FEED MANAGEMENT AND COMPUTER PRACTICES ON A SAMPLE OF NEW ZEALAND FARMS

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Preface

In an environment where producers are faced with the need to continually improve productive efficiency in order to generate higher levels of net income, a fundamental aspect is the provision of appropriate quantities of feed for animals while maintaining a stocking rate consistent with management and marketing requirements. The basis of low cost animal protein production in New Zealand is the low cost, relative to other countries, of the production of animal feed, namely pasture production. However, low cost production of feed is only "well used" where feed utilisation is optimal. In order to achieve this, feed budgeting techniques are required. Farmers allocate feed to their animals using a variety of techniques which range in sophistication. A result of this is the maintenance of a significant buffer between the optimal pasture production level and the feed demand. Better feed budgeting techniques would allow higher stock carrying capacities to be achieved, greater output for given levels of inputs and therefore higher productive efficiency.

This Research Report presents the results of a survey of farmers which investigated their feed budgeting practices and their ownership and use of computers. It is anticipated that in future, computer packages/systems will be developed which can aid in the feed budgeting activity and therefore contribute to higher productivity on New Zealand farms. This Report is the first in a series of five which will review computer use and the application of an expert systems approach to farm management.

The Agribusiness and Economics Research Unit is pleased to be associated with this work and to participate in its dissemination through this and future publications.

R L Sheppard
ASSISTANT DIRECTOR

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We are grateful to all the farmers who took the time to complete the rather demanding questionnaire. We hope the result of the survey and analysis will be of benefit to them.

The financial support of AGMARDT is acknowledged - without this support the study would not have been possible and we also wish to acknowledge the assistance of Susan Clemes who spent many hours entering the data into a data base, and of Sharon Hunt for the exacting typing job and subsequent modifications.

Summary

Pastoral production is a major component of the New Zealand economy. As such the efficiency with which pasture is utilized by the flocks and herds is of paramount importance. To assist with a study of grazing management a random survey of farm managers was conducted to find out their feed planning practices and problems. As computers may be a key in assisting managers with their feed decisions, the survey also included questions about farm computer use.

The postal survey was conducted over late 1992 and early 1993 using a stratified sample (location, land size, and farm type) of some 3000 farms. A response rate of 37.1% was achieved, this being similar to other postal surveys. A comparison of the respondents to both national statistics and those of a group of non-responders contacted by telephone suggested the sample was representative.

A frequently mentioned feed management problem was the decision on how much pasture to conserve as a feed store both in spring/summer as well as the autumn. Other significant problems, as perceived by the managers, were the questions of the grazing method for lambs (set stocking or rotational grazing), controlling pasture quality over summer (topping, etc.), when to dry off dairy cows, winter grazing management (rotation length, mob structures ...), and controlling pugging. Farmers clearly believe if solutions, or improved management procedures, could be found to all these problems their grazing efficiency could be very much improved.

They also believe that better information on local production conditions (growth details and patterns for a range of cultivars) would be very valuable, as would better weather forecasts. One of the reasons given for not using feed planning techniques is the unpredictability of weather and consequent feed production. This is understandable, but unlikely to be solvable.

Some 20% of farmers indicated they performed formal feed budgeting (creating and writing down forecasts of feed supply and demand), but most spend less than one hour per week on this function. Very few with a computer use it for feed budgeting calculations. The 20% is surprisingly high, from what might be expected from casual observations, but what farmers understand to mean by 'formal feed budgeting' probably varies quite markedly. Dairy farmers are the most common users of feed budgeting. In addition, younger farmers with a relatively high level of formal education are more likely to use feed budgeting.

When asked why they don't use feed budgeting, as might be expected, most simply comment that they don't believe the benefits compensate the time and effort involved.

Those farmers using feed budgeting mainly use eye estimates in judging pasture production and animal requirements. Many do comment, however, that improved measuring equipment would be beneficial. Presumably this means currently available equipment is not considered adequate.

In 1986 approximately 6% of New Zealand farmers said they had a computer. This current survey indicates the figure is now around 24%. Some of these computers are totally recreational, leaving some 19% of managers using their computer for business purposes. Of the remaining 75% of farmers some 39% believe they will never purchase a computer with the majority of the remainder believing they will purchase in the next five years. In reality, it is likely the 39% of farms will end up with a computer even if it won't occur until there is a new manager.

An analysis of the past purchasing pattern, and the anticipated one, indicates the current adoption rate is the maximum it is likely to attain in that we are approximately half way along the sigmoid adoption curve. It would appear the current adoption rate will continue for at least as long as computers have been available, and probably longer. At this stage the farmers that are most likely to have a computer have experienced formal education for a longer period than the others, and are likely to have a larger production unit.

Most business computers are IBM compatible, have a 640k RAM, a 40 Mbyte hard disk, a colour monitor and a dot matrix printer. MSDOS is the most common operating system, but it should also be noted Windows is becoming important.

More than 50% of farmers believe their computer investment has at least covered the associated costs, but 30% have no opinion. In the end, therefore, it is likely some 60 - 70% will believe a computer is worthwhile. The computer owners use their computer approximately seven hours per week, but only three of these are on business. Two hours are on entertainment leaving two hours for a range of other activities including education. This time input is less than what might be desirable. The range, however, is wide.

The main business uses are financial recording, budgeting and word processing. There is very little feed budgeting on average. The type of software used is mainly wordprocessing, spreadsheets and specialist financial. It appears there is a relationship between the hours put in on a computer and the regularity of its use - farmers who set aside a regular time each week or month tend to be the heavier users of their computer.

Computer owners, when asked for suggestions on how to improve farm computing, stress that better software and training courses are required. More courses are also suggested.

The survey has produced a number of clear messages for people involved in research and extension. If feed budgeting is to become more widespread better information and software is required, as is better and more extensive training opportunities. The same comments apply to the adoption and use of computers. The two probably go hand in hand as one way to make feed planning easier is to have good, and easy to use, software available.

CHAPTER ONE

INTRODUCTION

The production of animal feed and its efficient utilisation are vital components of the New Zealand economy. Similarly, the management of farm resources in general is crucial to New Zealand's economic well being. In this sense farm computers are becoming an increasingly important component of managerial efficiency. The study reported in this publication was designed to explore both the feed management and computer practices of New Zealand primary producers. The link exists as improved feed management may well be correlated with farm computer use so while conducting an investigation into feed management it was logical to explore computer uptake and use.

The primary motivation in surveying a random selection of farmers was to ascertain the feed management problems they were experiencing. A wider study concerned the potential for using expert systems (Jackson, 1986; Webster & Amos 1987) in feed management, and for this it was important to determine the major problems as candidates for development into expert systems.

The importance of feed management is demonstrated through contemporary figures of New Zealand's 'free on board' value of primary exports. The 1992 figures are (NZ Meat and Wool Board's Economic Service, 1993):

	$ Million
Pastoral Products	7813.4
Horticultural	1153.2
Cereals, seeds and cut flowers	116.8
Forest products	1785.5

Furthermore, land based primary production is approximately 63% of all exports. Pasture based products therefore represent some 45% of exports.

It is also clear feed management efficiency could be improved. If pasture production is compared to sheep requirements there is a wide discrepancy; Hoglund et al. (1979) give the following typical production figures from a range of sites:

	Kg DM/Ha/yr
Kaikohe	11,130
Wairakei	6,710
Manutuke	14,920
Kairanga	13,720
Masterton	10,300
Kirwee (dry)	10,000
Kirwee (irrigated)	13,390
Gore	11,400
Ballantrae	8,030

Jagusch (1973) estimates that a 50 kg ewe requires 521 Kg DM/Year for maintenance and production thus giving carrying capacities of 12.9 ewes/ha up to 28.6 ewes/ha for the production figures quoted above. The carrying capacities achieved are represented by the following figures (expressed as Stock Units/ha - a SU is based on a 50 kg ewe) (NZ Meat and Wool Board's Economic Service, 1992)

	SU/ha
South Island Hill Country	3.6
North Island Hard Hill Country	8.1
North Island Intensive	12.0
South Island Intensive Finishing	12.9

Despite the fact that a sample division does not allow for seasonal variations and other difficulties, and that average actual capacities do not reflect what the more efficient feed managers are achieving, there is clearly room for considerable improvement. The same probably applies to beef and dairy production, though possibly not to dairying to the same extent. This study is one move towards understanding the conditions and problems facing pastoral managers and therefore provides a platform for further work.

This report is organised into four main sections. A report on the survey procedure and details makes up the first, in the second a comparison between responders and non-responders is provided (it is clear there are few differences), feed management procedures and problems reported by the respondents are listed and discussed in the fourth whereas the last section contains details of micro-computer practices. A summary is provided at the beginning of the Report.

CHAPTER TWO

SURVEY PROCEDURES

To obtain a picture of the national situation it was decided to conduct a postal survey given that the information required was relatively straightforward. The funds available allowed a potential sample of three thousand. As the sample size necessary to obtain a good estimate of the population characteristics was not known at the time, the sample was made as large as possible given the resources available.

The information requested covered farm and farmer background, perceived feed management problems, feed budgeting practices, computer ownership, and computer use practices. The Appendix contains a copy of the questionnaire used.

A list of all primary producers classified as having economic units was obtained from Valuation New Zealand. This contained horticultural properties together with various other non agricultural categories such as 'mineral extraction' and 'forestry'. After their removal the list contained 38213 records which was subsequently stratified into regions, land use and land area. A sample of 3097 properties was then randomly selected from each strata, the number selected being proportional to the strata size.

The questionnaire was pretested with thirty farmers that were either known to use feed budgeting or were progressive producers. The final questionnaire incorporated their suggestions and comments and was posted over the first half of November 1992 with the last ones being sent on 18/11/92.

To those not responding, a reminder was sent in Mid December 1992, and another questionnaire in March 1993. To speed up the analysis process, it was decided to close the survey at the end of May 1993 even though the occasional schedule was still being received. Figure 1 gives the response pattern.

Tables 1 to 3 give the characteristics of the sample. The percentages in each category are virtually identical to the population percentages. This is to be expected as the sample was selected in this way.

Table 1

The Regional Distribution of the Sample

Region	Percent	
	Population	Sample
Northland	6.45	6.49
Auckland	4.65	4.65
Waikato	22.63	23.45
Bay of Plenty	4.18	4.23
Gisborne	2.10	1.97
Hawkes Bay	3.90	3.78
Taranaki	8.22	8.17
Manawatu - Wanganui	10.66	10.95
Wellington	3.00	3.04
Tasman	1.28	1.23
Marlborough	2.42	1.42
West Coast	1.35	1.23
Canterbury	12.77	13.08
Otago	7.31	7.27
Southland	9.03	9.27

Figure 1
Survey Response Pattern

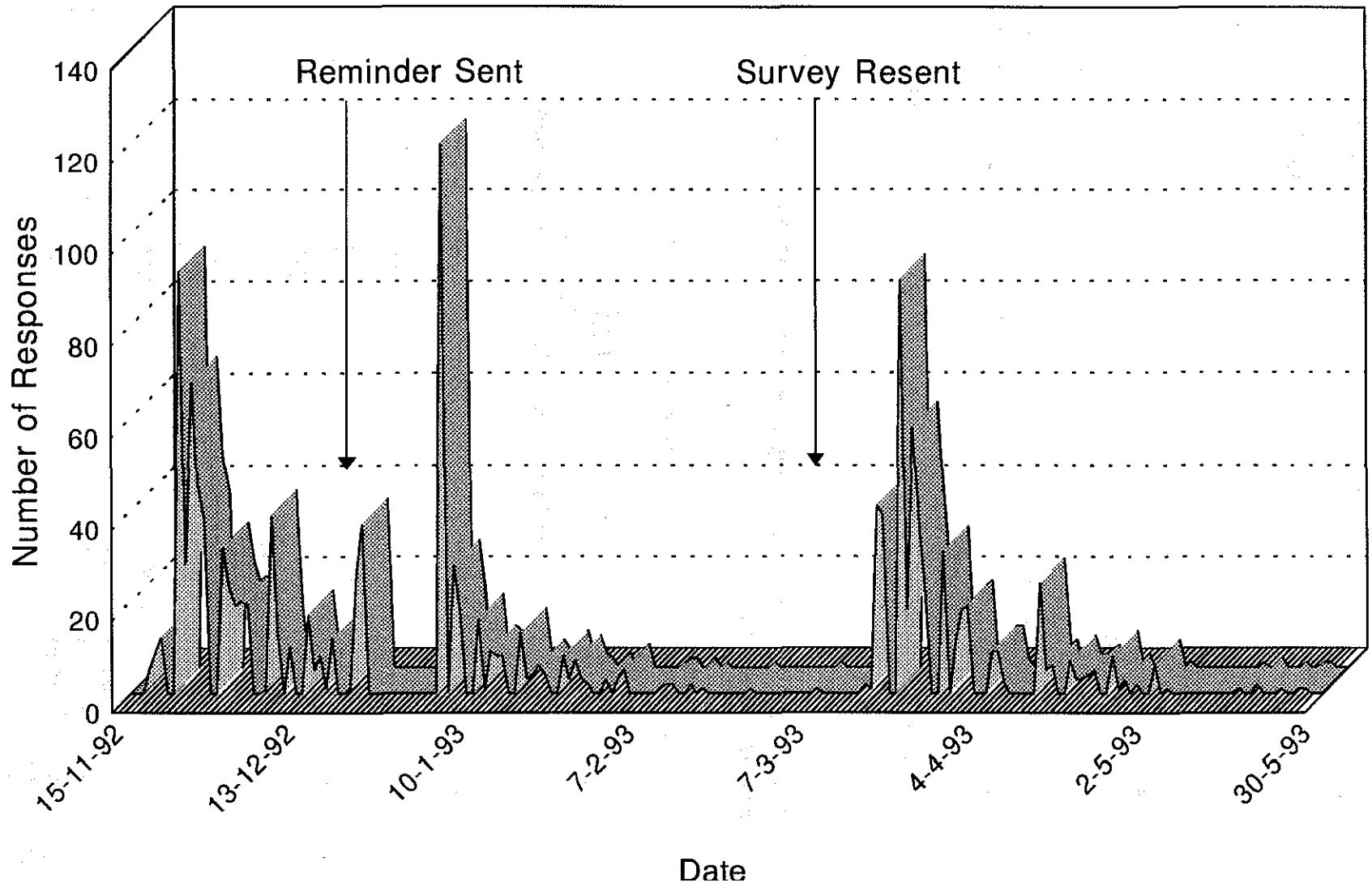


Table 2

The Land Use Distribution of the Sample

Land Use	Percent	
	Population	Sample
Arable	3.74	3.71
Dairying	35.66	36.16
Multi-use	3.48	3.00
Specialist livestock	6.50	5.97
Stock fattening	41.27	42.59
Store sheep	9.34	8.56

These categories might not be regarded as the most appropriate, but were dictated by the available data base.

Table 3

The Farm Area Distribution of the Sample

Area (ha)	Percent	
	Population	Sample
< 25	7.28	7.01
25 to < 50	14.04	14.21
50 to < 75	16.08	16.37
75 to < 100	11.31	11.49
100 to < 150	12.88	13.01
150 to < 200	8.97	8.94
200 to < 300	11.94	12.08
300 to < 400	5.79	5.62
400 to < 500	3.06	2.97
500 to < 750	3.67	3.55
750 to < 1000	1.53	1.39
1000 +	3.45	3.36

CHAPTER THREE

THE EFFICACY OF THE RESPONDING SAMPLE

To test the representativeness of the respondents their statistics can be compared to the population statistics for region, farm area and farm type as this data is held for the total population. In addition, for other statistics a sample of non-respondents was contacted by telephone to ascertain whether differences existed between them and respondents.

This testing is important as the response rate was not as high as was hoped. Of the 3097 questionnaires sent 287 need to be deducted to give the valid total. These were returned due to a range of reasons such as the farm recently being sold, gone no address, and so on. The number of valid responses was 1042 giving a response rate of 37.1%. This is similar to other surveys (Novak & Stegelin, 1988).

It is suspected the rate would have been higher if the questionnaire had been shorter, and had not involved what might be regarded as specialist areas - feed budgeting and computers. It was probably a mistake to label the questionnaire 'Feed Management and Computer Survey'. However, compared with many postal surveys the response was acceptable and, as indicated by the statistics presented below, it is highly likely the data collected was representative of the population.

Tables 4, 5 and 6 compare the responding samples' with the population according to region, land use and farm area distribution.

Table 4

Comparison of the Population and Sample Regional Distribution

Percent

Region	Population	Sample	Difference
Northland	6.45	7.97	+ 1.52
Auckland	4.65	3.26	- 1.39
Waikato	22.63	21.31	- 1.32
Bay of Plenty	4.18	3.93	- 0.25
Gisborne	2.10	1.44	- 0.66
Hawkes Bay	3.90	4.13	+ 0.23
Taranaki	8.22	8.16	- 0.06
Manawatu - Wanganui	10.66	9.40	- 1.26
Wellington	3.00	2.88	- 0.12
Tasman	1.28	0.96	- 0.32
Marlborough	2.42	1.34	- 1.08
West Coast	1.35	1.06	- 0.29
Canterbury	12.77	15.74	+ 2.97
Otago	7.31	7.58	+ 0.27
Southland	9.03	10.84	+ 1.81

Table 5

Comparison of the Population and Sample Land Use Distribution

Percent

Land Use	Population	Sample	Difference
Arable	3.74	4.22	+ 0.48
Dairying	35.66	37.72	+ 2.06
Multi - use	3.48	1.92	- 1.56
Specialist livestock	6.50	2.21	- 4.29
Stock fattening	41.27	46.35	+ 5.08
Store sheep	9.34	7.58	- 1.76

Table 6

Comparison of the Population and Sample Farm Area Distribution

Percent

Area (ha)	Population	Sample	Difference
< 25	7.28	2.69	- 4.59
25 to < 50	14.04	11.90	- 2.14
50 to < 75	16.08	17.08	+ 1.00
75 to < 100	11.31	12.38	+ 1.07
100 to < 150	12.88	12.86	- 0.02
150 to < 200	8.97	11.23	+ 2.26
200 to < 300	11.94	13.53	+ 1.59
300 to < 400	5.79	6.62	+ 0.83
400 to < 500	3.06	3.84	+ 0.78
500 to < 750	3.67	3.74	+ 0.07
750 to < 1000	1.53	0.93	- 0.60
1000 +	3.45	3.17	- 0.28

While there are some minor discrepancies, for example there are quite a few more stock fattening properties in the sample than might be expected, and there are rather less small properties (< 25 ha), overall the responding sample is a reasonable representation for these broad categories on an independent basis. The real test is the combined regional, land use and area groups. These are not listed here as there are 1080 groupings. However, a chi - squared test shows these groups are not significantly different; indeed the probability that they come from the same distribution was 1.0.

Following the cut-off date for accepting questionnaires a non-respondents survey was conducted to determine whether the responders were biased in one or more aspects. Following advice from an experienced market surveyor [1] efforts were made to contact approximately fifty non-responders. A telephone interview was carried out using essentially the same survey schedule as that posted. The questions excluded were those requiring thought and extensive replies.

Seventy one farmers were randomly selected from the non-responders main database - the distributions was based on the original stratification. Of these, phone numbers were found for fifty seven, the remainder were unable to be located in phone books. Attempts were made to ring all these farmers but 15 were unsuitable for a number of reasons (no such number, wouldn't respond, retired, poultry farm ...) leaving 42 valid responses.

Details for each of these farmers and farms were then compared with the data distributions and averages obtained from the postal responders. The following table lists the items compared and the probability that the two samples were drawn the same population.

[1] More, C., Lincoln University

Table 7

A Comparison Between the Responders and Non-Responders -

Probability* of Difference

Item	Probability
Farmers' age distribution	0.685
Farmers' average age	0.464
Farm type distribution	0.385
Farmers' education distribution	0.645
Use of feed budgeting distribution	0.560
Reasons for not using feed budgeting	0.576
Major difficulties and problems with feed budgeting	0.108
Computer ownership distribution	0.493
Average No. of years of computer ownership	0.894 +
Average No. of years until computer ownership	0.186
Type of computer distribution	0.272
Computer profitability distribution	0.564
Computer use practices	0.783
Average hours/month on financial budgeting	0.342
Average hours/month on livestock recording	0.365
Average hours/month on payroll work	0.337
Average hours/month on enterprise budgeting	0.546
Average hours/month on paddock recording	0.196
Average hours/month on letter or report writing	0.076
Average hours/month on financial recording	0.823 +
Average hours/month on spreadsheet work	0.516
Average hours/month feed budgeting	0.082

*From either Chi-square or F statistic calculations.

In order for a statistically significant difference between the responders and non-responders to be established, it is necessary for the probability of difference to be at least 90 per cent. In two areas (marked with +) the probability of difference approaches this level but for the majority of the factors, the probability of difference is well below the 90 per cent mark. This suggests very strongly that the non-responders were similar to the responders. Together with the population-sample comparisons, this provides considerable confidence in the results providing a good representation of the national situation.

CHAPTER FOUR

FARMER AND FARM CHARACTERISTICS

The following tables contain the data which describes the farmers and their farms. This was collected to determine whether there were any relationships between these attributes, feed management and computer practices.

Table 8

Farmer's Age Distribution

Age Groups (years)	Percent	
< = 30	9.4	
31 - 40	29.0	Mean 44.72 years
41 - 50	31.3	Std. dev. 11.09 years
51 - 60	21.5	Minimum 21 years
61 - 70	7.6	Maximum 80 years
71 - 80	1.2	

Table 9

Farmer's Formal Education Levels

Highest Level of Formal Education	Percent
No formal education	0.2
Primary school	3.5
Four or less years of secondary school	60.0
More than fours years of secondary school	11.0
Two or less years of tertiary education	14.4
More than two years of tertiary education	10.9

Table 10

The Farm Type Distribution

Type	Percent
Mixed cropping	10.0
Dairying	37.1
Deer	1.4
Sheep and Beef	17.4
Sheep	24.7
Beef	7.0
Other	2.4

Table 11

Farm Size As Reflected by the Stock Units

Stock Unit Range		Percent
0	-	100011.6
1001	-	200026.6
2001	-	300019.1
3001	-	400014.4
4001	-	50009.4
5001	-	60005.9
6001	-	70002.6
7001	-	80002.2
8001	-	90001.2
9001	-	100001.0
11001	-	120000.5
12001	-	130000.6
13001	-	140000.4
14001	+	2.9

Note that the regional and area distributions were presented in Tables 4 and 6. The farm type distribution is different from the land use information. The latter was obtained from the Valuation New Zealand data base, whereas the former was based on the data provided by the respondents. The farm types were based on the importance of each type of production. Firstly, all activity was converted into a stock unit (SU) equivalent using the parameters sheep = 1.1 SUs, beef = 5 SUs, dairy cattle = 7 SUs, goats = 0.9 SUs, deer = 1.75 SUs, pigs = 2.5 SUs, horses = 7 SUs, crops = 15 SUs/ha, all 'other' = 6 SUs/ha.

Secondly each farm was classified using the following criteria:

Farm Type	**S.U. Requirement**
Mixed cropping	> 20% of SUs in crop
Dairy	> 50% of SUs in dairy cattle
Hort/Orchard (other)	> 50% of SUs in horticultural crops
Deer	> 50% of SUs in deer
Sheep/beef	> 30% of SUs in sheep and > 20% of SUs in beef cattle
Sheep	> 50% of SUs in sheep
Beef	> 50% of SUs in beef cattle
Other	All Hort/Orchard and any others

The age distribution exhibits a significant number of younger managers, whereas the education distribution demonstrates an appreciable number of farmers leave school before the higher class ranges. Despite this there are still significant percentages (24% in total) that have tertiary experience. Unfortunately it is not possible to compare this to population figures. It is also interesting to note that dairy and sheep farmers tend to be younger than mixed farm types. The average ages (years) are mixed cropping 46.6, dairy 43.1, deer 49.1, sheep/beef 46.2, sheep 43.4, beef 50.3 and other 44.4 ($F = 5.04$, $pr = 0.0001$).

CHAPTER FIVE

FEED MANAGEMENT AND PROBLEMS

5.1 Introduction

Consultants and researchers have frequently advocated the use of detailed feed planning. This involves organising feed supplies and stock demand such that the two converge most of the time with due consideration to the costs and returns. The ultimate procedure involves feed budgeting - a procedure in which detailed forecasts are made of the supplies and demands. This might be on a weekly basis and would usually involve frequent updates. As will be noted below, in reality only a minority of farmers engage in feed budgeting even though most practitioners regard it as a worthwhile practice.

The data presented in this chapter explore feed budgeting practices with a view to elucidating some of the problems and difficulties as well as the advantages. With this kind of information there may be clues as to how systems can be improved. The data also focuses on feed management problems in general. Attempts to relate feed budgeting practices to farmer and farm attributes is also reported. Again, this information may be helpful in suggesting ways and means of improving management, and provides research targets.

5.2 Decision problems

Respondents were asked to list the feed management decisions that they found difficult to answer in each of the seasons. The responses, while all presented in slightly different ways, tended to fall into a range of categories. The following tables list these for each season and give the percentage of respondents mentioning each one. Where possible problems common to all types of stock farms have been amalgamated.

Table 12

Feed Management Decisions That Farmers Find Difficult to Answer

SPRING (N = 783)	%
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows	20.1
How much can I afford to take out of rotation for hay or silage (when to shut up for silage/when to cut silage, correctly identifying a surplus)	13.4
Coping with an unforeseen feed shortage (priority animals, if worse - options)	11.1
Stocking rate and mix of capital to trading stock (cattle to sheep ratio)	6.1
Controlling pasture quality (topping etc.)	6.0
Use of growth boosting fertiliser (includes nitrogen), and when to apply	4.6
Calving/lambing dates/patterns	4.5
Balancing the needs of different mobs (priorities)	4.3
Parturition feed management (stocking rate for lambing)	4.1
Weaning, balance feed and age of lambs/calves	3.6
Controlling the pugging problem	3.4
Buying/use of supplements for milkers (buying/availability of high energy supplements e.g. barley, maize economics)	2.8
Selling stock	2.8
Technical/diagnostic type problems	2.6
Post parturition feed management, rotation speed of cows in early lactation (feeding of the dairy herd after calving)	2.4
Whether to put in winter feed and/or summer feed crop	2.0
Pre-parturition feed management	1.8
Use of surplus feed (buying in lambs, sell grazing, hay or silage)	1.7
When to induce late cows	1.1
Calf rearing (feeding - amount)	0.6
How much and how often to feed stock in bad weather	0.6
Management of the ewes after weaning	0.1
How to feed stags to maximise velvet production	0.1

Table 13

Feed Management Decisions That Farmers Find Difficult to Answer

SUMMER (N = 583)	%
Controlling pasture quality (topping, deferred grazing and bring in again)	22.6
How much can I afford to take out of rotation for hay or silage (when to shut up for silage/when to cut silage, correctly identifying a surplus)	13.7
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows	11.5
When to sell trading (prime) stock-keep another week or sell	9.6
Coping with an unforeseen feed shortage (priority animals, if worse - options)	8.4
Weaning, balance feed and age of lambs/calves	5.3
When to sell, culls, (culling cows)	5.3
Stocking rate and mix of capital to trading (cattle to sheep ratio)	3.8
Balancing the needs of different mobs (priorities)	3.6
Technical diagnostic type problems	3.3
When/how much forage crop to plant	3.1
Feed management with regard to the use of hay, ASP, etc (when to start, when to stop, other supplements and combinations of)	2.9
When to start irrigation	1.4
Flushing ewes, what on and where	1.0
What supplement to buy in for autumn/winter	1.0
Use of growth boosting fertiliser (includes nitrogen)	1.0
When to dry off a group/herd of cows (autumn calvers)	0.9
What stock to buy in	0.7
When to dry-off individual cows (low producers, also drying off progressively)	0.7
When to start mating	0.5
When to put young light cows on once a day milking	0.3
Planning for a seasonal shortage (regular, planning for a yearly feeding pattern)	0.3
When to renovate pastures	0.3
When to start feeding crops	0.3
Shearing time (when to/whether to shear lambs)	0.2

Table 14
Feed Management Decisions That Farmers Find Difficult to Answer

AUTUMN (N = 639)	%
When to dry off herd/group (spring calvers)	17.7
Quantity of feed to conserve/accumulate for winter (how much/when to shut it up)	15.0
When to sell trading (prime) stock-keep another week or sell	9.1
Flushing decision when and how much (use grain, go off farm)	8.9
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows	8.5
Coping with an unforeseen feed shortage (priority animals, if worse, options)	6.9
Stocking rate and mix of capital to trading stock (cattle to sheep ratio)	6.3
Autumn feed management with regard to the use of hay, ASP, etc (when to start, when to stop, other supplements and combinations of)	4.5
Use of growth boosting fertiliser (includes nitrogen, when/how much)	4.4
Controlling pasture quality (topping, deferred grazing and bring in again)	3.4
Balancing the needs of different mobs (priorities, same mob later, deferred grazing)	3.4
Technical/diagnostic type problems	2.7
Sale/culling of surplus cattle/hoggets etc	2.5
Undersowing/oversowing options (mix), and when	1.7
When to put the ram/bull out (what ram to put out, wool or meat breed)	0.9
When to move to once a day milking	0.9
Buying/use of supplements for milkers (buying/availability of high energy supplements e.g. barley, maize economics)	0.8
Weaning, balance feed and age of lambs/calves	0.8
Hogget management (when to start feeding forage crops)	0.6
Irrigation, when to stop	0.5
When to dry-off individual cows	0.5

Table 15
Feed Management Decisions That Farmers Find Difficult to Answer

WINTER (N = 502)	%
Winter feed management with regards to grazing pattern (rotation length, fast or slow, mob split, etc.)	34.7
Winter feed management with regard to the use of hay, ASP, etc (when to start, when to stop, other supplements and combinations of)	21.9
Controlling the winter pugging problem but need to maintain rotation as best can	16.7
Stocking rate and mix of capital to trading stock (cattle to sheep ratio)	6.0
Coping with an unforeseen feed shortage (priority animals)	5.4
Balancing the needs of different mobs (priorities)	3.8
Technical/diagnostic type problems	2.8
Use of growth boosting fertiliser (includes nitrogen when/how much)	2.4
How much and how often to feed stock in bad weather	1.6
Grazing off (cost)	1.2
Feeding young stock relative to other demands	1.0
Controlling pasture quality (topping, deferred grazing and bring in again)	0.8
When to shear	0.8
Planning for a seasonal shortage (regular, planning for a yearly feeding pattern)	0.4
Sale of trading stock	0.4
When to induce cows	0.2

While there is a wide range of problems, a limited number emerge as the major difficulties. These include:

Rotational &/or set stocking conundrums.
Feed conservation - when, how much.
Coping with unforeseen shortages.
Controlling pasture quality.
When to dry off milking cows.
Winter feed management.
Controlling pugging.

This evidence clearly points to the areas when computer assisted decision aids, such as expert systems, may well be of assistance.

5.3 Ideas to Improve Feed Management

The respondents were asked to express their views about information, procedures, assistance .. that might improve feed management and/or make the system easier to implement or more efficient than those currently available. Tables 16 & 17 contain a summary of their comments and the percentage of respondents making the comment.

Table 16

Systems and/or Assistance Necessary to Make Feed Management More Effective

(N = 623)	%
Improved weather forecasts and calculation of DM available.	24.7
Better information on pasture plants and fodder production patterns (e.g. more information on new plants like sala Brome which can stand rougher grazing treatment, pasture response to irrigation to assist scheduling, higher producing/more resistant pasture plants, what to grow, wastage, utilisation).	14.8
Localised records on factors affecting production (e.g. regional monitoring of rainfall, temp, soil temp, and soil moisture: ground temperature readings for local areas for better direction on grass growth, daily/weekly growth rate data for pasture by district and soil type).	12.0
Better/easier to use system to measure/calc pasture growth/usage/wastage, inexpensive way of calculating DM available for stock requirement.	7.7
Better market information (i.e. information showing average best times to buy and sell (e.g. what time of year on average are bulls the cheapest per kilo to buy), more feedback from meat companies and marketing organisations (highs and lows)).	6.9
Technical/diagnostic type information/systems (better/faster).	6.4
Better information on feed requirements (e.g. simple charts showing acreage of certain lengths of grass required for stock for next 1-3 months).	5.3
Monthly local farm discussion groups to pool ideas.	5.0
Better information on alternatives (incl. information on new supplements as they become available, cheap high energy supplements, better information on the different feeds).	4.5
Better information on animal growth and development (e.g. lamb and cattle growth rates, optimum achievable levels per day to allow you to see how your system compares, a list of other control or stock management policies that could be implemented to a purely finishing stock system, milk production on different pasture including fat: protein ratio).	3.5
Local training workshops (incl. on feed budgeting).	3.4
A computer model that allows experimenting with supplements, nitrogen, off-farm grazing, different grazing lengths.	2.9
A pasture measuring system that measures DM content (seasonal DM content differences make a mockery of current equations).	1.9
Bureaus etc. to perform calculations.	0.3

Table 17
Ideas to Make Feed Management Easier or More Efficient

(N = 90)	%
Always budget on having excess feed to accommodate any season (having extra supplements for those really bad years.)	43.3
Better local information on grass and fodder production etc.	8.9
Clear easy to read feeding tables/graphs (general stock requirements at time of year and all types of feed values for time of year).	8.9
Grasses which produce plenty of quality feed in dry spells, alternative species.	8.9
Better/easier grass measurement.	6.7
Technical/diagnostic information on minerals and protein in plants and effects on animal.	6.7
Localised records on factors affecting production (e.g. regional monitoring of rainfall, temp, soil temp, and soil moisture: ground temperature readings for local areas for better direction on grass growth, daily/weekly growth rate data for pasture by district and soil type).	5.6
Specialists who can be employed to help.	4.4
Better/easier LW calculations.	3.3
Better computer software (easier to use and more powerful).	2.2
Courses on feed budgeting etc.	1.1

Clearly there is a demand for more extensive but locally based data and information on factors affecting production and requirements. Many producers also noted that a conservative approach was a key to success (always budget for a buffering surplus).

5.4 Feed Budgeting

As noted earlier, many professionals and farmers believe formal feed budgeting is technically and financially beneficial. Yet, it is not a common practice. The following tables explore farmers' use of feed budgeting.

Table 18
Farmers' Use of Feed Budgeting
(N - 1041)

Budgeting Use	Percent Responders	Non-Responders
Have never used formal feed budgeting	68.6	76.2
Used to use formal feed budgeting	10.3	4.8
Currently use formal feed budgeting	21.1	19.0

A surprising number of farmers believe they use feed budgeting, though exactly how they interpret the meaning of the words "feed budgeting" is, clearly, not known. However even the non-respondenders gave a high figure. This was somewhat of a surprise as with the survey being labelled as a feed management investigation you would expect the enthusiasts to reply.

Table 19
Hours per Month Devoted to Feed Budgeting

(N = 262)

Hours	Percent	Hours	Percent
0-1	16.5	6.1 - 7	1.2
1.1 - 2	21.7	7.1 - 8	6.1
2.1 - 3	8.0	8.1 - 9	1.1
3.1 - 4	21.4	9.1 - 10	3.8
4.1 - 5	7.3	10.1 - 11	0.8
5.1 - 6	6.9	11.1 - 12	1.5
		12.1 +	5.8

Mean 4.62
Standard deviation 4.74
Range 0.15 - 40.0

Some 76% of respondents spend less than one hour per week on feed budgeting suggesting the majority of the 21% carry out fairly informal calculations.

Table 20
Effect of Age on Time Devoted to Feed Budgeting

Age Range (yrs)	Ave. Hours/Month	No. of Respondents
0 - 30	7.12	48
31 - 40	4.01	106
41 - 50	4.44	68
51 - 60	4.64	30
61 - 70	3.42	6
71 +	24.00	2

An analysis of variance showed the differences were highly significant. (F = 4.55 pr = .0005) and a comparison of paired means indicated the first three were different (using the t test @ 5%) as was the last group (but small number). Youth clearly breeds enthusiasm. This is also borne out by Table 21.

Table 21
Use of Feed Budgeting Relative to Age

Use of Feed Budgeting	Mean Age (Yrs)
Never used	46.90
Used to use	40.96
Currently use	39.46

(F = 46.61 pr = .0001)

The paired t tests show differences (@ 5%) between 'never used' and the other two groups but not between 'used to' and 'currently'.

Dairy farmers in particular are the most important users of feed budgeting with nearly a third in the 'currently use' category.

Table 22

Relationships Between Farm Type and Feed Budgeting
(N = 1041)
Use of Feed Percentages on a Row Basis Budgeting

Farm Type	Never Used	Used to use	Currently Use
Mixed cropping	74.0	10.6	15.4
Dairy	58.8	9.8	31.3
Deer	80.0	13.3	6.7
Sheep/Beef	76.2	12.1	11.6
Sheep	71.2	11.3	17.5
Beef	82.2	4.1	13.7
Other	68.0	8.0	24.0

Dairy farmers in particular are the most important users of feed budgeting with nearly a third in the 'currently use' category.

Table 23

Hours Per Month Spent on Feed Budgeting Relative to Farm Type

(N = 267)

Farm Type	Ave. Hours/Month
Mixed cropping	3.76
Dairy	4.51
Deer	6.00
Sheep/beef	4.97
Sheep	5.12
Beef	8.83

(F = 0.92 pr = 0.483)

These apparent differences were not statistically significant.

Table 24

Relationship Between Education and Feed Budgeting
Column Percentages

(N = 1020)

Use of Feed Budgeting	Education Level - Highest Attained					
			Secondary		Tertiary	
	No Formal	Primary	≤ 4 yrs	> 4 yrs	≤ 2 yrs	> 2 yrs
Never used	100.0	91.7	75.3	57.1	53.7	51.3
Used to use	0.0	0.0	7.0	18.8	17.7	15.3
Currently use	0.0	8.3	17.7	24.1	28.6	33.4

(X^2 = 65.61, Pr = 0.0)

There is a clear relationship between the use of feed budgeting and education level. When comparing the hours on feed budgeting with education, capital value and total stock units there were no significant relationships.

To be able to predict whether a farmer is likely to practice feed budgeting a LOGIT (Pindyck and Rubenfeld, 1976) analysis was carried out. The dependent variable is

$$Z = \log\left(\frac{P_i}{1 - P_i}\right)$$

Where P_i is the probability, in this case, of the $_i$th individual using formal feed budgeting. The best and most logical equation was

$$Z = 0.361\ E - 0.393\ F - 0.466A$$

Where E = education level
F = farm code
& A = age code

The age codes are given in table 8, and the education levels in table 9. (The codes/levels start at 1 (less than 30 years, no formal education), and progress through to 6 (greater than 71 years) and more than two years of tertiary education). The farm codes express the degree of intensity starting at 1 for dairying, 2 for mixed cropping, and 3 for all other farms.

The model statistics indicate a good fit and significance. The Akaike Information Criterion and the individual coefficients were all highly significant, and the Tau - c was 0.717 indicating a good ranking between observed and predicted outcomes.

To aid interpretation of the equation it is useful to provide a table of the probability of using feed budgeting for various combinations of the independent variables. Table 25 contains this data for combinations for which observations existed.

Table 25

Probability of a Farmer Using Feed Budgeting for Various Combinations of Farm Code, Farmer Age and Level of Education.

(See text for code meaning)

Farm Code	Age Code	Education Level	Probability	Farm Code	Age Code	Education Level	Probability
1	1	3	0.55570	2	3	6	0.49542
1	1	4	0.64212	2	4	2	0.12703
1	1	5	0.72019	2	4	3	0.17269
1	1	6	0.78689	2	4	5	0.30049
1	2	3	0.43978	2	4	6	0.38128
1	2	4	0.52966	2	5	1	0.05985
1	2	5	0.61766	2	5	2	0.08369
1	2	6	0.69856	2	5	3	0.11584
1	3	2	0.25565	2	6	1	0.03842
1	3	3	0.33007	2	6	2	0.05421
1	3	4	0.41410	3	1	3	0.36304
1	3	5	0.50345	3	1	4	0.44983
1	3	6	0.59258	3	1	5	0.53979
1	4	2	0.17733	3	1	6	0.62722
1	4	3	0.23619	3	2	2	0.19959
1	4	4	0.30729	3	2	3	0.26347
1	4	5	0.38889	3	2	4	0.33913
1	4	6	0.47723	3	2	5	0.42401
1	5	2	0.11917	3	2	6	0.51363
1	5	3	0.16253	3	3	2	0.13533
1	5	4	0.21778	3	3	3	0.18335
1	5	5	0.28540	3	3	4	0.24361
1	5	6	0.36425	3	3	5	0.31602
1	6	2	0.07827	3	3	6	0.39860
1	6	4	0.14875	3	4	2	0.08944
1	6	6	0.26449	3	4	3	0.12351
2	1	3	0.45779	3	4	4	0.16815
2	1	4	0.54776	3	4	5	0.22479
2	1	5	0.63471	3	4	6	0.29378
2	1	6	0.71367	3	5	2	0.05807
2	2	2	0.26975	3	5	3	0.08125
2	2	3	0.34637	3	5	4	0.11259
2	2	4	0.43188	3	5	5	0.15398
2	2	5	0.52165	3	5	6	0.20703
2	2	6	0.61004	3	6	2	0.03725
2	3	3	0.24958	3	6	2	0.05259
2	3	4	0.32300	3	6	6	0.14079

Clearly, the younger, more highly educated farmers are more likely to use formal feed budgeting.

To obtain ideas on how feed budgeting might be made more accessible, producers were asked why they didn't use the technique, or why they had stopped using it. The responses are in table 26.

Table 26
Reasons for Not Using Feed Budgeting

(N = 658)

Reason	Percent
No need, do it in head, never needed to, no benefits, use experience, can't be bothered, not interested.	60.2
Too complicated, don't understand, don't know how.	10.3
Variable climatic conditions make carefully planned feed budgets of little value in some seasons.	10.3
Insufficient time and resources.	9.4
Have learnt all the lessons, rely on past experience.	4.7
No confidence/experience in pasture/animal requirement estimates.	3.2
Accept that it's important and taking steps to start.	1.1
Perceived to be not accurate enough.	0.8

The majority believe feed budgeting would be of little benefit to them, whereas a significant number of others believe training would help. Risk and uncertainty invalidating the results is also a factor. Table 27 contains feed budgeters' comments on the difficulties they experienced and these also indicate similar conclusions.

Table 27

Difficulties and Problems Experienced by Feed Budgeting Practitioners
(N = 202)

Difficulty/Problem	Percent
Extra time and resources required (need for regular updates, teaching staff, getting a computer, etc).	31.2
Can't predict the weather (the effect climate has on budget forecasts).	17.8
Inaccuracy in estimating pasture cover (time of year).	14.4
Lack of confidence in predictions.	9.4
Inaccuracy in predicting pasture growth rates.	9.4
Inaccuracy in predicting energy values of pasture.	5.4
Inaccuracy in predicting utilisation.	3.5
Inaccuracy in estimating animal requirement.	3.0
Including management options in the calculations is difficult.	2.0
Try to stick to plans when shouldn't - causing stress on man and beast.	2.0
Quality of supplements.	1.5
Without a computer it is hard to build up info and/or compare seasons.	0.5

When it comes to suggestions on how to improve feed budgeting the provision of more information and equipment seems to predominate. Table 28 contains the limited number of responses that were provided.

Table 28

Comments on Improving Feed Budgeting
(N = 24)

Idea	Percent
Better measuring equipment (DM, probe, etc.).	25.0
Standardised system throughout the country.	25.0
Better/more readily available growth data for each district (incl. nutrient data).	12.5
Low cost technical service to do measuring and/or calculations (budget) for the farmer (bureau).	12.5
Better training/teaching resources/courses (short-courses).	12.5
Better/easier to use software.	4.2
A pre-programmed calculator of paddock number and sizes to make it easier to determine farm pasture cover.	4.2
Introduction of clear easy to read feeding tables/graphs (general stock requirements at time of year and all types of feed values for time of year).	4.2

In contrast to the difficulties and problems, Table 29 lists the benefits feed budgeters believe they obtain from the practice.

Table 29

The Benefits obtained from Feed Budgeting
(N = 145)

Benefit	Percent
Easier to determine when to perform critical tasks such as drying off, weaning, when to shut up, lambing/calving date.	31.0
Efficiency improvements (incl. increased stocking rate, better use of feed, stock ready on time, know when to induce, etc.).	24.1
Predicts surpluses and therefore allows time to plan.	17.9
Predicts shortages and therefore allows time to plan.	11.0
Sense of security, greater satisfaction, less panic decisions, sleep better at nights, peace of mind.	11.0
Find out the high and low producing areas of the farm and the recovery times of these areas post-grazing.	2.1
Greater control over what is happening on the farm.	1.4
Building up growth rate data for the property.	1.4

Regarding the techniques and procedures used by feed budgeters, the following tables give such factors as the methods used to perform the calculations, the calculation units used, period lengths, and so on.

Table 30

Feed Budget Calculation Methods
(N = 321)

Method	Percent
With pencil, paper and/or calculator	82.6
Personal computer	6.4
Hand held computer	2.8
Other	6.4

Table 31

Units Used in Feed Budgeting

(N = 327)

Unit	Percent
Kgs of dry matter/lbs of dry matter	72.5
Stock units/ewe equivalents.	46.8
Calories/megajoules	10.1
Cow/sheep grazing days.	50.8
Other	4.6

Note these are not exclusive.

Table 32

Feed Budgeting Techniques

(N = 327)

Technique	Percent
Cut and weigh feed production	5.8
Estimate feed production by eye	79.8
Use a pasture probe/plate	20.5
Regularly weigh livestock	26.6
Estimate animal weight/condition	51.4
Other	6.4

Table 33

Basic Frame for Feed Budget Calculations

(N = 327)

Frame	Percent
Calculations based on individual paddocks	54.7
Calculations based on groups of paddocks	28.4
Requirement calculations based on individual mobs	58.4
Requirement calculations based on combined mobs	20.2
Various other	7.6

Table 34

Period Ahead for which Forecast Feed Demand/Supply

Period Ahead (weeks)	Percent
< = 2.0	15.6
2.1 - 4.0	33.8
4.1 - 6.0	11.5
6.1 - 8.0	8.9
8.1 - 10.0	1.5
10.1 - 12.0	11.9
> 12.0	17.0

Mean 8.20, Std devn = 8.96, range 1 - 52.0

Table 35

Average Number of Weeks Between Updates of Feed Budgets

Percent in each season

Week Range	Spring	Summer	Autumn	Winter
< = 1.0	40.2	21.1	24.2	25.4
1.1 - 2.0	25.2	20.4	29.8	29.5
2.1 - 3.0	8.0	17.2	13.6	10.2
3.1 - 4.0	20.9	28.9	26.8	27.0
> 4.0	5.7	12.6	5.5	7.7
n =	187	128	198	244
Mean (weeks)	2.54	3.14	2.93	3.06

The traditional methods of pencil, paper and calculator using dry matter units with eye estimation clearly predominate.

The feed budgets are updated every four weeks or so, and are calculated for a slightly reduced period. Presumably there is a gap between the end of one calculation and the next update.

CHAPTER SIX

COMPUTERS ON FARMS

6.1 Introduction

Computers are becoming an increasingly important component of farmers' decision making. When personal computers were first introduced the majority of farmers did not believe they would be of value. This situation has changed, though there is still a major software development, as well as a general education task ahead of those involved in the industry. As the success of feed management procedures is likely to be related to computers it is important to study the current situation regarding their use and uptake. This leads to conclusions on how to proceed to ensure the assistance computers can provide is maximised.

Personal computers at what many would regard as an economic price have only been available for six or so years. Furthermore, it was only some thirteen years ago that they first appeared, but over this time many researchers have studied their use. Many of these studies have contained views on what is possible, in contrast to reports on what is actually happening though these are now starting to appear as the data is becoming available.

Some examples include Scudamore (1985), The Development of On-farm Computer Systems, Duttweiler (1985), The Farm Computer - Possibilities and Limitations, Sonka (1986), Computer Aided Farm Management Systems - Will the Promise be Fulfilled; Adamowicz et al (1986), An Assessment of Current and Potential Use of On-Farm Computers, Ohlmer (1989), Farm Management Information Systems Based on Farmer Operated Computers - Development, Use and Effects, Powell et al (1990), Computer Use and Nebraska Farmers - Implications for Farm Management Extension Education, Ohlmer (1991), On-Farm Computers for Farm Management in Sweden: Potentials and Problems. It is interesting to note the changing titles as the years have passed.

This chapter contains the responses provided by the respondents both about their ownership and use of computers and their views on potential ownership if they are yet to purchase. The data is analysed to explore the uptake rate situation, and to relate farmers and farm characteristics to ownership and use. It is interesting to note that Pryde and McCartin (1987) found that in 1986 some 6% of New Zealand farmers had a computer, whereas this survey suggests the 1993 figure has increased to around 20%. In 1990 Nuthall (1992) surveyed a group of farmers receiving a computer newsletter - the respondents believed some 8.4% of producers had a computer. This latter survey involved 1244 producers with a computer, and 458 non-owners. While not a random sample, the respondent's views on computers need to be considered seriously due to the large number. Comparisons will be provided later in the report.

6.2 Uptake of Computers

Scudamore (1985) believes, as do many others, that computers will become an integral part of farming. As noted above, this has not happened yet. Gibbon and Warren (1992) discuss some of the barriers to adoption and conclude that reducing 'the cost of experimentation' (allowing producers to try a computer without a large outlay) would be a major benefit. Education must also be an important factor. Studies in the United States (Putler and Zilberman (1988), Batte et al (1990), Jarvis (1990)) clearly show that there is a strong correlation between a producers level of education and computer ownership. It is likely education breaks down the barrier of a fear of the unknown and, perhaps, a belief that a computer is too complex. It will be shown that a similar conclusion is also possible in New Zealand. Age and farm size also seem to be important in most of the studies. In contrast, Baker (1992) found that in agribusiness the age and education of the manager was not important - in these cases the size and type of business was relevant. All these conclusions clearly have implications for extension and computer software professionals.

The current farmer computer ownership situation in New Zealand is given in Table 36.

Table 36

Computer Ownership in New Zealand

(N = 1035)

Category	Percent
Own a computer	24.4
Have access to a computer	9.2
Do not own or have access	66.4

Of those with a computer 19.3% use it for business purposes leaving 5.1% who do not. The 19.3% contrasts with the 6% quoted above for 1986. These figures can be compared with the U.S. situation - 15% of New York dairy farmers (1988), 25% of Californian farmers (1986), and 16% of Ohio farmers (1990) (Batte et al (1990)).

Of those that do have a computer their length of ownership is given in Table 37.

Table 37
Length of Computer Ownership
(N = 240)

No of Years	Percent
≤ 1	25.5
1.1 - 2.0	10.8
2.1 - 3.0	15.4
3.1 - 4.0	7.9
4.1 - 5.0	10.0
5.1 - 6.0	9.6
6.1 - 7.0	4.6
7.1 - 8.0	6.7
8.1 - 9.0	2.1
9.1 - 10.0	5.8
> 10.0	1.6

Mean = 4.15 years
Std. devn. = 3.19 years
Range 0.01 to 20.0 years.

If the trend continues the numbers of new entrants to computing should continue to rise. Table 38 gives the expected number of years before the non-owners anticipate they will purchase.

Table 38
The Number of Years Before Buying
(or Starting to Use for Business) a Computer

(N = 681)

No of years	Percent
≤ 1.0	8.0
1.1 - 2.0	9.2
2.1 - 3.0	5.6
3.1 - 4.0	2.8
4.1 - 5.0	8.2
> 5	3.2
Dont Know	14.1
Never	48.6

Mean = 3.28 years
Std. devn. = 2.51
Range 0.1 - 15.00

Taking all respondents, 19.3% use a business computer, 11.4% don't know when they will purchase, 39.2% believe they will never purchase, 27.5% will purchase over the next five years, and 2.6% will purchase in more than 5 years. It has taken about 13 years to reach a one fifth penetration and it will take another five years to achieve a further quarter penetration. The speed is increasing. It is suspected it will be even greater than this as the 40% who believe they'll never purchase are undoubtedly mistaken in the sense that some will, and others will be replaced by younger managers.

If the purchase date distribution is combined with the anticipated purchase date distribution it is possible to obtain an idea of where on the traditional sigmoid uptake curve New Zealand farmers are currently located. A good fit, after leaving out the 'Don't know' and 'Never' data, is obtained using the following exponentional sigmoid equation:

$$Y = 104.7/(1 + 1.042e^{-.342X})$$

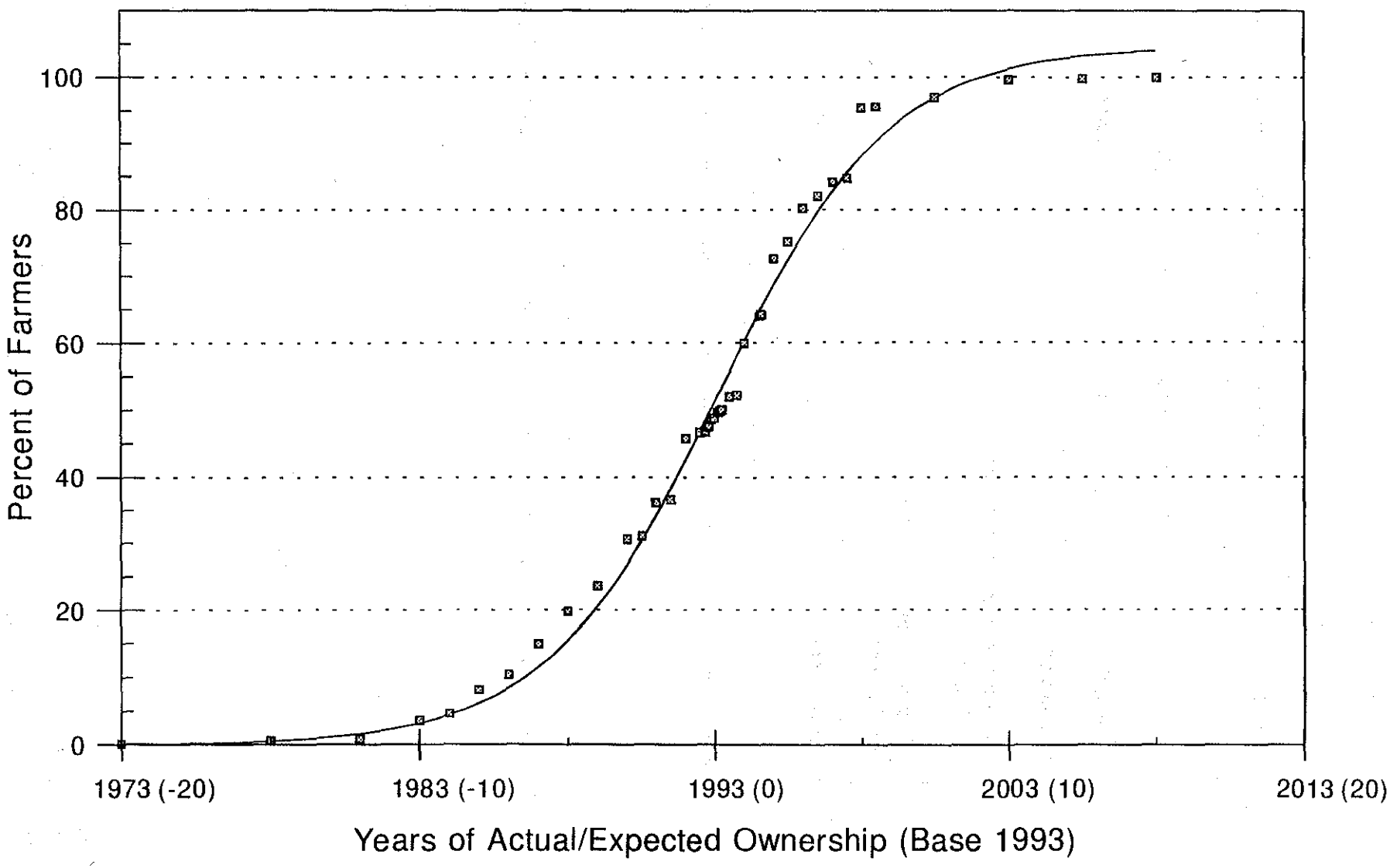
Where Y = The cumulative percent of producers owning a business computer.

X = The number of years of ownership. (X goes from -20 to +20 with 1993 being 0. It in fact goes beyond these dates but the curve for periods beyond ± 10 years is virtually horizontal to the X axis).

While a non-linear regression technique was used to obtain the curve (Gauss - Newton method utilizing a Taylor series expansion - Pindyck & Rubenfeld (1976) page 228) so that the normal statistics are not strictly valid, they give some indication of the usefulness of the equation. The F statistic suggested the equation was highly significant and the R^2 of 0.9976 indicates it explains most of the variation. If a cubic function is fitted to the data using linear regression a reasonable, but a less logical, fit is obtained. However, in this case the coefficients are valid. The R^2 was 0.9686 and $F = 380.45$ (pr = .0001).

A visual check of the plots suggested the exponential sigmoid was a better fit. Figure 2 gives the sigmoid curve. It must be remembered that producers who said they would never acquire a computer or who were non-specific about when, were not included. The curve suggests farmers are acquiring computers at the maximum rate they are ever likely to, and that this will proceed for some time yet. If an allowance is made for the 'nevers', this probably means the 'some time yet' is longer than the curve suggests (i.e. well beyond another 10 years).

Figure 2
Computer Uptake Rate



To better understand the factors affecting computer ownership the following tables relate age, education and farm size to ownership.

Table 39

Age Related to Computer Ownership

Category	Average Age (years)	No of Respondents
Do not own	45.65	647
Own a computer, but not used for business	44.70	51
Own a computer, and use for business	43.29	195
Have access only	41.00	93

(F = 6.09, pr = .0004)

Computer owners tend to be younger, but the differences are not great, though significant.

Table 40

Farm Land Capital Value Related to Computer Ownership

Category	Average Capital Value ($)	No. of Respondents
Do not own	438132	687
Own a computer, but not used for business	429849	53
Own a computer, and use for business	485510	200
Have access only	471063	95

(F = 2.43, pr = 0.0636)

Table 41

Total Stock Units Related to Computer Ownership

Category	Average Stock Units	No. of Respondents
Do not own	3146	679
Own a computer, but not used for business	3124	52
Own a computer, and use for business	4561	192
Have access only	6208	95

(F = 20.21, pr = .0001)

The data suggests larger farms are more likely to use a computer for business, and in the case of the total stock units (which includes an allowance for cash crops) this relationship tends to be stronger and significant. It is interesting to note the 'have access only' category, particularly in Table 41. Perhaps larger properties are prepared to hire their computer assistance.

Table 42

Education Related to Computer Ownership
(Column Percentages)

Highest Formal Education Level

Category	No Formal	Primary	Secondary ≤ 4 years	Secondary > 4 years	Tertiary ≤ 2 years	Tertiary > 2 years
Do not own	100.00	88.89	72.7	55.36	53.79	47.75
Own - but not business	-	-	6.25	20.54	11.03	16.22
Own - use for business	-	11.11	15.63	19.64	27.59	33.33
Have access only	-	-	5.43	4.46	7.59	2.70

(X^2 = 76.47, pr = 0.0)

Table 43

Education Related to Computer Ownership and Purchase Intentions
(Column Percentages)

Highest Formal Education Level

Category	No Formal	Primary	Secondary ≤ 4 years	Secondary > 4 years	Tertiary ≤ 2 years	Tertiary > 2 years
Own a Computer	-	16.67	20.27	25.26	33.33	37.00
Will buy	-	16.67	22.61	34.74	29.37	42.00
Maybe buy	-	-	11.70	9.47	13.49	9.00
Never buy	100.0	66.67	45.42	30.53	23.81	12.00

(X^2 = 76.47, pr = 0.00)

Tables 42 and 43 clearly show the relationship between computer ownership, or intended ownership, and formal education. That is, the higher the formal education, the more likely a farmer is to own, or intend to own, a computer. The differences in the cell percentages are highly significant.

The data on ownership and farm/er attributes was used to assess the probability of ownership through logit analysis. Given the significant relationships between education and total stock units with computer ownership it was logical to use these variables.

Given

$$Z = \log\left(\frac{P_i}{1 - P_i}\right)$$

Where P_i is the probability of the i^{th} individual owning a computer used for business, the equation obtained was

$$Z = 0.3048\ E + 0.0704\ S - 2.9159$$

where E = education level using the codes defined in section 5.4
S = total stock unit code where the codes are:

Code	S U Range	Code	S U Range
1	0 - 1000	9	8001 - 9000
2	1001 - 2000	10	9001 - 10000
3	2001 - 3000	11	10001 - 11000
4	3001 - 4000	12	11001 - 12000
5	4001 - 5000	13	12001 - 13000
6	5001 - 6000	14	13001 - 14000
7	6001 - 7000	15	> 14000
8	7001 - 8000		

The relationship was highly significant, the coefficients were similarly highly significant and Tau - c was 0.621 indicating a high correlation between predicted and observed probabilities.

Using the relationship the probability of a farmer with various combinations of education and stock unit codes having a computer can be calculated. Table 43 contains this data.

Table 44
Probability of Computer Ownership for Various Combinations of Education and Stock Units Held

Education Code	S.Unit Code	Probability	Education Code	S Unit Code	Probability
1	1	0.07306	4	3	0.18461
1	2	0.07797	4	4	0.19545
1	3	0.08319	4	5	0.20676
1	4	0.08872	4	6	0.21855
1	5	0.09458	4	7	0.23081
1	6	0.10079	4	8	0.24355
1	7	0.10735	4	9	0.25676
1	8	0.11429	4	10	0.27043
1	9	0.12161	4	11	0.28455
1	10	0.12934	4	12	0.29910
1	11	0.13748	4	13	0.31407
1	12	0.14604	4	14	0.32943
1	13	0.15505	4	15	0.34517
1	14	0.16450	5	1	0.21057
1	15	0.17441	5	2	0.22252
2	1	0.09658	5	3	0.23494
2	2	0.10290	5	4	0.24783
2	3	0.10958	5	5	0.26119
2	4	0.11665	5	6	0.27501
2	5	0.12410	5	7	0.28927
2	6	0.13196	5	8	0.30396
2	7	0.14024	5	9	0.31906
2	8	0.14895	5	10	0.33455
2	9	0.15810	5	11	0.35041
2	10	0.16770	5	12	0.36661
2	11	0.17776	5	13	0.38311
2	12	0.18829	5	14	0.39988
2	13	0.19929	5	15	0.41689
2	14	0.21076	6	1	0.26567
2	15	0.22272	6	2	0.27964
3	1	0.12663	6	3	0.29404
3	2	0.13463	6	4	0.30887
3	3	0.14305	6	5	0.32410
3	4	0.15190	6	6	0.33971
3	5	0.16120	6	7	0.35568
3	6	0.17095	6	8	0.37198
3	7	0.18116	6	9	0.38858
3	8	0.19184	6	10	0.40544
3	9	0.20300	6	11	0.42252
3	10	0.21463	6	12	0.43979
3	11	0.22674	6	13	0.45721
3	12	0.23932	6	14	0.47473
3	13	0.25238	6	15	0.49231
3	14	0.26590			
3	15	0.27987			
4	1	0.16434			
4	2	0.17424			

The probability of ownership rises to nearly 50% for highly formally educated farmers with a large property. In contrast, a small farm with a manager without formal education has only a 7% chance of being a computer owner.

If the same analysis is carried out for farmers intending to purchase a computer a similar equation is obtained. For those intending to purchase in three or less years the equation is:-

$$Z = 0.4394\,E + 0.00374S - 3.1751$$

and for greater than three years:

$$Z = 0.2464\,E + 0.0451S - 3.0375$$

The relationships were highly significant but the stock unit coefficient was not. Tau - c was 0.629 and 0.594 respectively.

6.3 Characteristics of Computers Held

Respondents were asked to specify details of their computer. This information needs to be considered when designing systems, though undoubtedly any design must recognise that computer capacity is increasing quite rapidly. It is not known however, how often farmers replace their computer. The following tables give the responses.

Table 45

Types of Computers Owned
(N = 243)

Type	Percent
IBM or IBM compatible	75.7
Apple McIntosh	3.7
CP/M Based	0.8
Other (Commodore 64, Atari, Amiga etc)	19.8

Table 46

Size of Hard Disk
(N = 158)

Size (Mbytes)	Percent	
≤ 20	27.2	
21 - 40	36.6	Mean = 53.3
41 - 60	6.9	Std. devn = 40.02
61 - 80	8.9	Range 1.0 - 240.0
81 - 100	4.4	
> 100	15.8	

Table 47

Size of Floppy Drives

Size (Kbytes)	Disk One (N = 125)	Disk Two (N = 49)
	Percent	Percent
≤ 1.22	49.6	18.4
> 1.22	50.4	82.6
Mean .	1.15	1.74
Std. Devn.	2.33	2.97
Range	0.2 - 800.0	1.0 - 800.0

Table 48

Random Access Memory
(N = 150)

Size (Mbytes)	Percent	
< 0.64	5.4	mean = 1.62
0.64	48.7	Std devn. = 2.35
0.65 - 1.0	18.1	Range 0.1 - 16.38
> 1.0	28.2	

Table 49

Type of Graphics Card
(N = 215)

Type	Percent
Hercules	5.6
EGA	6.0
CGA	3.3
VGA	24.7
Super VGA	25.6
Other	1.4
Do not know	33.5

Table 50

Type of Monitor
(N = 231)

Type	Percent
Monochrome	20.8
Paper white	2.6
Colour	74.9
Other	1.7

Table 51

Type of Printer
(N = 212)

Type	Percent
Dot matrix	90.6
Ink jet	2.8
Laser	3.8
Colour	2.8

Table 52

Other Hardware
(N = 41)

Type	Percent
Mouse	70.7
Modem	22.0
Other	7.2

(But note the small number replying)

Table 53

Operating system
(N = 253)

Type	Percent	
MS Dos	68.0)	
DR Dos	4.0)	= 74.8%
PC Dos	2.4)	
OS/2	0.4)	
MacIntosh	2.4	
CP/M	1.2	
Other	3.2	
Windows	25.7	

(The total is greater than 100% as some Windows users have also ticked MSDOS)

It is clear IBM Compatible computers using MSDOS with colour monitors and dot matrix printers predominate. Windows is also important. Hard disks are mainly 40 Mbytes or less. It would appear there are a wide range of floppy drive sizes.

6.4 Computer Profitability

With increasing numbers of producers investing in computer systems it is likely most believe reasonably significant benefits are available. As yet studies demonstrating ex post that a computer investment has been profitable are not available. Various studies have, however, reported that farmers believe computers have been profitable. Examples include Jofre - Giraudo et al (1990) and Nuthall (1992). The value of computerised decision models have also been studied. For example, Debertin et al (1981) found a percentage of farmers using a centrally operated linear programming model believed the assistance was beneficial.

For this study Table 54 contains the simple replies of whether the producers believe their computer has been profitable.

Table 54

Computer Profitability
(N = 224)

Category	Percent	Percent with Don't Knows Removed
Has been profitable	45.1	65.2
Just breaks even	8.5	12.3
Does not cover costs	15.6	22.5
Do not know	30.8	

The comparable figures reported by Nuthall (1992) are 'profitable' 56.3%, 'break even' 11.5%,'not covering costs' 10.3% and 'don't know' 21.9%. The greater number believing in the good economics of a computer in the specialist study is in part due to all respondents being business users of computers. It is clear, however, that around three quarters of producers who have an opinion believe a computer system has covered the costs. In the U.S. Batte et al (1990) found 83% of a sample of Ohio farmers believed their computer was 'useful', and Novak and Stegelin (1988) found 93% of their respondents were 'satisfied' with their computer experiences.

The age of respondents in the various profitability categories is given in Table 55.

Table 55

Computer Profitability and Age

Category	Average Age (years)	No of Respondents
A profitable investment	42.5	95
Just breaks even	43.5	17
Does not cover costs	47.7	20
Do not know	43.4	55

(F = 2.10, pr = 0.1016)

It would appear the younger farmers tend to believe their investment was profitable, though this conclusion is only marginally significant. When profitability was related to land value and total stock units there were no obvious correlations.

For education there was a tendency for those with a higher level of formal education to have an opinion (i.e. most of the 'don't knows' had an education code of 1 or 2). A logit analysis showed that there was a slight increase in the probability of a farmer believing the computer was profitable as formal education increased. Table 56 has the results.

Table 56

Probability of Believing a Computer is Profitable According to Education

Highest level of Formal Education	Probability
Primary	0.55646
≤ 4 years Secondary	0.58425
> 4 years Secondary	0.61150
≤ 2 years tertiary	0.63808
> 2 years tertiary	0.66384

This limited relationship was highly significant.

6.5 Computer Use and Practice

To direct software development and extension work it is useful to understand how farmers' computers are used. A range of studies have been conducted throughout the world. Three examples include Stewart (1984), Dancey (1985) and Nuthall (1992). Common conclusions are that computers are primarily used for financial management. This current study re-enforces their work and is particularly important as it is contemporary and the sample was randomly selected. The following tables present the data collected.

Table 57

Hours Per Week Devoted to Various Computer Uses
(N = 226)

Column Percentages

Hour Range	Business	Accessing Central D.Bases	Entertain-ment	Education	Community Work	Other
0 - 1.0	20.4	81.9	31.3	38.0	69.0	52.1
1.1 - 2.0	34.4	-	20.6	22.5	16.4	17.4
2.1 - 3.0	11.3	9.1	3.6	8.5	5.5	4.3
3.1 - 4.0	13.4	-	10.7	9.9	3.6	4.3
4.1 - 5.0	7.5	9.1	8.9	8.5	3.6	4.3
5.1 - 6.0	3.2	-	3.6	1.4	-	-
6.1 - 7.0	0.5	-	2.7	1.4	-	-
7.1 - 8.0	1.1	-	0.9	1.4	-	4.3
8.1 - 9.0	0.5	-	-	-	-	-
9.1 - 10.0	3.2	-	12.5	7.0	1.8	4.3
10.1 - 11.0	-	-	-	-	-	-
11.1 - 12.0	1.6	-	-	-	-	-
12.1 - 13.0	-	-	-	-	-	-
> 13.0	2.6	-	5.4	1.4	-	8.6
N =	186	11	112	71	55	23
Average one*	2.84	0.06	2.13	0.99	0.39	0.46
Average two+	3.41	1.34	4.30	3.15	1.57	4.49

* based on 226 users
+ based on the number actually performing each function.

The average total hours per week is 6.87. This is less than the 9.51 found by Nuthall (1992). This is no doubt due to the fact that all the respondents in the Nuthall (1992) survey were business users.

Furthermore, Nuthall (1992) found 6.67 hours were spent on business compared with this study's 2.84. Clearly entertainment is an important use of so called farm computers. Of the 226 respondents replying to the question, 112 said their computer was used for an average of 4.3 hours/week on entertainment. In Nuthall's specialist farm computer survey the average entertainment use was 0.92 hours/week.

When the hours per week spent on business activities are related to farm and farm characteristics there is very little apparent correlation. There is, however, a tendency for IBM or IBM compatible (& CP/M) computers to be associated with higher business use. This is a significant difference. (Average hours/week for IBM, IBM compatible & CP/M computers was 3.7, for all others 2.0.)

Table 58 contains data on the structure of the business use.

Table 58
Details of the Business Use of Farm Computers
(Hours/Month on Various Functions)
(N = 195)
Column Percentages

Range of Hrs/ Month	Farm Budgets	Stock Records	Payroll	Enterprise Budgets	Production Records	Word Proc.	Financial Records	Spread Sheet	Feed Budget	Other
0-1.0	23.1	33.3	70.0	72.4	52.4	49.1	15.3	44.8	35.7	35.3
1.1-2.0	22.3	18.2	10.0	24.1	28.6	20.4	22.8	32.8	42.9	17.6
2.1-3.0	9.7	3.0	5.0	-	9.5	5.5	7.6	3.4	7.1	5.9
3.1-4.0	17.1	13.6	5.0	-	-	12.0	20.2	8.6	14.2	-
4.1-5.0	8.2	6.1	-	3.4	4.8	3.7	5.1	-	-	11.8
5.1-6.0	1.5	4.5	-	-	4.8	0.9	5.9	1.6	-	5.9
6.1-7.0	0.7	-	-	-	-	-	0.8	-	-	-
7.1-8.0	9.0	6.1	-	-	-	0.9	6.8	5.2	-	11.8
8.1-9.0	0.7	1.5	-	-	-	0.9	-	-	-	-
9.1-10.0	3.7	6.1	5.0	-	-	2.8	7.6	1.7	-	-
> 10.0	3.6	7.5	5.0	-	-	3.7	7.5	1.7	-	11.8
N =	134.0	66.0	20.0	29.0	21.0	108.0	118.0	58.0	14.0	17.0
Average hrs one *	2.72	1.59	0.23	0.20	0.20	1.58	2.93	0.70	0.14	0.47
Average hrs two +	3.91	4.61	2.20	1.25	1.77	2.85	4.79	2.34	1.89	4.88

* based on 195 users
\+ based on the number actually carrying out each function.

Farm budgeting and financial recording are the most important functions. These are followed by stock records and word processing. Most other functions are of minor importance overall, though for those interested in a particular function this is clearly not the case. For example, payroll work is significant for the 20 respondents using this software (2.2 hrs). These figures indicate the total time spent on business averages at 2.69 per week. This compares favourably with the 2.84 hrs/week given in Table 56, thus reinforcing a belief in the consistency of the replies given.

Nuthall (1992) similarly found financial recording and farm budgeting were most important functions; though word processing surpassed budgeting in the time used. Stock recording was not nearly as important relatively, though the average hours spent were greater. Both surveys found feed budgeting, payroll work, enterprise budgeting, and production recording were relatively insignificant activities on average, though, of course to some individuals they were important functions. A relevant question is whether these figures would change given more suitable software, particularly with aspect to production records (paddock, field, production plot records and analysis) and feed budgeting. These latter two might well be integrated.

With respect to the general types of software used Table 59 gives the responses.

Table 59
Business Software Used
(N = 253)

Type	Per Cent Having
Word processor	58.9
Spread sheet	49.8
Database	17.4
Specialist financial	52.6
Specialist production	7.1
Payroll	4.3
Other	5.1

Clearly, wordprocessing, spreadsheet, and specialist financial recording and analysis software are the important types.

Regarding farmers' practices in their computer use habits, Table 60 contains their replies.

Table 60
Frequency of Business Computer Use
(N = 198)

Category	Percent
Regular period each week	35.9
Regular period each month or two	27.8
When have spare time	22.2
On a rainy day	11.1
At the end of the financial year	0.5
Other	2.5

It does seem as though the majority are specifically setting aside time for their computing as is recommended. Even so, a significant proportion still devote 'spare time' to bookwork. When trying to relate these patterns to farm and farmer attributes there were not any clear correlations other than with business hours per week on a computer. It was found that those devoting a regular time each week were those spending the most time per week on business computer use. The results of a logit analysis gave:

$$\log\left(\frac{P}{1-P}\right) = 0.7346\,H - 1.8812$$

Where P = probability of devoting a regular time each week to business computing.

H = hours per week devoted to business computers based on codes of 1 = ≤ 2.0, 2 = 2.1 - 4.0, 3 = 4.1 - 6.0, 4 = > 6.0

This relationship was highly significant, as were the coefficients, with a Tau - c of 0.672.

Interpreting the equation gives the following probabilities.

Table 61

Probability of Using a Computer on a Regular Weekly Basis

Hours/Week of Business Use	Probability
≤ 2.0	0.24111
2.1 - 4.0	0.39843
4.1 - 6.0	0.57995
> 6.0	0.74215

This kind of relationship is to be expected. When respondents were given the opportunity to express their views on improvements required to increase the benefits obtainable from farm computers, fifty four took the opportunity to make the following observations.

Table 62

Comments on How to Improve Farm Computer Benefits

Comment	Percent Making the Comment
Better software (standardised format between programmes (windows environment), simpler, more appropriate, wider range for farming).	31.5
Better training systems, workshops, etc. (more training opportunities), general and specific.	25.9
Links to information databases.	16.7
Links to banking.	7.4
Lower priced software.	5.6
Be more self disciplined about data entry.	5.6
Links for buying and selling products.	3.7
Better/available bureau (contract basis, getting use of equipment and operator skills).	3.7

It would appear the training and educational requirements of farm computer users is not being met. Better software at a reasonable price is always a requirement.

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APPENDIX ONE
Copy of the questionnaire sent by mail

Feed Management and Computer Survey
November 1992 / March 1993

Please answer all questions in those sections relevant to your situation. When completed, please return the questionnaire in the return envelope provided (no stamp required). Please use extra paper for your responses if necessary.

Section 1 General

1) Are you the manager of a stock and/or arable farm that is an economic unit (*please tick one box*)? An economic unit supports at least one person.

Yes	No

If you answered 'Yes' go to question 2. If you answered 'No' and another person is the manager please forward the questionnaire and introductory letter to this person. If neither is the case please return this questionnaire in the return envelope provided (no stamp required) without answering any more questions. Thank you for your help.

2) Please write in the number of stock wintered (*as at 1 July 1992*).

a)	**Do not have stock.**	
b)	Sheep.	
c)	Beef Cattle.	
d)	Dairy Cattle.	
e)	Goats.	
f)	Deer.	
g)	Pigs.	
h)	Poultry.	
i)	Horses.	
j)	Other (*please specify*).	
k)	Other (*please specify*).	

3) Please write in the area of crops (ha) grown this season (*92/93 season*).

a)	**Do not have crops.**	
b)	Wheat.	
c)	Barley.	
d)	Oats.	
e)	Maize.	
f)	Peas.	
g)	Small Seeds.	
h)	Process Crops.	
i)	Forage & Feed Crops.	
j)	Other (*please specify*).	
l)	Other (*please specify*).	

Questionnaire continues on reverse side.

4) What is your age in years? . . . . . | |

5) At what level did you complete your **formal** education (*please tick one box*)?

a)	No formal education.	1
b)	Primary.	2
c)	Secondary - four or less years.	3
d)	Secondary - more than four years.	4
e)	Tertiary - two or less years.	5
f)	Tertiary - more than two years.	6

If you ticked 'Do not have stock' in question 2 then go to Section 4, 'Computers', on page 6.

Section 2 Feed Management Decision Making

6) Please list and briefly outline, in order of importance for each season, those feed management decisions that you find difficult to answer, or for which you feel you often do not make the correct decision. Examples include deciding when to wean each mob or group, how much winter feed to grow, and deciding on stock numbers.

i) Spring

Description	Reason for difficulty
a)	
b)	
c)	

ii) Summer

Description	Reason for difficulty
a)	
b)	
c)	

iii) Autumn

Description	Reason for difficulty
a)	
b)	
c)	

iv) Winter

Description	Reason for difficulty
a)	
b)	
c)	

7) What kind of help, advice, information, or system do you think would be of benefit in making your feed management decisions more effective? It goes without saying that better long term weather forecasts would help.

a)
b)
c)

Questionnaire continues on reverse side.

8) Do you have any other comments on feed management that you believe would make it more efficient and/or easier?

Section 3 Feed Budgeting

9) Have you used **formal** feed budgeting (*please tick one box*)? Formal feed budgeting involves calculating and writing down feed supply and demand.

a) Have never used formal feed budgeting. 1
b) Used formal feed budgeting in the past. 2
c) Currently use formal feed budgeting (*all or part of the year*). 3

10) If you no longer use, or have never used, formal feed budgeting please list the reason(s) for stopping or not starting.

If you have never used formal feed budgeting go to Section 4, 'Computers', on page 6. If you currently feed budget, or have used feed budgeting in the past, please complete this section.

11) On average, how many **hours** do (did) you spend each month on formal feed budgeting.?

12) How do you calculate your feed budgets (*please tick one or more boxes*)?

a) With pencil, paper and/or calculator. . . . .
b) Use a hand held computer. . . . .
c) Use a personal computer. . . . .
d) Other (*please specify*). .....

13) Please list the benefits you have obtained from feed budgeting.

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