FARM MANAGEMENT BY COMPUTER

PROSPECTS AND POSSIBILITIES

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1. INTRODUCTION

Almost since computers first became generally available for research purposes, farm management professionals have been using their power to help farmers make improved decisions. In 1966 university computers were used for optimal farming systems research and not long after this cash recording and analysis systems based on mail communication were instituted on a trial basis. This latter experiment followed work in the United States (Michigan State University) based in part on calculator like devices which, when attached to the mouthpiece of a telephone, could be used to send data to a remotely based computer. The printed results were then mailed back. The Michigan experiment proved to be successful partly because U.S. farmers rely less on accountants than Australasian producers for tax returns and, consequently, were receptive to a machine that solved the problem of many late and confusing nights. In the end most of this work relied on mailing the data to a central computer rather than the telephone device as this proved unreliable. The technology available today has, however, markedly changed this situation.

Despite the early computer work using sophisticated operations research techniques, the management aids that have prospered are the simple budgeting and accounting systems. Some success was, however, achieved in Indiana with using linear programming by bringing farmers to the University in workshop groups. The campus computer, with the help of experts, was then used to produce machinery and cropping programmmes for each farmer. The experts were an important ingredient of the process as setting up and interpretation required experience.

After several years of workshops the experts lost their enthusiasm so the 'Top Farmer Programme', as it was called, waned. Perhaps the advent of powerful personal computers and improved interface systems might eventually enable linear programming to be re-instated without the need for expert assistance.

Even given the early successes with recording systems, it was really not until the end of the 70's and early 80's when micro-computers started to become available that computer based management aids started to become a truly significant factor in farm management. While many people believed central computers could be useful through mail-in operations, the facts were that the form filling, transcription errors and mail delays prevented any real growth. With the chance of removing these frustrations the situation changed overnight. This paper contains a discussion on the developments that have subsequently occurred worldwide in computer based management aids as well as thoughts on the future developments required and the form these might take. A conclusion on the steps necessary to achieve the needed improvements is also provided.

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Growth in on-farm computers has occurred because most producers find the process and results useful. A recent survey indicated some 54% of computer users believed the benefits covered the costs (cash costs were believed to average $582/annum) whereas 18% were of the reverse opinion and the remainder 'didn't know'. It is interesting to note objective economic assessments of the value of a computer do not exist. While many estimates have been made these lack real validity, except for the cost calculations, and will remain estimates until it is possible to carry out before and after surveys following several years' computer use. The costs of holding a typical business computer is around $2500 depending on the interest and depreciation rates assumed. If labour is also a charge this becomes approximately $4000 so it is clear a profit increase of around $5000 is necessary for the investment to be worthwhile.

In some respects cost-benefit studies will be superfluous as the consumer society will tend to force computers on all families in much the same way as cars and television sets, to give two examples, have become necessities. For better or worse, the computer will increasingly become an integral part of society. Similarly, many other electronic based technologies will be introduced. Chip controlled fuel injection and computer controlled cultivation equipment depth are two examples. Massive development funding is going into evolving devices for all areas of agricultural activity so farm managers will increasingly be faced with using electronic based equipment. This will certainly change the nature of on-farm repairs.

2. DEVELOPMENTS IN COMPUTERS AND AGRICULTURAL SOFTWARE

Of major significance has been the dramatic change in both the power and cost of micro-computers. The technological revolution has meant what was once regarded as a large main frame computer can now be put on a desk for a fraction of the cost. In 1981 a business computer that is currently available for $3000 cost $19000 in today's money values. Furthermore, the 1981 computer had only a fraction of today's memory sizes and was much slower. An even smaller and very much less sophisticated machine purchased in 1967 cost nearly 500,000 1989 dollars. If these trends continue computing power will reduce to calculator like costs. In reality this is unlikely - the cost of the physical components and marketing will impose a much higher lower limit. While costs are unlikely to decrease significantly the power and sophistication will tend to increase (e.g. screen quality). The ability to connect computers to various devices such as electronic scales has also been developed to a high degree. Similarly, telephone line hookups between a range of computer sizes is now quite commonplace and easy to operate, thus widening farm office access to data and general computing on a worldwide basis.

General software for personal computers has also advanced quite significantly, particularly in terms of ease of use and power. Specialist agricultural software has also progressed, but not to the same extent as general business software as with a smaller market, the resources devoted

to development is only a fraction of that occurs in the general market. Essentially the basic cash book, financial recording and budgeting routines available for agriculture are sophisticated and quite powerful in some cases, though they might not be as well presented as general systems and the supporting documentation, help systems, and training software is certainly not as well developed. Similarly, reasonable systems have been developed for animal, crop and paddock recording, but when it comes to sophisticated planning and decision making packages, there is a distinct lack.

Current software enables worthwhile and beneficial on-farm computing, particularly for farmers with reasonable managerial and computing skills. There are, however, a vast range of opportunities to improve the helpfulness (some would say intelligence) of the existing software so that its use becomes easier, and to integrate the range of packages available to enable a farmer to have a complete system providing all needs. The further development of software to achieve these ends will require careful planning and experienced computer people with a clear understanding of farm management.

A feature of agricultural micro computer software development has been the large number of groups involved. With easy access to computers and the development of fourth generation languages, as well as the high level language BASIC (beginners all purpose symbolic instruction code), it has been possible for many individuals and groups from enthusiastic farmers through to consultants to develop and market packages. Latterly, however, the initial enthusiasm has decreased as the economics of developing, and more importantly, marketing and supporting software means large numbers of what were initially inexperienced groups cannot survive. In the United Kingdom, for example, there were some 62 individuals or groups developing software in 1984, but in 1987 this had dropped to 35 with only nine having a reasonable range of software. From a viable business view, however, there were only two groups having any real impact on the market at the end of 1987, and one of these was very much larger than the other. In the United States it is reported that, similarly, there are very few groups surviving without subsidisation from a major sponsor. Given the costs and skill required for developing and supporting good software it is logical that the number of groups should diminish to something like, say, one per 20-40,000 farmers.

Another significant development has been the use of micro software by agricultural accountants and consultants, and similar groups, for providing farmers with a service. Usually a farm secretary is employed to liaise with the farmer and subsequently enter the data. The resulting printouts are then used by the professionals as basic information for advising the farmer. This procedure is particularly helpful for farmers who are either too busy, or are not prepared, to learn to use a computer themselves. Where this approach differs from the generally unsuccessful mail in/out systems is the personal assistance of the secretary and the subsequent interpretation of the output by an expert. It is interesting to note that large groups such as the U.K. Milk Marketing Board and the Danish Agricultural Computing Centre (L.E.C.) use this approach.

Much has been said about the 'intelligent' computer over the years. Latterly, a branch of artificial intelligence called 'expert systems' has been growing in prominence as a potential development area for agricultural computers. The essence of the concept is the computer based mimicking of an expert adviser, thus giving all farmers access to an expert at an affordable cost. I.C.I. in England, for example, have developed a system that advises on crop disease control; Purdue University in the U.S. have developed a grain marketing adviser, Texas A & M a financial adviser, to give three examples. These early systems are relatively simple, but if in the longer run techniques for capturing the knowledge, rules and interractive approaches of the experts can be developed, the concept of an expert system will play an important role in the years to come. Whether maximisation models can be integrated with expert systems is another question. Current optimum seeking models are frequently impractical due to the complex nature of primary production. Perhaps combination models using heuristic approaches can make a contribution though the cost of development will be great.

3. ADOPTION RATES AND EDUCATION

Since the early 80's the uptake of personal computers has been increasing both in urban and rural areas, though the penetration has been greater in urban businesses where cost savings can be quite significant and certainly more obvious. The office functions of billing, payroll and inventory work can be readily handled by computers, whereas in the farm office these functions are of little importance. The benefits mainly come from increased production and financial efficiency rather than direct cost cutting except for lower accountancy fees, where the farmer is prepared to negotiate. These cost reductions are seldom, however, sufficient to cover the costs.

The latest large scale survey figures (December 1986-sample of 3,325) indicate that 5.7% of New Zealand farmers own a computer and another 4.1% believe they have regular access to one. However, many of these computers are not really suitable for business purposes. Some 11% did not have a disk drive and another 50% only had one drive. Another survey (June 1987) of farmers in Australasia actually owning computers (586 replies from people receiving a specialist newsletter), showed only half had specialist agricultural software indicating either their machine was not capable of running the software, or they used general business software. The national survey showed some 3.4 hours per week were spent on business computing, whereas the specialist survey of farmers with computers produced a figure of 8.0 hours per week. A possible conclusion is that the national survey covered many farmers who do not actually use their machine for business computing. From the evidence, it might be surmised that there are some 2,700 producers in New Zealand with computers (there are approximately 45,000 full time producers), but possibly only 1,500 use them seriously for business purposes and only 1,000 or so use specialist software.

A national survey in New Zealand a year earlier indicated the number with computers was 1.3% lower than in December 1986. Given 1981 was probably the first year micro-computers were available in any numbers, it

could be surmised that growth has been steady though there is no indication of the standard error. Comments from the U.K. suggest that the growth there has declined and perhaps the 1.3% figures is a reflection that growth has steadied as numbers in 1981 and 1982 were probably much lower suggesting 1983-84 would have to be higher than 1.3% to give the 5.7% total. In contrast, casual observation would suggest the interest and acceptance of computers being expressed by farmers is increasing quite appreciably. The factual evidence really is not sufficient to strongly conclude in either direction.

In the United Kingdom it is believed some 7,000 farmers have computers (8% out of about 90,000 full time producers) and 4,000 have Videotex terminals - these are not mutually exclusive. The major agriculture software group maintain they have supplied 1,600 farmers with software and it is believed some 4,000 producers in total have specialist software from one source or another.

The New Zealand and U.K. situations are not comparable as there are many more specialist managers in Britain. Magazine surveys in the U.S. suggest some 12% have computers, whereas in Australia, commentators believe the penetration is somewhat less than in New Zealand.

Besides farmers, consultants and accountants are also using computers and specialist software. There are no surveys indicating the numbers, but casual observation would suggest one half to a third have computers. Certainly all Ministry of Agriculture and Fisheries consultants now have access to a computer. It is only a matter of time before all these people will be using micros.

With world wide trends to break down protection for agricultural production there will be increasing pressures on farmers to become more efficient. Combined with the consumer society pressures, there is little doubt that eventually all farmers will have an on-farm computer. This might not always be used efficiently, but it will be a necessity for many banking and related activities. This process will take at least a full generation as general computer using habits probably need to come from school training though there are clearly exceptions to this. It is also relevant that there will be an increasing number of electronic devices around the farm and many will require a computer to control them.

While some farmers will continue to use the secretarial-consultant type combinations for computer use, the majority will need to understand computers themselves. There is clearly a heavy demand for education and extension. Indeed, the survey work shows half the respondents believe there is insufficient information on micro-computers and an important reason given for not yet owning a machine is 'no local help available'. (Comments such as 'computers are too expensive' and 'not enough time to learn' also feature prominently.) To the inexperienced any new device is frightening, particularly where its operation is not observable, and needs to be quietly and efficiently introduced through demonstrations, trials and training. If Australasia is to maintain its competitive edge in agricultural production, a concerted and well planned adult education programmeme is required. This must not only look at computers, but also at management techniques and procedures as the two are part and parcel of efficient computer use. It is often reported that some of the computers

purchased and up gathering dust in the back cupboard. This is understandable as many producers have no experience of computers and end up purchasing the wrong machine and, or, software. Education will prevent some of these problems.

4. DEVELOPMENTS IN OFF-FARM COMPUTING

Off-farm computing refers to central computing services which a farmer can access for direct use in management activities. This falls into five main categories - the provision of facts and figures (e.g. the price of hoggets sold an hour ago in some market), direct marketing and ordering activities (e.g. a computer based remote auction), banking, messaging and the provision of managerial calculations (e.g. estimating the cost of replacing a machine). All these developments have been made possible through the increasing availability of efficient and reliable networks, some on a worldwide basis, based on not only the telephone network, but also on dedicated data transmission lines (increasingly using fibre optic technology, rather than outdated copper).

The simplest system is teletext - the provision of information through unused broadcast lines using the normal television system. Early systems in the U.K. enabled some 200 pages of information to be constantly broadcast on each channel and picked up by entering the page number required on a remote keypad. This tended to be data of general interest such as 'what's on', weather data and airline bookings which could all be constantly changed through automatic computer hookups. The initial systems also had some basic agricultural information such as market news. Today it is now technically possible to have some 16,000 pages available, thus increasing the possibility of including an appreciable amount of agricultural data. This has not happened in Australasia as yet and is unlikely to do so for some time due to the cost of maintaining the data relative to the cost of a T.V. licence. Once the data can be automatically maintained through, for example, the auction markets' computer being directly linked to the television station computer, there is a real possibility of keeping the cost to manageable proportions. The availability of regional stations will also be important as the local market data, for example, has limited geographic applicability.

Of more long term significance is the development of videotex services (a telephone connection to a mainframe computer, either through a special terminal or a personal computer). Success to date in New Zealand of this technology has not been great. The first specialist agricultural system developed has been withdrawn, though a new system with the backing of both Radio New Zealand and the Bank of New Zealand has been introduced. Both in New Zealand, and world wide, many general videotex systems are available and some agricultural systems also exist, though none of the latter can claim to be other than pioneer operations with promise.

The advantage of videotex systems for accessing straight information is the user can nominate exactly what is required (provided it exists), and today's computers can virtually hold unlimited quantities of data. The problem is collecting and maintaining it. The past systems have been unsuccessful due to a failure to provide timely and managerially useful data. Information on the average two tooth price at a sale held two days

ago in a market 150 miles away is not particularly useful. If, on the other hand, the data appears almost the minute a sale occurs, giving weight, quality and price range data for all markets of interest, there is a lot more useful data. When all markets and businesses are computerised it will be possible to immediately make the data generally available through automatic connections. Furthermore, the raw data will be put through an analysis programme to assess trends, deviations and any other useful data and immediately made available. Human intervention will not be necessary other than in initially keying the data at the auction face thus minimising the cost of the whole operation. Reaching this stage of complete automation of economically useful data will, however, take many years of trials and experiments.

AGNET, a videotex system developed and maintained by the University of Nebraska, makes every effort to comply with this automation principle. While the extent of the information available is not yet great, data such as weather station records and U.S. Department of Agriculture statistical reports, are automatically fed into the computer from the sources the minute the data is released. The British system similarly receives data from the Meteorological Office and the Meat and Livestock Commission's machines.

As videotex is interactive it is also possible to order supplies and conduct banking using the system. Certainly as most banking groups are computerised there is no reason why all banking and bill paying should not become controllable from the farm office. Furthermore, as produce suppliers acquire bigger computers and join networks it should eventually be possible to order all supplies from the home office. These developments are occurring in the U.K. and will appear on the new New Zealand system. Certainly when these systems are readily available the advantages to a farmer of joining a network will be persuasive.

Over the last few years British farmers have enjoyed the choice of two videotex services. Probably due to the costs involved relative to the number of farmers using the system, these have recently been consolidated into one system (FARMLINK). Currently it is believed the numbers using videotex are increasing at a faster rate than micro-computers, though the number is still only 4,000. Britain has been experimenting with these systems for around ten years and they are still learning what is required. This learning will continue for many years before a really useful system will be available and will depend in part on the general introduction of computers and networks throughout the agribusiness sector.

Videotex also allows a farmer access to computer programmes stored on the central computer. AGNET, for example, has a wide range of packages available from budgeting systems through to human diet calculations. Of the 150 packages available the most popular are beef and pig growth simulation, crop budgeting, least cost feed mixing, irrigation calculations, machinery costing and land purchase calculations. The difficulty of carrying out extensive data entry and calculations over a telephone is the cost, speed and possible corruption, and even termination, of the process. The AGNET system does, however, provide micro computer data input systems enabling off-line data entry so that once the central computer is dialled up, data entry can proceed

automatically and rapidly. Similarly, the results can be returned and stored for later perusal. Due to the increased costs, inconvenience and potential reliability problems, in the longer run producers will tend to do as much computing as possible on their own micro-computer. There will be situations, however, where connection to a large computer will be necessary to get the job done.

The obvious case where a large computer will be required is for jobs that exceed the memory capacity of a micro. Probably of more significance will be where the software is not available for a micro either due to size or cost reasons. For calculations that might only be required every few years it will not be economic to purchase the software, so renting the package on a central computer makes sense. Another important case for central computer access is where it holds data required for a calculation. While this might be downloaded, where a sizeable software package is required it can just as easily be used on the central machine.

An excellent example of efficient use of a central computer is the U.K. Milk Marketing Board's Dairyfax system. Their mainframe is constantly fed pedigree and production data on an individual cow basis so this mass of data is made available, through videotex, to individual producers. Following, for example, the collection of milk from a farm, the manager can dial up Dairyfax and immediately obtain testing data on the individual farm's production. Equally, individual cow records can be accessed, several cows sorted on a selected recorded trait and so on. Besides personalised data retrieval, calculations are also possible. An excellent example of this is the forecasting of milk production. The producer keys in calving data and the computer takes production to date and for the remaining dates forecasts production using past data, lactation curves and calving details. If the farmer had to key in all the data already held in the computer, the time input would be excessive and consequently probably would not get done. With time, there will be more and more examples of efficiently using data already held in central computers, rather than requiring time consuming duplicate re-entry.

The alternative to connecting to the central machine is the forwarding of data to each farm. The U.K. Milk Marketing Board also offers this service by providing an individual producer's production data on a floppy disk if so required. The slight disadvantage is of the farmer not having complete access to the very latest data. The milk production forecast, for example, would have to rely on historic data up to the date of forwarding the disk. This might also include the latest payment figures and where these had changed the monthly cash flow forecasts would be incorrect.

Videotex, and similar systems can also be used for messaging. This involves typing a message and sending it down the telephone line to the central computer where it is stored in the addresses file. When the intended recipient logs on, a note indicating a message is waiting is displayed, so this can be immediately accessed. This same message can also be sent to multiple 'mailboxes' so many members of a group can be easily and quickly contacted. The proponents of electronic mail believe it is very cost efficient through saving both time and direct costs. A consultant, for example, can collect all his 'mail' first thing in the morning and send replies whether or not the farmer is in his office. He

is not, in theory, disturbed by the phone yet can receive and send messages within 24 hours, or faster if required, at a much lower cost than ordinary toll calls. Clearly, however, telephone calls are necessary in some cases. Most videotex systems around the world provide this service. Specialist messaging networks also exist.

The other important central computer based innovation that has not seen major advances is electronic marketing. In 1976, for example, a trial system for marketing store cattle was set up in Texas. Sales were conducted totally through the medium of a computer including both auction and contract sales with third party grades providing the quality assessments. This system has since been shut down due to lack of support, though the concept of saving costs by not having to transport stock long distances to a central auction was conceptually correct. Since these early experiments a number of pig marketing systems have been evolved into viable operations. Examples occur in Australia, Canada and England. With time, more systems will develop, particularly where objective descriptions of the product can be supplied. Wool is a good example. No doubt, where products are internationally marketed, international computer based auctions will occur though people in the wrong time zone will find this a little tedious.

Where growth has occurred in the marketing area is the provision of simple market information (market noticeboard). One of the most popular services in AGNET is the listing of hay available. If a producer has hay for sale, or he wants to buy, this fact is logged into the computer so a buyer obtains a list of potential sources in his area and can subsequently make phone contact. These simple noticeboard systems will grow and eventually evolve into full marketing systems with associated automatic banking.

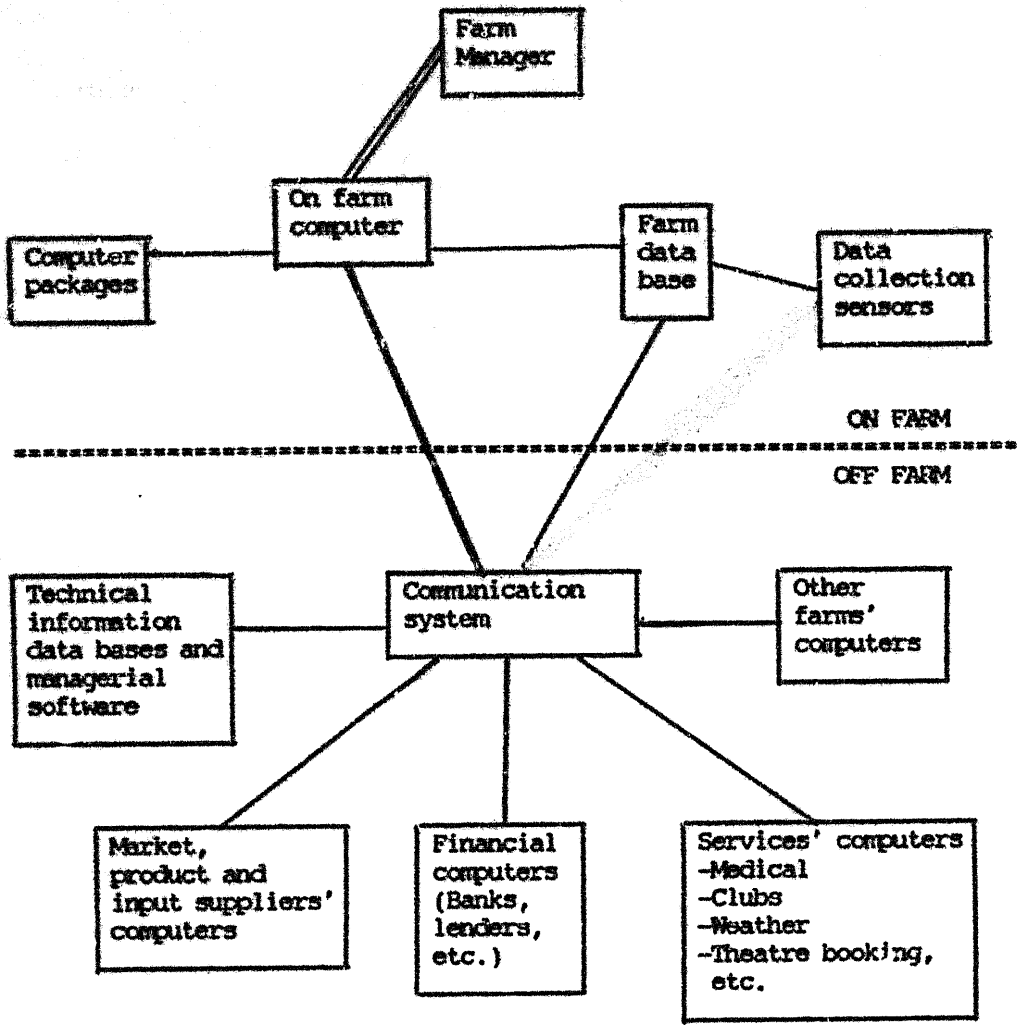
Finally, the concept of a 'bulletin board' should be mentioned. A number of enthusiasts using micro computers with hard disks and a modem have set up publicly available (through telephone connections) files of information and programmes. Each tends to specialise in different areas. Members of the club collect together public domain programmes from various sources and locate them on the micro thus making them available to other members in the group. The bulletin board software which maintains and manages the system is usually also available as public domain software so all that is required to start a bulletin board is a suitable computer, enthusiasm to maintain the system and files, and a means to advertise the availability of the system. Many groups have been set up throughout the world including New Zealand. As each relies on the enthusiasm of one, or a small group of people, they continue for a while and eventually disappear. In the longer run the service provided will be taken over by large, professional videotex based systems. In the meantime they will continue to provide local support for the enthusiasts.

5. [redacted]

Farmers require a system that is simple to use, is not excessively time consuming and provides all the decision data and support necessary to make good decisions. Achieving this will be difficult and expensive, but within 10 to 15 years considerable progress will have been achieved. The ideal system will be completely integrated and will manage itself. The computer will be constantly left on and will be connected to central networks so that data will be received and sent as and when required. Similarly data received from sensors located around the farm will be received and integrated into the farm data bases so the farmer always has at his fingertips the necessary decision information. Most farmers will never be particularly interested in the computer as a machine, but rather in the information and integration it can provide. Consequently, the system must be easy to use and must manage itself as much as possible with the minimum of data entry being needed from the farmer himself. Figure 1 contains a representation of the components that should be included in an ideal system.

The farmer will want to be alerted to problems occurring around the farm (e.g. potential feed shortage) and to when action is required (e.g. start irrigating a particular paddock). Being provided with a constant record of the current state of the property and resources (bales of hay left, stock numbers in each group, liveweight of the animals, number of cows in calf....) and the market conditions (latest wool, lamb, urea, fence post..... prices) will also be important for enabling proposed alternatives to be evaluated both technically and financially. All banking, selling and ordering will also be integrated so when, for example, lambs are sold the funds will automatically flow and be recorded in the farmer's financial records, the stock numbers will be adjusted and details of the weights and grades displayed on the screen as required. Clearly, achieving this level of

Figure 1: The Components of an Ideal Computer Based Management Information System.



integration and sophistication is a major job, but one which is technically feasible. In Denmark, for example, there is a major central computing system, funded by farmers and government, into which all milk production and a major portion of meat production data is automatically fed. This system then issues payment cheques, maintains individual farmer production records, keeps national records and also enables advisers to carry out budgeting tasks using the co-ordinated data. While this is currently a main frame system with terminals located at milk processing plants, abattoirs and extension offices, moves are being taken to integrate micro-computers as a step towards what might be a complete integrated system as pictured in the diagram.

The success of an integrated system will depend very much on both the development of appropriate on-farm software and automatic data capture systems. Integration of banking, marketing, purchasing and data base services will not be difficult and is already starting to occur. Its progress will depend on the speed with which each sector acquires computers and appropriate software. The development of the on-farm software will, however, take a long time and massive research funds. Currently available software consists of a series of modules - obtaining across the board integration will be the real challenge.

Farmers will not spend a lot of time collecting and entering data. Currently, good farmers rely on maintaining a mental picture of their resource and production situation as well as all the external factors and markets. This is maintained through constant, but automatic observation of newspaper reports, radio messages, and farm conditions while shifting stock and so on. The excellent farmers assess the conditions well and act accordingly. The bottleneck to the computer assisted system will be repeating the operation. Considerable research, however, is proceeding into developing sensors of various kinds. Examples include milk line devices to pick up mastitis and even when a cow is in season, automatic weather stations and soil probes enabling a constant picture of growing, harvesting and irrigation conditions, infra red devices for recording the dry matter quantity in various paddocks, and also the composition of the sward, not to mention automatic insect traps that might enable careful spray routines to be controlled. It has even been suggested that all machinery should contain monitors enabling every square metre of land to be recorded for yield, moisture level, soil fertility and so on with the objective of treating each area according to its merits. Far fetched? At least two groups around the world are starting to explore this possibility, the argument being that treatment for the average conditions in a paddock ends up either wasting resources or providing too much. Whatever the economics of this degree of detail, success in obtaining a completely integrated and semi-automatic computer based management centre will depend very much on the development of relatively inexpensive and reliable sensors for automatic data capture as well as the integration of data from suppliers', sellers' and bankers' computers. The latter group is where the first developments will occur.

Associated with all these developments will be a need to concentrate on developing systems compatible with farmers' ways of working. Manuals need to be thrown away and extensive on-screen help, hand holding and action suggestion procedures perfected. Everything required needs to be at the farmers fingertips and made very easy to use.

6. SOCIOLOGICAL EFFECTS

Much has been written about the potential effect of computers on the structure of society. In rural areas little effect has yet been seen and it is unlikely major effects will ever occur due to the computers themselves. It is more likely that general economic conditions will have a greater bearing in that, for example, as farms get larger and more extensive to cope with the economic pressures, the need for service towns will decrease leaving the rural areas less populated. It is these economic pressures that will force computers onto the scene in an effort to cut costs in servicing areas. Similarly major businesses will develop computer based operations for use in urban areas. By a process of attrition this influence will extend into rural areas.

As banks and businesses become computerised it will no longer be necessary to have so many branches in small towns and similarly stock markets will decline. This assumes, of course, that farmers will have their own computers enabling access to all these services. Going to town will no longer have the same business functions. Rural people will need to develop their own local contact and social groups to replace some of the town activities which, while ostensibly business orientated, provide important social contacts.

The computer will become an important part of the social scene through the messaging services. Meetings will be easily organised, as will ordering library books, arranging school outings, and even ensuring adequate health care through providing regular contact with a general practitioner who will probably be located further away than currently. Messaging will enable problems to be logged in so the G.P.s and practice nurses can assess all these at fixed times sending a reply as required. The medical service will not be constantly interrupted with telephone calls thus increasing efficiency and also encouraging people to seek advice as they know it is not causing a disruption. The same will apply to veterinary and general advisory services.

While rural populations will decline due to economic pressures, it could be that total agriculture related employment will not decrease to the same extent. The numbers being employed in the computer and related industries will increase to compensate at least to a certain extent. These, however, will be located in larger urban areas though it has been argued by at least one writer that rural areas near larger towns may see an increased population. The logic is that with good computer communication employees can work in their home setting at a terminal and so can indulge in a desire for rural living. This cannot be too remote, however, as meetings in the central office will be necessary to co-ordinate activities and provide that social contact between employees which is important for efficiency.

The suggested changes will not occur overnight. Like the introduction of computers onto farms, it will not only take the provision of computers in all businesses, but also at least a generation change to have a population as at home with key boards as they are with cars, TV and videos. The speed of change will also depend in part on the introduction of speech recognition systems; thus making data entry and receipt easier. Researchers have developed machines that can recognize 20 or so words without the need for special voice printing, but believe it is only a matter of time before this is greatly extended. When this occurs computers will very much be part of a modern society.

7. CONCLUSIONS

The last eight years have seen major advances in the provision of on-farm computer assisted management aids. This has resulted in the general acceptance of at least the concept of farm managers relying on computers as an important tool. The numbers actually using computers is not yet, however, great but it is only a matter of time before the majority will be involved to a greater or lesser extent. Complete penetration will only occur after at least a generation change. By this time integrated and very much more extensive systems will be available providing the farmer with an invaluable managerial centre.

The challenge is to organise the orderly development of useful and easy to use farmer orientated systems to best advantage and least cost. While much of the technology required is available, the knowledge of exactly what systems are required, and will actually be used by the farmer, is badly lacking, as is the software to perform the required functions in a totally integrated fashion. Questions such as 'what is the minimum amount and type of information required for good decisions?', 'what is the best way to collect the raw data at least cost?", 'what is the place of expert systems?', 'how far will man go towards accepting the dictates of a machine?', are all examples of the questions which must first be answered before extensive work on developing appropriate software is even contemplated.

The immediate first steps in developing existing systems should be to:

(i) further develop financial packages as these are the one system common to all farmers' requirements. These must be made extremely easy to use but also be totally flexible to cope with all variations. While flexible systems exist now, they require the farmer to be knowledgable of the system. The new system must remove this requirement through constant on-line help, complete integration, hand-holding suggestions about what to do next, and automating every possible step for which data is already held,

(ii) enable financial systems to be integrated with banks and product suppliers/receivers either through disk posting or telephone connections. This move is to do with automating data entry so all transactions are logged right through all records with little human effort,

(iii) develop integrated data entry systems that accept all data as the farmer thinks about it, and them transfers to relevant components to the correct data base. Thus, for example, financial data goes to a financial system, production data to a paddock data base. Currently farmers need to operate several independent packages. A solution to this problem will not be easy,

(iv) provide off-farm connections for simple notice board and messaging services. These will provide a start into more sophisticated marketing and product ordering systems. Progress will be slow, however, due to the chicken and egg problem of needing large numbers to cover cost of sophisticated systems,

(v) develop learning and tutorial packages in conjunction with adult educational packages. Manuals must be thrown away - they are farmers' pet hate,

(vi) put greater effort into assessing the economics of providing improved management information through computers. Can the research expenditure be justified?

Given the relatively small population involved in agriculture, if the groups interested in computer applications continue to operate as independent small groups, progress in developing the required systems will be slow and inefficient. Farmers are individually too small to make any progress at all, there are no local computer companies that can invest the required funds, and the local software manufacturers are too small to generate the research funds. The only way to make real progress is for all benefiting groups to pool their resources and develop a research and development programmeme. This means farmer levies and contributions from computer companies, banks, rural based businesses as well as Telecom, as these are all groups that would individually profit from the kinds of developments suggested as being possible. Central government must also have a part to play in stimulating this activity. Perhaps they should be involved directly in the research, though traditionally this work has often been effectively carried out by university institutions.

If funding for a research group can be organised, the task must be to develop and set up prototype systems, carry out farm tests and implement subsequent modification until a reasonable system has been evolved. The next step would be the commercialisation of the system and its subsequent continued development as, clearly, new electronic devices will continue to be developed and require integration. The initial research group might well evolve into an industry owned group charged with the responsibility of maintaining the system. A blue print for such a group is the banks' computer company which enables all banks to integrate and automate their activities.

There is certainly a major challenge for primary production to effectively integrate computers to best advantage and improve the efficiency of resource use.