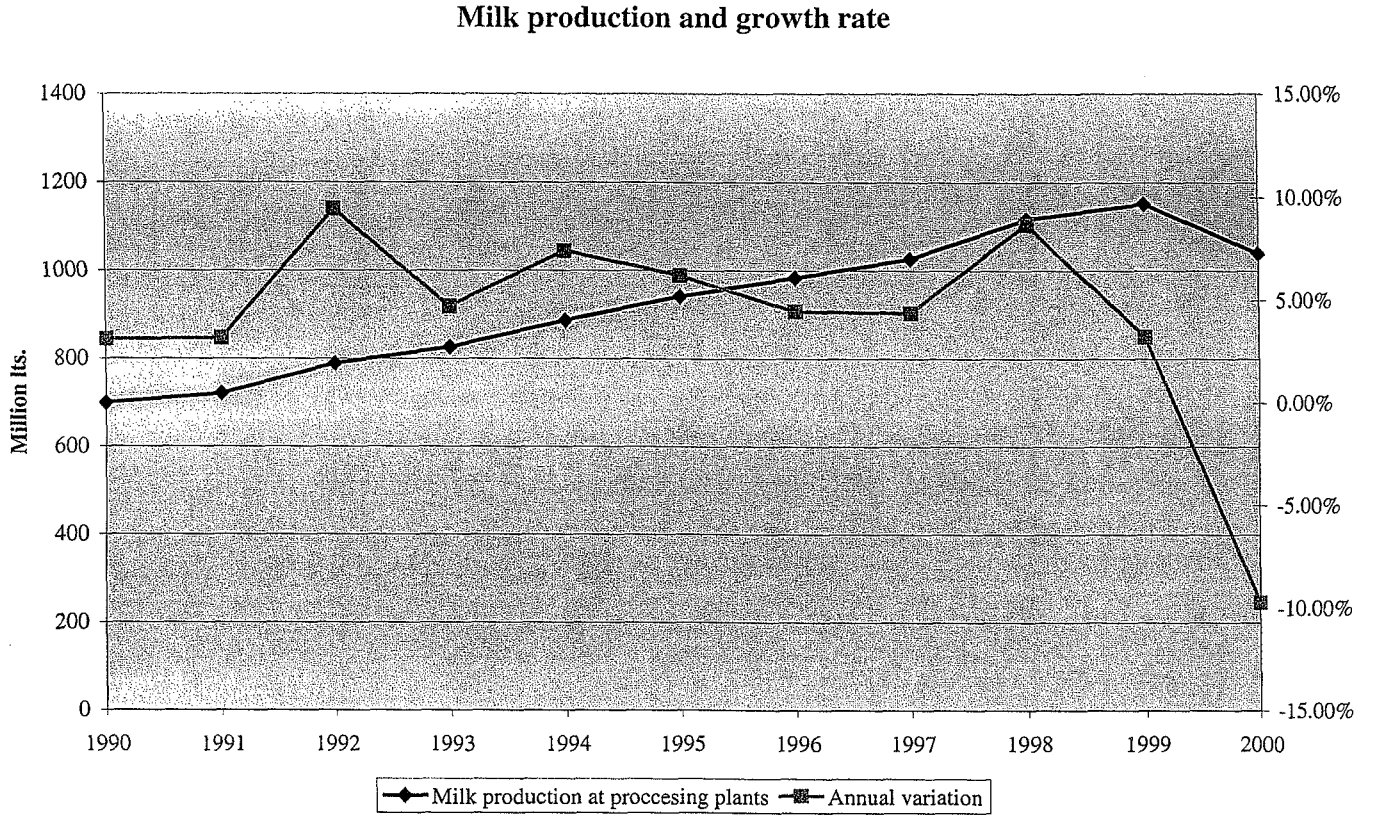
A Appendices

A.1 The Uruguayan dairy industry

A.1.1 Overview

Milk production is growing in importance as an agricultural product with total milk production growing approximately five percent per annum in the last decade, even despite the bad last season (2000) which was explained by extremely adverse climate conditions. Figure A.1 presents annual milk production received by processing plants.

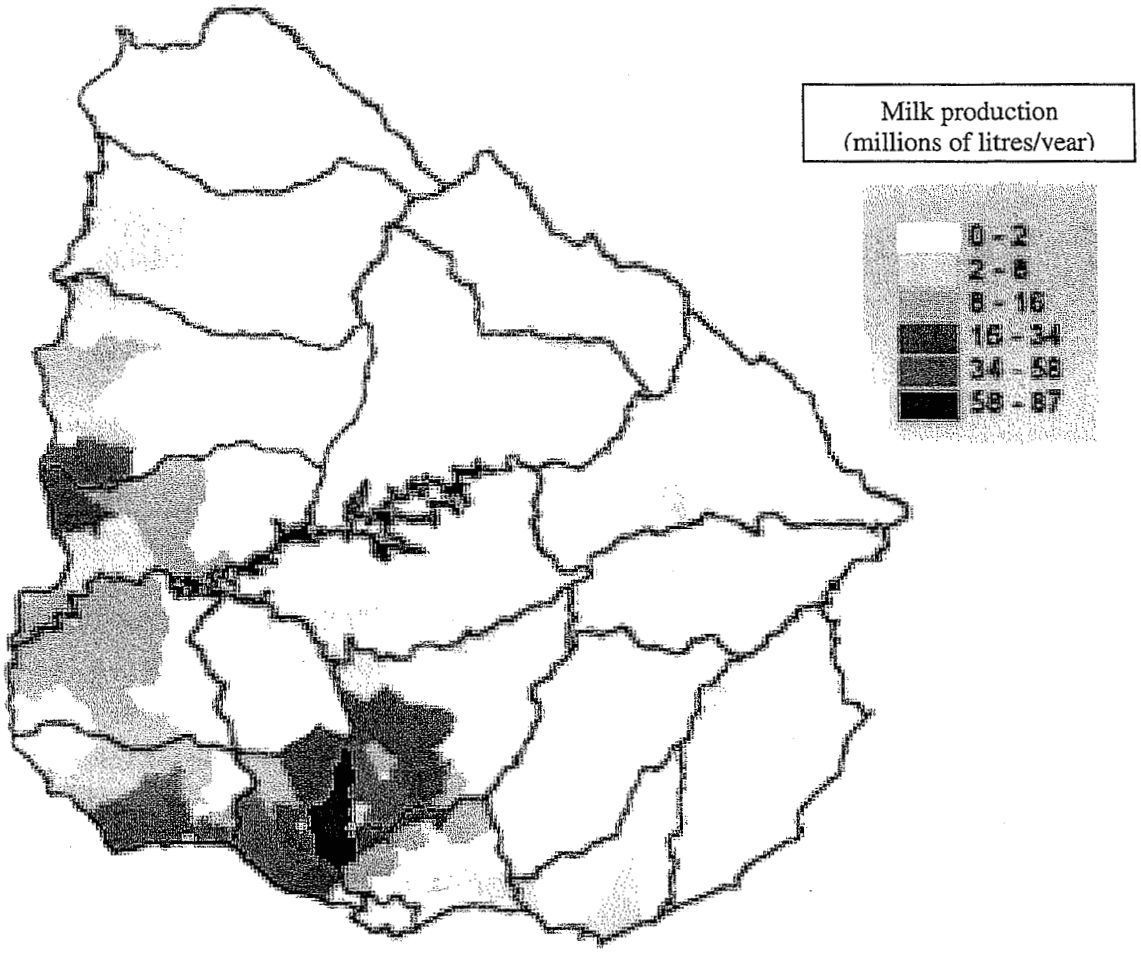
Figure A.1 Milk delivered to the processing plants and milk production growth rate: 1990-2000



Source: www.mgap.gub.uy/opypa/bdd/

The majority of dairying in Uruguay is centred in the southwestern regions. This is largely due to historical (proximity to urban centres) and to soil type variations, and the locality of processing plants. Figure A.2 presents a map of Uruguay showing the dairy regions in dark shading.

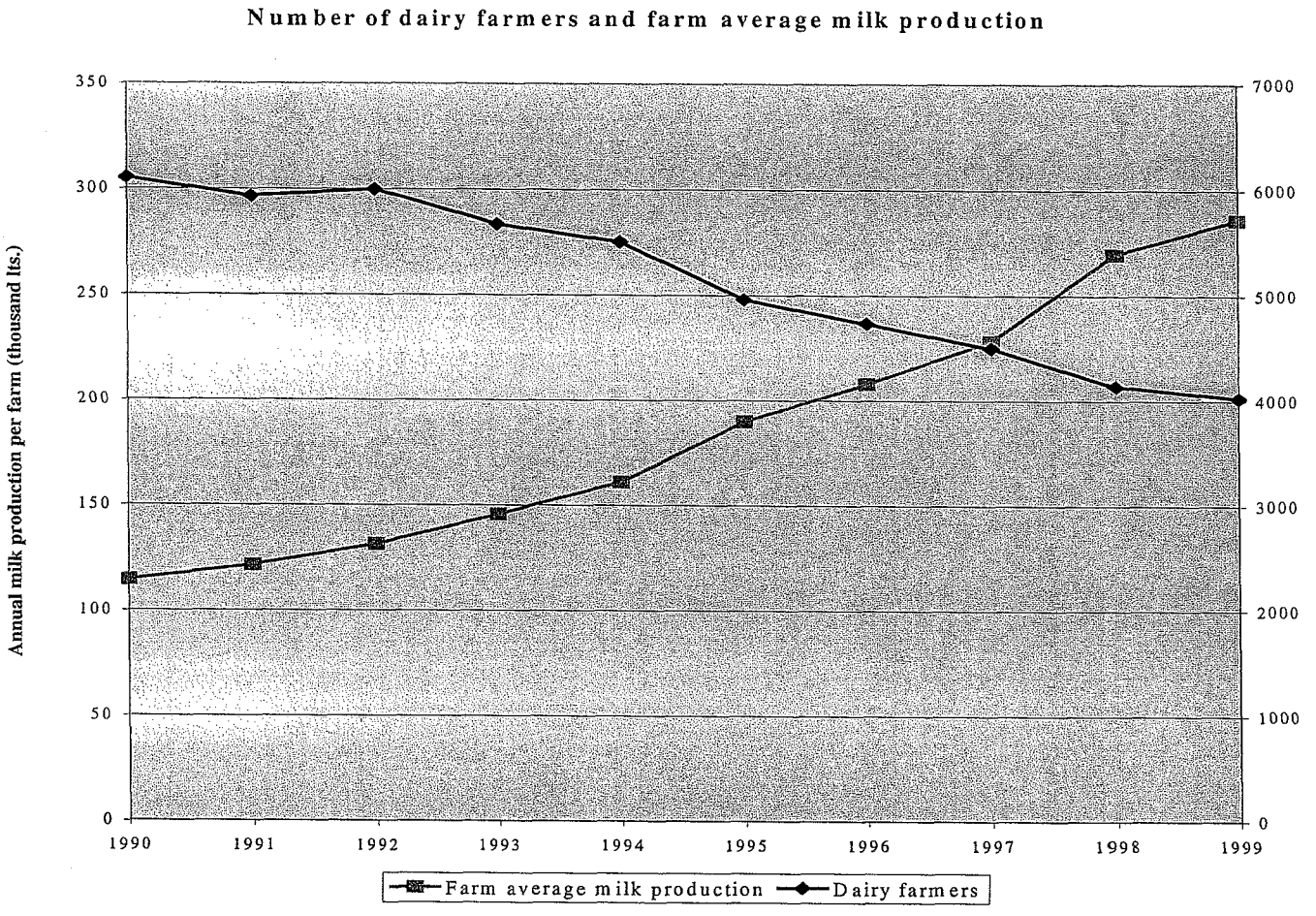
Figure A.2 Uruguayan dairy regions (1997)



Source: MGAP, 1999

The average farm size is trending upwards, while the total number of dairy farms is declining. Figure A.3 presents farm size in terms of milk production and the number of dairy farmers. Besides the increase in farm size it is also noted that technological progress is important. Figure A.4 shows the trends in milk production per cow and per hectare. These increases are mainly due to improved feeding management and pasture production. Figures from two dairy farm surveys carried out in 1988 and 1998 showed an increase in improved pasture area of 20%, 100% in grazing crop area, and 51% and 107% in the amount of concentrates and reserves per litre respectively (MAGP, 1999).

Figure A.3 Evolution of farm size (average annual milk production per farm) and number of farmers



Source: www.mgap.gub.uy/opypa/bdd/

Figure A.5 presents farm financial results (return on total access). Unit price and unit cost are expressed in relative terms (1995/96=100) and the rate of return as a percentage. The last season (1999/2000) showed a significant drop in the milk price, reflecting export difficult due to Brazilian currency devaluation. Additionally, as was noted, the unit cost showed an increase due to the adverse weather conditions. Both trends explained the significant drop in financial results.

A.1.2 Management practices

The dairy industry in Uruguay has many similarities to the New Zealand dairy industry. Both industries are (largely) unsubsidised, are export-oriented, and both are based on pasture grazing systems. Listed below are some of the main points of note about a typical dairy farm in Uruguay:

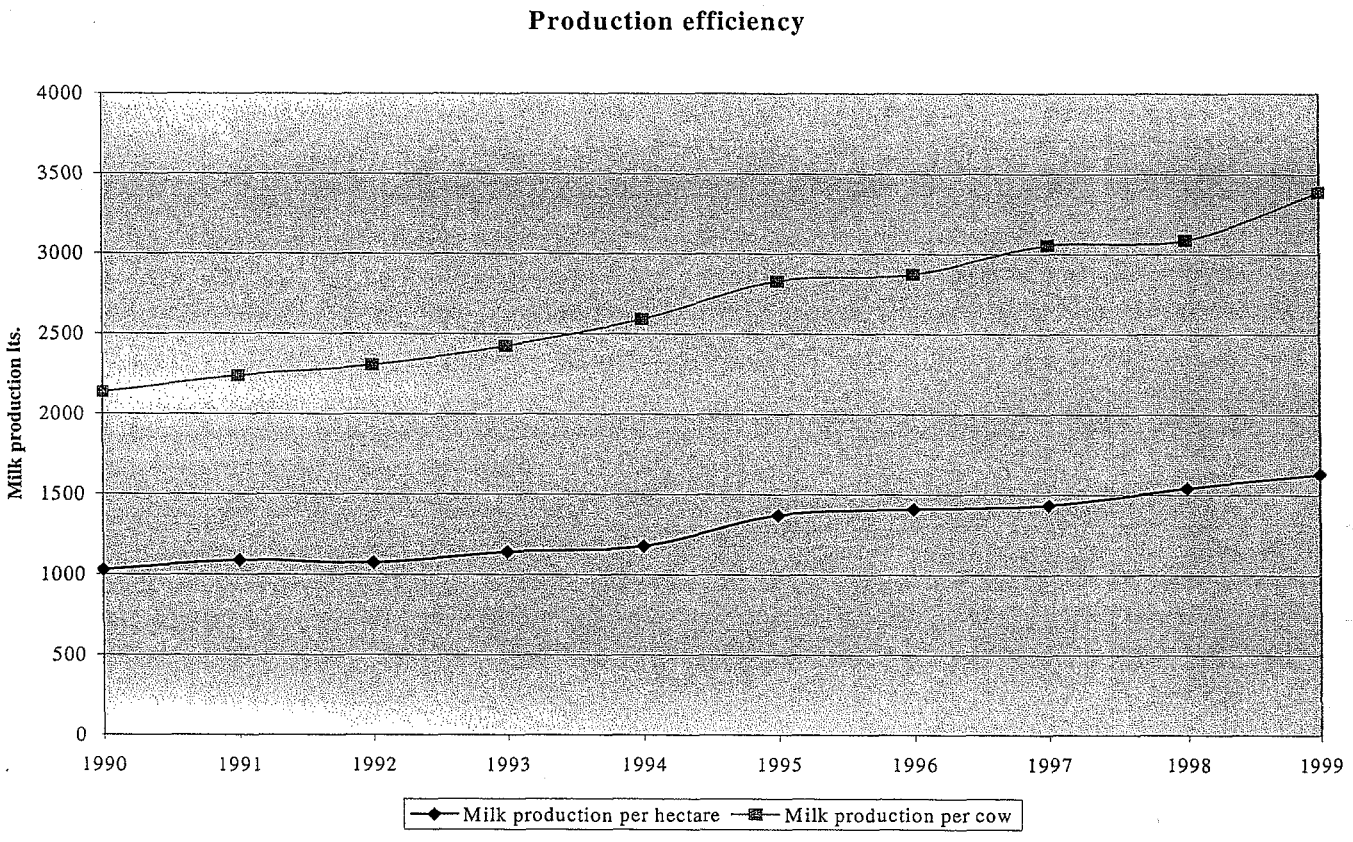
a) Average farm area: 149 hectares (MGAP, 1999). A large variation in farm size.

b) Average stocking rate: 0.50 cows per hectare, plus young stock (Agrinet, 2001; MGAP, 1999).

c) Average production per hectare: 1683 litres per annum. Top farmers average 3000 to 4000 litres (Agrinet, 2001; MGAP, 1999).

d) Average production per cow: 3160 litres per annum. Top farmers average 5000 to 6000 litres(Agrinet, 2001; MGAP, 1999).

Figure A.4 Evolution of two efficiency ratios: output per cow and output per hectares



Source: www.mgap.gub.uy/opypa/bdd/

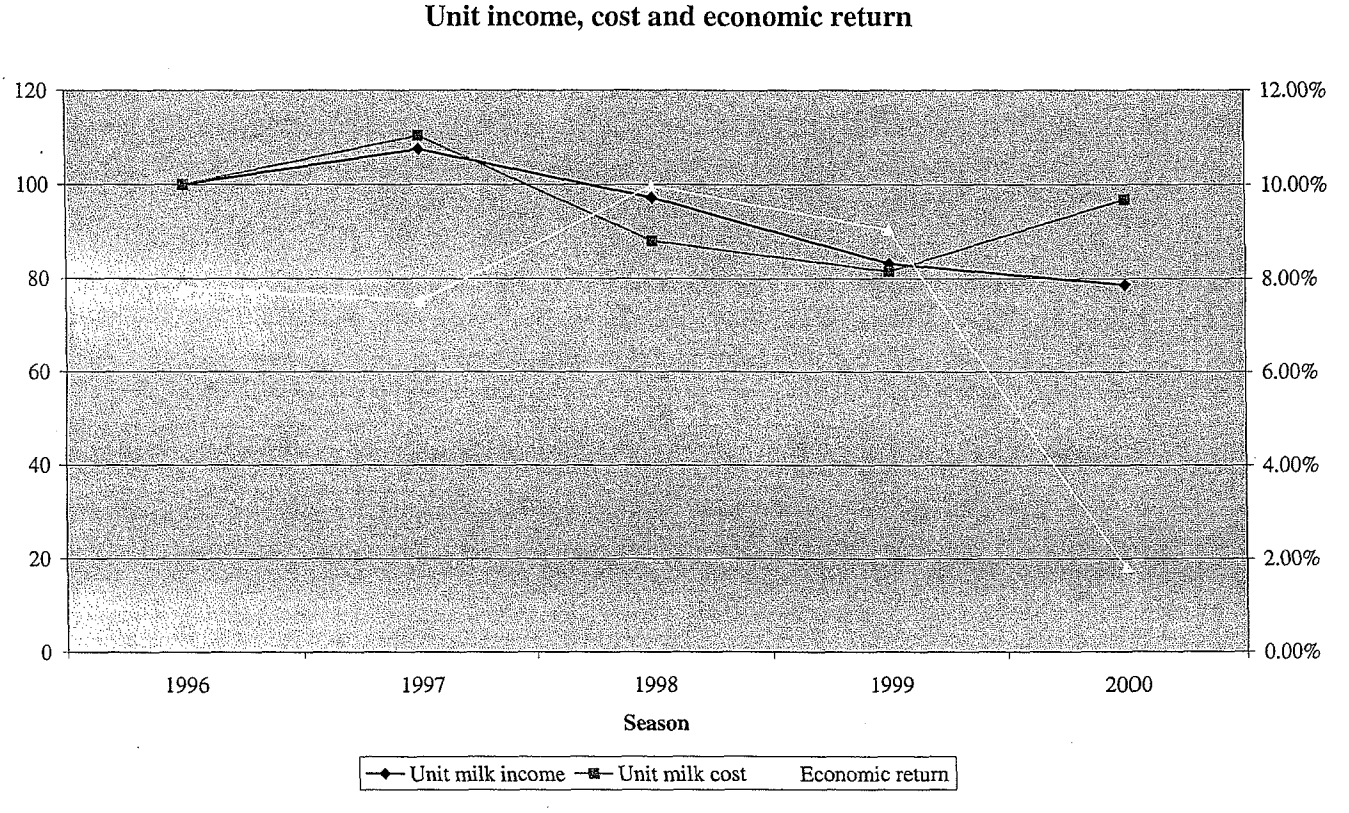
e) Pasture production: average of 6000 kg/DM/year. Top farmers average 8000 to 9000 kg/DM/year including conserved feed. Pasture utilisation estimated at 60%. Pasture feed budgeting is used by very few farmers (Allen, 2001).

f) Typical diet: 55% pasture, 35% reserves, 10% concentrates (MGAP, 1999).

g) Virtually all cows are Holstein-Friesian, based on USA and Canadian genetics. There are two herd testing services run by Mejoramiento Lechero and the Holstein-Friesian association. Both services test 40.000 cows per years (10% of the national herd).

h) Under the quota system, farms are required to supply milk every day of the year. Companies usually increase winter (May to August) milk prices to stimulate winter supply. Calving patterns vary widely, the typical system is all year around, but top farmers implement autumn-spring calving systems.

Figure A.5 Dairy farm financial results: 1995/96 to 1999/2000



Source: Agrinet (2001)

A.2 Mail questionnaire

Farm Management Group - Lincoln University

Dairy Farmers' Information Systems Questionnaire

All information given is strictly confidential. Any published results will contain only averages and non-identifiable information.

Section 1. General

Tenancy relationship: _____

1. Please give the following information about your dairy production system for the last season.

Effective (milking) area:_____hectares
Milkers:_____head
Non-calved heifers:_____head
Calves reared:_____head
Runoff owned _____hectares and/or runoff rented_____hectares
Approximate value of other purchased feed (for example silage)_____dollars

2. How many years have you been dairy farming in total? _____years

3. Which family members, if any, are regularly involved in farm decisions? (Tick the most appropriate box)

Myself..... ☐
I and my spouse/partner..... ☐
I, my spouse/partner and my son(s) and/or daughter(s)..... ☐
I, and my son(s) and/or daughter(s)..... ☐
Other (please specify_____ ☐

4. For each family member actually involved in decision making, please give the level s/he completed their formal education? (Tick the appropriate box)

	Yourself	Spouse	Child1	Child2	Child3
Primary or less	☐	☐	☐	☐	☐
Secondary – four years or less	☐	☐	☐	☐	☐
Secondary – more than four years	☐	☐	☐	☐	☐
Tertiary – two or less years	☐	☐	☐	☐	☐
Tertiary – more than two years	☐	☐	☐	☐	☐

(note here if more members are involved_____)

5. Which non-family people have a reasonable input into farm decision making? (Tick each relevant box)

	A little	Quite a lot	Heavy
involvement	☐	☐	☐
Farm consultant	☐	☐	☐
Accountant	☐	☐	☐
Lawyer	☐	☐	☐
Friend or neighbour	☐	☐	☐
Other (please specify_____)	☐	☐	☐
Other (please specify_____)	☐	☐	☐

Section 2 Farm information management

6. Which of the following best describes your **financial recording system**? (Tick one or more boxes; for computers please give name of software (SW))

Informal system with reliance on bank and similar statements as backup ☐
Manual (or hand-written) record system ☐
Computer-based record system: SW_____ ☐
Both manual and computer-based: SW_____ ☐
Accounting or consulting service ☐
Other (please specify _____) ☐

7. Who does the tax requirements? (Tick one box)

Myself..... ☐
Spouse/Partner..... ☐
Son/daughter..... ☐
Accountant..... ☐
Other (please specify _____) ☐

8. Which of the following best describes your **pasture and other feed-crop recording/management system**?

(Tick one or more boxes; for computers please give name of software (SW))

My memory..... ☐
Notes on calendars..... ☐
Pocket notebook/Farm diary..... ☐
Field record book (hand-kept)..... ☐
Computer-based system: SW_____ ☐
Consultant or company service: name of service_____ ☐
Other (please specify _____) ☐

9. Which of the following best describes your **livestock recording /management system**?
(Tick one or more boxes; for computers please give name of software (SW))

- ☐ My memory.....
- ☐ Notes on calendars.....
- ☐ Pocket notebook/Farm diary.....
- ☐ Livestock record book (hand-kept).....
- ☐ Computer-based: SW_____
- ☐ Consultant or company service: name of service_____
- ☐ Other (please specify _____)

Section 3 Farm office

As a farmer you perform different kind of tasks, e.g. milking, renewing pastures, fixing fences, supervising staff, purchasing inputs, planning the whole operation, etc.

10. On average, what percentage of your working time do you spend doing:

Field work and other physical farm activities _____%
Management work including farm office time or its equivalent _____%
Other (please specify_____) _____%
100%

11. On average, how many **hours per week** (including phone time) do you spend in your farm office (or its equivalent) organising your farm activities and staff?

_____hours

12. What farm office machines do you have? (Tick one or more boxes)

- ☐ Fax machine.....
- ☐ Telephone answering machine.....
- ☐ Cellular phone.....
- ☐ Photocopier.....
- ☐ Computer.....
- ☐ Other (please specify _____)

If you do not use a computer for business, please go on to question 18 Section 5
If you use a computer for business, please continue answering the following questions.

Section 4 Computer usage

13. Who is the primary computer operator on your farm? (**Tick one box**)

Myself.....
My spouse.....
Other family member.....
Hired personnel.....
Other (please specify _____)

14. How long has this person been using computers? _____years

15. (i) What percentage of computer time is spent on each of the following? (Give a percentage of total computing time)

Farm business..... %
Learning and education..... %
Leisure/personal..... %
Communication..... %
Off farm business..... %

100%

(ii) What is the average **TIME PER DAY** that the computer is used? ____ hour

16. How many **HOURS PER MONTH** do you spend using each of the following packages or system? (leave blank if zero) (SW=software)

Wordprocessor (SW name_____)
Financial and accounting record system (SW name _____)
Pasture and crop record system(SW name _____)
Livestock record system(SW name _____)
Feed budgeting(SW name _____)
Herd testing(SW name _____)
Integrated farm management package (SW name _____)
Other spreadsheet use (SW name _____)
Other database use (SW name _____)
Internet
E-mail
Other (please specify _____)

17. Which statement best describes how often the computer is used for business (Please tick **one box**)

A regular period each week during evenings.....
A regular period each week during daytime.....
A regular period each month.....
On rainy days.....
In irregularly available spare time.....
Several days at the end of the financial year.....
Exactly when the need arises.....
Other (please specify _____)

Section 5 Information sources

18. Which of the following sources of information are used on your farm? Please rate the importance of each on a 1 to 3 scale (1=not at all,2=a little,3=very important)

Daily newspaper.....	
Farm publications.....	
Commodity newsletter or magazines.....	
Breed journals.....	
Electronic news	
Daily farm reports on radio or television.....	
MAF reports (market, analysis and others).....	
Livestock Improvement advisory service publications.....	
Field days/seminar.....	
Neighbours/local contacts.....	
Other (please specify _____)	
Other (please specify _____)	

If you do not use the Internet, please go on to question 20 in Section 6

19. Indicate how frequently you use the internet for each of the following information/functions by entering in each box either **1=very occasionally, 2=occasionally, 3=frequently**

E-mail.....	
News and weather information.....	
Market information (prices, suppliers).....	
Technical information	
Economic information (interest rate, exchange rates, etc.).....	
Updates on changes to agricultural legislation.....	
Latest research results.....	
Entertainment and fun.....	
Ordering equipment and supplies.....	
Dairy company news.....	
Other (please specify _____)	
Other (please specify _____)	

Section 6 Manager

20. What percentage of your total income is derived from dairy farming? _____%

21. What is your age? _____years

22. Any ideas or suggestions about what is wrong with your current information/decision system?

_____
_____
_____
_____

23. Any ideas or suggestions as to what new/better information/decision system you would like?

_____
_____
_____
_____

24. What new things, if any, have you done in the last 3 years to improve the information you have for making decisions? (for example, you have started using a new diary, or you have purchased a computer, subscribed to a new magazine...).

_____
_____
_____
_____

A.3 Goal test-Edinburgh Farming objective scale

The following are some goals and objectives voiced by farmers. Please indicate to what extent these objectives are important to you by circling the appropriate number. Please answer all of the questions.

Statement	Strongly agree				Strongly disagree
1. It is important to pass the farm to a member of family	1	2	3	4	5
2. It is important to stay in farming whatever happens	1	2	3	4	5
3. It is important to have the respect of other farmers in the community	1	2	3	4	5
4. It is important to enter and win in shows	1	2	3	4	5
5. In adopting new ideas it is important to lead rather than follow.	1	2	3	4	5
6. Making a comfortable living is all that is important.	1	2	3	4	5
7. Being fully productive is important.	1	2	3	4	5
8. It is important to plan for retirement.	1	2	3	4	5
9. It is important to keep debt as low as possible.	1	2	3	4	5
10. Having interests outside of farming is important.	1	2	3	4	5
11. There is too much emphasis put on preventing pollution.	1	2	3	4	5
12. It is important to use chemicals sparingly.	1	2	3	4	5
13. Having a successfully diversified farm is important.	1	2	3	4	5
14. Improving the quality of the farm generally is important.	1	2	3	4	5
15. Improving the quality of my life is important.	1	2	3	4	5
16. Improving the living standards of family life is important.	1	2	3	4	5
17. It is important just to operate on a day to day basis.	1	2	3	4	5
18. It is important to spend time with the family.	1	2	3	4	5

Statement	Strongly agree				Strongly disagree
19. It is important to plan for holidays off the farm.	1	2	3	4	5
20. It is important to minimise risk in farming.	1	2	3	4	5
21. It is important not to overproduce, on the farm.	1	2	3	4	5
22. It is important to encourage wildlife on the farm.	1	2	3	4	5
23. It is important to leave the land in as good a state as one received it.	1	2	3	4	5
24. Having up-to-date machinery/equipment is important	1	2	3	4	5
25. It is important to have the best possible livestock/pasture.	1	2	3	4	5
26. It is important to make the largest possible profit.	1	2	3	4	5
27. It is important to fully utilise all your resources.	1	2	3	4	5
28. It is important to increase the size of the farm.	1	2	3	4	5
29. Financial commitment should be taken over a long term.	1	2	3	4	5

A.4 Nuthall's Managerial Style Record- Personality Traits Test

For each of the following statements please indicate how true they are with respect to your management style. Each question has five boxes beside it – tick only the ONE that best records the degree of truth in the statement.

1. You tend to mull over decisions before acting.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

2 You find it easy to ring up strangers to find out technical information.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

3. For most things you seek the views of many people before making changes to your farming system.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

4. You usually find discussing everything with members of your family very helpful.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

5. Where there are too many jobs for the time available you sometimes become quite anxious.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

6. You tend to tolerate mistakes and accidents that occur with employees and/or contractors.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE
7. You share your successes and failures with neighbours.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

8. Keeping records on just about everything is very important.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

9. You admire farming colleagues that are financially logical and don't let emotions colour their decisions.
   TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

10. You sometimes don't sleep at night worrying about decisions made.
    TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

11. You find investigating new farming methods exhilarating and challenging.
    TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

12. You tend to write down options and calculate monetary consequences before deciding.
    TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

13. You tend to worry about what others think of your methods.
    TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

14. You are happy to make do with what materials you have to hand.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

15. You find talking to others about farming ideas stimulates and excites you as well as increasing your enthusiasm for new ideas.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

16. Having to make changes to well-established management systems and rules is a real pain.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

17. You normally don't rest until the job is fully completed.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

18. You normally enjoy being involved in farmer organisations.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

19. You sometimes believe you are too much of a stickler for checking and double checking that everything has been carried out satisfactorily.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

20. When the pressure is on you sometimes become cross and short with others.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

21. You generally choose conclusions from experience rather than from hunches when they are in conflict.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

22. You are inclined to let employees/contractors do it their way.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

23. You not only speak your mind and ask questions at farmer meetings, but also enjoy the involvement.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

24. It is very important to stick to management principles no matter what the pressure to do otherwise.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

25. You are much happier if everything is well planned ahead of time.
TRUE [ ] [ ] [ ] [ ] [ ] NOT TRUE

A.5 Learning styles-Kolb's Learning Style Inventory

Instructions

There are nine sets of four descriptions listed in this inventory. Mark the words in each set that are most like you, second most like you, third most like you, and least like you. Put a four (4) next to the description that is most like you, a three (3) next to the description that is second most like you, a two (2) next to the description that is third most like you, and a one (1) next to the description that is least like you (4 = most like you; 1 = least like you). Be sure to assign a different rank number to each of the four words in each set; do not make ties.

Example

0	Happy	4	Fast	3	Angry	1	Careful	2

(Some people find it easiest to decide first which word best describes them (4 -Happy) and then to decide the word that is least like them (1- Angry).
Then you can give a 3 to that word in the remaining pair that is most like you (3- Fast) and a 2 to the word that is left over (2- Careful).

1	Discriminating		Tentative		Involved		Practical	
2	Receptive		Relevant		Analytical		Impartial	
3	Feeling		Watching		Thinking		Doing	
4	Accepting		Risk taker		Evaluative		Aware	
5	Intuitive		Productive		Logical		Questioning	
6	Abstract		Observing		Concrete		Active	
7	Present-oriented		Reflecting		Future-oriented		Pragmatic	
8	Experience		Observation		Conceptualisation		Experimentation	
9	Intense		Reserved		Rational		Responsible	

A.6 Questions that were theoretically related to five basic personality traits

Table A.1 Questions that were theoretically related to five basic personality traits

Personality trait	Question number (from appendix 3)
Openness	1, 9, 11, 16, and 21
Conscientiousness	3, 8, 12, 17, and 24
Extroversion	2, 7, 15, 18, and 23
Agreeableness	4, 6, 14, 20, and 22
Neuroticism	5, 10, 13, 19, and 25