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*Farm Level Information Systems as an Aid to  
Decision-Makers*

The popular press has made us more aware of the microelectronic revolution and the projected impacts it will have on society. One of the products of the microelectronics revolution is the microcomputer. The newest generation of microcomputers has the computational capacity of the mid-size mainframe computer of only a decade ago at a small fraction of the cost. This breakthrough in computation power and availability has prompted some to become enthusiastic about the potential of microcomputers. Berge (1984) suggests that microcomputers can do:

... project scheduling, resource allocating, fund accounting and decision analysis. Such sophisticated operations as cost-benefit analysis, financial projections, food policy modeling, cattle herd optimization and general farm management programs can now be done by managers with little previous experience in these 'speciality' areas.

Such enthusiasm seems to stem from a narrow focus on capabilities of the computer hardware and not realizing that the hardware is only one aspect of a computer-based information system. A computer-based information system has at least five components: (1) hardware, (2) software, (3) supporting databases, (4) the end user's analytical ability and (5) the sales, service, and training support system. Through time the relative importance and capabilities of these components have been greatly altered. In the following sections the history of computer utilisation in agriculture at the farm level will be reviewed. Attention will then be directed to the challenges and opportunities ahead if more effective use of this technology is to be achieved in the future.

### HISTORICAL PERSPECTIVE

Use of computers to address actual problems of farmers began in the mid-1950s with the advent of general purpose digital computers. The dairy production records and farm accounting systems were among our first applications. These systems used batch-operated computers and utilised the mail service for delivering information to and from the data

processing centre. Many of these projects still function and operate today. Although improvements have been made in the format of the records the method for processing data remains basically unchanged.

Although these production records and accounting systems could identify the strengths and weakness of the farm business, their capabilities for planning purposes were limited. For predictive information, a new and different approach was deemed necessary. Farmer workshops were first used as a technique to deliver computerised planning models to farmers. However, this approach had problems because of the limited number of farmers that could be serviced and the time delay between completing the input form and the return of the computer output.

With the availability of timesharing computers in the mid 1960s, several groups began developing software and delivery systems for farmer and farm advisor use. Based on data from the TELPLAN timeshare system, nearly 70 per cent of the usage was related to the execution of models addressing routine (or structured) problems (Harsh 1980). Routine problems are defined as those commonly faced by farm managers – ration balancing, scheduling of livestock facilities, pedigree evaluation, irrigation scheduling, etc. Since these problems are frequently faced by managers, they often have a good understanding of the analysis process necessary to make a management decision. Models used to a lesser degree on the TELPLAN system were those designed to analyse problems that are not routine in nature. Problems of this type are usually more complex. Examples include evaluating the impact of a major business expansion, adopting new technology or forming a partnership. Since these problems are generally more complex and occur less frequently, managers needed substantial assistance in utilising the models that addressed these questions. To provide assistance, agricultural advisors often worked directly with farmers. The use of timeshare systems broadened the audience reached but it still remained fairly small. Furthermore, the link between the descriptive information (e.g., the accounting system and production records) and the planning models is generally a manual process.

Advancements in microelectronics resulted in the development of programmable calculators in the early 1970s. Farmers had available to them a low cost, portable and personalised computer capacity. Many decision aid models were developed for this technology. Acceptance of the programmable calculator by farmers was initially encouraging. Because of size and speed limitations and the new microcomputer technology that developed later, the use of programmable calculators has declined.

To follow the programmable calculator in the mid 1970s was the mass merchandised microcomputer. Suddenly, farmers had available to them substantial computer processing capacity and data storage capacity at a very low cost. Many have hailed it as the revolution which will place computerised data processing capacity in the hands of nearly all

commercial farming operations. Faced with this startling reality, there has been a heavy emphasis on developing software for farm based microcomputers (Strain and Simmons 1984).

## CURRENT ASSESSMENT

In examining the development of these problem-solving systems, several observations can be made. As new and more sophisticated computer hardware has emerged, there have been major efforts to apply it to the problems of agriculture. Also, there has been a conscientious effort to move the data processing closer to and place it under the control of the end user (i.e., the farmer).

Anderson (1982) has classified information systems by the type of functions performed. His classification of systems is as follows: (1) Transaction Processing System (TPS) – pure data-processing programs for gathering, updating, and posting information according to predefined procedures; (2) Management Information System (MIS) – a system with predefined aggregation and reporting capabilities, often built upon a TPS; (3) Decision Support System (DSS) – an extensible system with intrinsic capability to support *ad hoc* data analysis and reduction, as well as decision-modelling activities.

Most of the software for firm level usage are either of the TPS or MIS nature. A recent study by Hepp (1984) of commercially available microcomputer software indicates that accounting packages by a large margin are the most common form of software. Other applications relate mainly to decision aids (e.g., ration balancing, irrigation scheduling, etc.) and crop and animal production records. Software of the DSS nature remain to be built and tested.

Although progress has been made in applying computer technology to agricultural problems, the proportion of the potential audience reached remains small. Harsh (1980) discovered one of the major problems in getting the TELPLAN system utilised was the training of the end user. The analytical skills of the end users were weaker than anticipated and a major educational effort was required to get farmers and farm advisors to feel confident in using computer models. This was particularly the case with the more complex models.

The supporting databases for agricultural software are currently inadequate. Many of the problems faced by farmers require data they generally do not have available to them. This includes data from their own operations as well as external data such as commodity prices and weather forecasts. Some of the software available for on-farm use exceeds the manager's ability to accurately supply the necessary data needed to support these models.

If decision makers are going to make effective use of a computer based information system, they need an adequate support system to assist them. The support system for agriculture is currently very weak. As a rule, farmers feel that the computer salesmen generally do not know the

subject of agriculture and likewise cannot visualise which software packages might be useful to them and/or how to apply them to their particular situation.

### FUTURE CHALLENGES AND OPPORTUNITIES

The potential for improving the decision making process of farmers in the future is encouraging. Few would doubt that the current computer hardware is capable of supporting a fairly sophisticated farm-level information system. Increased attention must be given to the other component of the information system. This will involve several aspects including the development of decision support systems, use of expert systems and optimum control models, development of technology to automate the data collection, and enhancing the support system.

TABLE 1 *A framework for information systems*

Type of Decision	Management Activity			
	Operational control	Management control	Strategic planning	Support needed
Structured	Inventory control	Least cost ratios	Choosing enterprise mix	Clerical or Man. sci. models
Semi-structured	Restructuring the farm's debt	Set production goals for the business	Expanding the business	Decision support systems
Unstructured	Hiring farm employees	Delegation of business responsibilities	Major restructuring of the business	Human intuition

*Source:* Adapted from Keen and Morton (1978) to reflect agricultural examples.

The framework suggested by Keen and Morton (1978) can provide guidance for developing information systems for the future and identifying potential problem areas (see Table 1). The on-farm information systems of the future should concentrate on addressing the structured and semi-structured decisions. Structured decisions are those which require very little involvement on the part of the manager in using management skills to reach a decision. For such decisions a number of computerised decision aids have already been developed (e.g., least cost ratios, irrigation scheduling, etc.). However, more models from management science are needed to address these decisions. This is particularly the case for structured decisions which relate to strategic planning. Furthermore, Kuhlmann, et al. (1984) has indicated, the need

for more extensive use of adaptive optimum control models to address structured decisions. In many cases these control models could be of the closed loop type. Closed loop control models are particularly powerful tools for monitoring and controlling certain aspects of the business (Fischer 1982; Rausser 1979). However, the applications of these models in agricultural production has been very limited.

The potential for improving the efficiency of farms with structured decision models is very encouraging. However, in developing these models, greater attention must be given to integrating them into an overall decision support system (DSS).

One of the problems currently confronting farm managers in using models to address structured problems is the lack of farm specific data. The information system of the future must be designed so that it captures the farm specific data (e.g., field performance rates) needed by models that address structured decisions. If the data-capturing process can be automated (e.g., collecting daily milk production figures on individual cows), priority should be given to achieving this goal. Otherwise, the data capture process will divert time from other management tasks.

The analytical skills of the manager will have an influence on acceptance of models to address structured decisions. Experience indicates that once the concepts underlining these models are understood, farmers are very willing to utilise them in their business. However, teaching these concepts to a large number of farmers is potentially a major problem. One possible solution is to develop software that is capable of teaching the manager these concepts. Software with these attributes should explain to the user upon command why a given item of input information is important in the analysis, what is a reasonable or acceptable input value, the analytical procedures used in the analyses, why these procedures are used, and how to interpret the results of the analysis. This is a level of support and information far greater than the 'help' command that is found on some agricultural models.

The semi-structured decisions faced by farm managers are more complex. Although analytical models can be used to assist the manager in the decision-making process, a fair amount of discretion is required of the manager in reaching a decision. To assist the manager in addressing semi-structured decisions a decision support system is needed. DSSs currently do not exist for agriculture although a few are in the planning stage or under development. Building a DSS is a long-term and multi-disciplinary project. The DSS, being a flexible system which can support *ad hoc* analysis and modelling activities, will need to be tailored to different types of farming operations. The DSS required for a dairy farm will be different to one for a vegetable farm. Although some components of the DSS can be shared, others will be unique to type of farm operation.

Unlike structured decisions where management science models often suggest the appropriate decisions to make, the DSS supplies the manager with selective information depending upon the scenario being analysed.

Also, the decision-making process is geneally heuristic in nature. Some farm managers have good heuristic skills, but many do not. Furthermore, a significant proportion of the managers do not have the expertise to know which analytical procedure is appropriate for the problem. One approach to address these problems is to use experts to advise the manger on semi-structured decisions. Unfortunately, qualified experts are scarce in supply and their services can be expensive. These problems are not unique to agriculture. Other areas (e.g., medicine, and mineral exploration) are using the new science of expert systems (ES). An ES integrated into a DSS would be able to guide the manager through the decision making process in much the same fashion as an expert advising the farmer directly. ES has three main parts: (1) a user interface; (2) an inference engine, and; (3) a knowledgebase. Currently, there is microcomputer software that addresses the first two components. (Hayes-Roth et. al. 1983). Therefore, the most difficult aspect of developing an ES will be the generation of the knowledgebase. The knowledgebase is extracted from the experts and the process can be time-consuming and costly depending upon the problem and the experts' ability to relate their knowledge.

Finally, a better support system will be needed if more sophisticated information systems are going to be implemented on farms. These support systems will need to supply the manager with better technical support and training. In some European countries, the agriculture co-operatives are starting to assume this responsibility. Hopefully, this trend toward increased support will continue to grow.

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