discussion paper no. 2

Management Information Systems for the Horticultural Firm

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Foreword

The development of micro computers has highlighted the need for accurate information at a property level in order to have suitable input data for planning and decision making. This review reveals limited research in developing horticultural information systems and a disappointing response from the farming community in various countries to a generalised recording scheme. Attempts to impose formalised recording schemes have suffered from lack of involvement of growers in the planning stage and limited contact between advisers and growers after the information has been collated and returned.

The Horticultural Management Information System developed by Carlsson and his co-workers in Sweden has received ready acceptance by growers. It seems that Calrsson is succeeding because he has compiled his information system with a close and frequent consultancy approach.

The conclusions drawn in this review suggest that the simple intimate approach to information systems initially, lead to grower interest and increasing enthusiasm.

R. N. Rowe
Professor & Head
Feb 1981

CONTENTS

CONTENTS continued:

1. INTRODUCTION

This review commences with a discussion of farm management information systems in general as a basis for providing a framework for an indepth consideration of management information systems used by horticultural firms. Particular attention is given to the critical issues of implementation and the use of planning or forecasting models.

2. NEED FOR INFORMATION BY THE FARM FIRM

Within a business, the flow and nature (quality and quantity) of information is important. Dent (1974) states that management is basically concerned with making decisions on the basis of information available.

A business can be considered as an open system existing in and interacting with a constantly changing environment. Information is needed by the manager to reduce his uncertainty about the environment and the condition of the firm. As well information is needed to change the beliefs of the manager. Blackie (1974) points out that a business cannot operate rationally without knowledge, firstly of its current state and also of its environment. Information on these matters must be obtained and transmitted to the manager of the business by means of some information system.

3. OBTAINING INFORMATION

Information systems of various types exist in all organisations and range in complexity and level along various dimensions : formal and informal; manual, mechanised, computer

based; financial, technical, etc. In its simplest form, an information system may operate entirely independently of the manager (e.g. receiving market information through radio and newspapers; a chemical company posting to growers information about a new pesticide) and it may have arisen as a consequence of the haphazard accumulation of knowledge over time. With increasing pressures on the farm business in today's economic climate, there is however a growing demand for specific and up-to-date, and, by inference, for specialised information systems to meet the specialised needs of the manager (Blackie, 1974). Purpose built information systems, therefore, are becoming a major growth point in operations research (Wedekind, 1973).

4. WHAT IS A MANAGEMENT INFORMATION SYSTEM?

Churchman (1968) defines a system as

"a set of parts to accomplish a set of goals".

This leads onto various definitions of a management information system (MIS). Higgins (1976) defines a MIS as:

> "a system which provides the manager in the organisation with the information he needs in order to take decisions, plan and control."

Lee and Nicholson (1973) view a MIS as

> "that process which collects or records data, processes that data, and changes the belief of managers".

Neither of these definitions is complete or comprehensive enough, especially in relation to the information aspect. Mauldon, Schapper and Treloar (1969) provide the key missing links when they state that

> "to be useful to farmers as business managers information must be timely, relevant and accurate".

However in spite of these preceding definitions, the term MIS is a misnomer when used in relation to farms. While by inference one would expect MIS's to be formal systems that provide the farm manager with all necessary information for effective management of the farm firm, in actual practice the meaning of farm MIS has been used in a much more restricted context within the literature. Most studies use the term MIS to refer to systems providing information on the state of the firm itself (i.e. internal information) in financial and technical production terms. Few, if any, embrace marketing, developments in new technology, actions of competitors, etc, that is, farm MIS's tend to ignore information about the environment within which the firm exists. In non-farm organisations however, the marketing factor in particular constitutes an important part of the formal MIS.

Kanter (1970) states that a MIS is not a supplementer of management or a panacea whereby management can obtain instant solutions to previously intractable problems. It is best considered as an interdependent series of communication channels designed to enable management to control an organisation. Stated another way, the MIS is the common subsystem that permits the other subsystems of the farm firm to function as a whole to achieve particular objectives. Information from the MIS is a catalyst for integrating the subsystems of an organisation. As Murdick and Ross (1971) further note, systems theory and the notion of information feedback are

fundamental to the decision making process and to the design of supporting information systems. MIS's are an integrated feedback mechanism which can be used by managers to analyse both the results of past actions and the potential consequences of future plans. An information system may merely present data suitable for further analysis by other means or it may actually analyse past performance and make projections of real system behaviour. In either case the essential feature is the existence of a continual exchange between the real and the information system (Blackie, 1974).

Blackie (1976) further notes that as the stochastic and biological elements of the farm business exert their influence, so the MIS should be able to accomodate the changes imposed by these factors.

5. MANAGEMENT

5.1 The Functions of Management

Management information systems should only exist to support decisions and hence an understanding of managerial activity is a prerequisite for effective MIS design and implementation (Gorry and Scott Morton, 1971).

Management is not simply a question of making decisions and waiting for the outcome of these decisions, for farm production is a dynamic process which requires management attention constantly through time. The changing nature both of the climate and the economic environment as well as the natural inherent biological variation in farming enforces the need for a series of decisions to ensure a successful outcome for the business.

The management function comprises a variety of complex activities but these can generally be classified into one of four independent phases : planning, execution, control and feedback. Decision making will take place at each one of these phases.

Planning is the primary function of management. A farm as a business organisation is a social system and hence goal seeking. Broadly speaking, planning involves establishing objectives and determining the enterprise mix, the necessary resources and the economic organisation of the business which are necessary to achieve these objectives. Planning is forward looking and in part involves modelling the farming system in a sufficient degree of accuracy so that alternative strategies can be compared with confidence. As well, planning will need to decide the kind of information necessary to effectively operate the farm.

Short, medium and long term planning is involved (tactical versus strategic decisions).

Execution is the process of putting plans into action. Seldom do things go according to plan. Deviations from plans may be due to

* unforeseen climatic conditions
* changes in the performance parameters of the farming system
* less than total implementation of the planned strategy
* changing economic circumstances
* poor predictions.

Hence, feedback and control are essential to the management function.

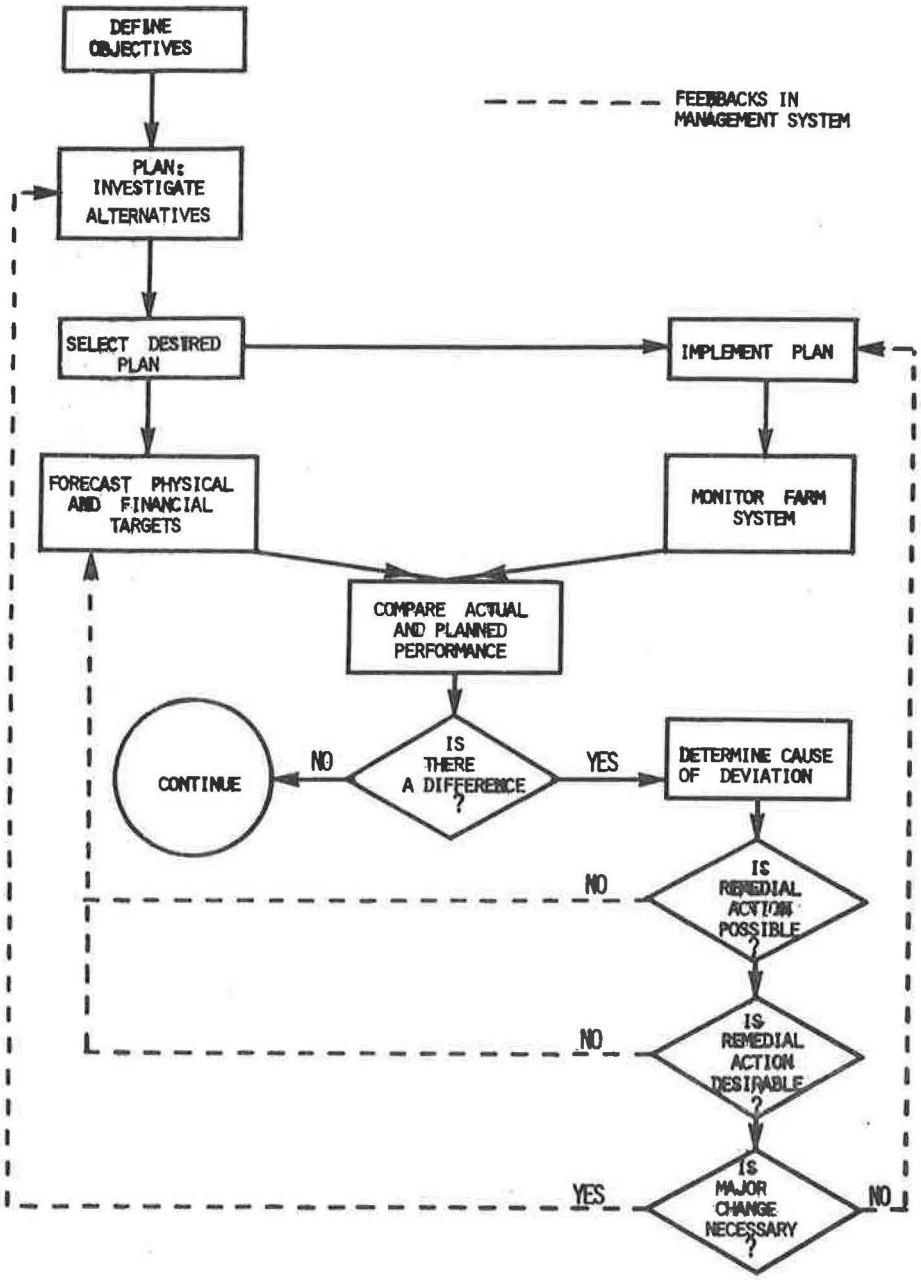
Control involves measuring performance, comparing this with planned performance and applying corrective action if necessary.

Feedback informs management of these deviations and hence it is vital to future planning.

Set out in Figure 1 is one particular version (Dent, 1974) of the management cycle that integrates the preceding discussion.

Blackie (1976) considers the ideal of an information system as one which may be used to assist in the development of a management strategy, to monitor the progress of that strategy and to revise the original strategy should this prove necessary. Too often planning is an exceptional rather than a routine part of management with the planning role of MIS's being overshadowed by their analysis and control functions. Yet control - which is most effective where there is a rapid flow of monitoring data from the business - infers the existence of adaptive behaviour which, in turn, necessitates planning. If a MIS is to be considered comprehensive, the effects of adaptive behaviour should be rapidly reflected in future analysis of firm performance. Planning is thus removed from its pedestal as a special and infrequent function of management and is regarded in its true role as a continuing series of short run tactical decisions influencing long run strategy. In this light, the need for planning for a stable, as well as a changing situation is apparent. Where information systems invoke planning as an exceptional, rather than a routine part of management,

FIGURE 1: The Management Cycle



SOURCE: Dent, J.B. 1974: Application of Systems Concepts and Simulation in agriculture. Lecture delivered in the School of Agriculture, Aberdeen, April 18, 1974.

the link between recording, control and adaption behaviour will obviously be defective.

5.2 Information Needs of Management

Each farm firm differs in its combination of enterprises, ways of administration and in its goal and objectives. Consequently the detailed requirements of each firm for business information will differ (Blackie, 1976).

As a result Blackie sees the important function of the management scientist to analyse the organisation and its requirements for control. This involves the definition of the type of and frequency with which information is needed (Jaffe, 1967). Information systems ought to be centred around the important decisions of the firm. It is therefore important to observe Ackoff's (1967) warning that one cannot specify what information is required until the key decision processes of the firm have been modelled in at least a descriptive sense. Only then can an analysis of the value of particular information be made (Gorry and Scott Morton, 1971).

While the specific information requirements of different firms will differ, their generalised information requirements can be stated.

Information for control is different in nature from that needed for planning. Planning is concerned with structuring the future, whereas control is based more on the past and trends. Generally, control information may be classified into such categories as market information, productivity, resources used, financial information, performance standards, etc. For planning purposes, two basic types of information are needed - that about the environment (e.g. price levels, government actions, changing market demand, actions of competitors etc.) and the internal activities of the firm itself (e.g. cash flow, productivity, credit rating, sales forecasts).

Conner and Vincent (1970) using a different method of categorisation have identified descriptive, diagnostic, predictive and prescriptive information as being important to the functions of management. Such information is needed to answer basic management questions such as "what is", "what is wrong", "what if ...." and "what should be done?"

Finally it should go without saying that the preceding has implied a strong user orientation.

6. HORTICULTURAL FIRMS - THEIR NATURE, CHARACTERISTICS AND INFORMATION REQUIREMENTS

Horticultural firms are concerned with the production of perennial and annual fruit, vegetables, nut, flower and nursery crops. Compared with agronomic crops, horticultural crops represent a more intensive form of production in terms of high cost and return per unit area. As a result the

average sized horticultural holding may only represent about 1-4% the area of a comparable agricultural holding.

While the particular information requirements for each individual firm need to be ascertained if a relevant MIS is to be developed and used by the firm, it is still worthwhile listing some of the characteristics of horticultural firms that will determine/affect decision making. Some of these have been obtained from Gillard (1970).

* Horticultural firms tend to be very labour intensive. Labour management is an important task.
* Competition exists between firms for the available domestic markets. This is a distinguishing feature from agricultural firms. As a result, marketing management is important.
* Comparative advantage is important due to micro-environmental effects.
* Most horticultural products are highly perishable, particularly fruits. This affects marketing decisions.
* Uncertainty can be an important influencing factor, especially weather with its effects on product perishability and product demand. Uncertainty is also important in relation to changing consumer tastes and the long delay to cropping with perennial tree crops.
* With perennial crops there are problems of enterprise fixity.
* Many firms have a diverse number of enterprises, e.g over five different crops may be grown in 12 months with vegetable and flower crops.

* Glasshouse crop growers have particular problems in carefully controlling their environment. Mismanagement can be quite devastating.
* With perennial tree crops and vines, decisions need to be made concerning the timing of replacements.
* Horticultural managers are generally lacking in much secondary education or management training.

7. A REVIEW OF MANAGEMENT INFORMATION SYSTEMS IN USE BY HORTICULTURAL FIRMS

7.1 Introduction

Historically, and up to the present time, most horticultural firms do not use a formalised MIS[1] except for taxation accounts which can only be considered an MIS in a rudimentary sense. However over the past few years a number of developments are taking place which may lead to this changing, albiet, very slowly.

MIS's used by horticultural firms, can be classified in a number of ways, including:

* whether they cover the total management cycle or only part of it

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1 This is based on the author's extensive contact with horticultural firms and consultants within South Australia while employed with the Department of Agriculture and Fisheries. It is also based on an extensive literature search.

* whether they have been specifically designed for horticultural firms or as general farm MIS's which can be used for all types of farm firms including horticultural ones
* whether the MIS is to be grower operated or operated by or with the assistance of consultants
* whether the "whole farm" is to be catered for or only particular enterprises.

Blackie (1974) states that a fully effective management aid must cover all elements of the management cycle (planning, action, monitoring and adaption) - in effect the requirement is for a complete management system rather than separate techniques only appropriate to part of the cycle. Management scientists have tended to concentrate on particular elements of the management cycle rather than the cycle as a whole. In considering the management cycle as a system and the four elements as subsystems, it is worth remembering that a fundamental truth concerning systems of all types is that optimisation of any one subsystem cannot be presumed to lead to overall system optimisation.

As previously noted by Blackie (1974), the essential feature of MIS's as an integrated feedback system is the existence of a continual exchange of information between the firm and the information system.

Hence the following criteria were used to decide whether or not to admit particular candidates as MIS's, viz:

* attempt to cover all stages of the management cycle
* regular and rapid exchange of information must take place between the firm and the MIS.

In reviewing MIS's used by horticultural firms, consideration will be taken of the many factors considered in parts 1 to 5 inclusive.

MIS's used by horticultural firms will be classified on whether or not they have been specifically designed for horticultural firms.

7.2 MIS's Specifically Designed for Horticultural Firms

There are very few documented examples of MIS's specifically designed for and being used by horticultural firms. All developments in this area are taking place in Europe, mainly in glasshouse crops.

7.2.1 The Swedish Experience:

Prof. M. Carlsson, Dept. of Horticultural Economics, Agricultural College of Sweden, has developed a project known as Horticultural Economics Investigation (or TEV) (see Carlsson and Johansson, 1972; Carlsson and Eriksson, 1974; Carlsson, 1976).

This work commenced in 1965 to obtain data from horticultural firms (mainly concerned with glasshouse crop production) for research and teaching purposes. Since then the project has developed into one concerned with the development of methods for the management of individual horticultural firms. This has involved the development of individual MIS's on a consultancy basis by the Dept. of Horticultural Economics.

The approach involves a strong client (decision maker) orientation in terms of providing a service to identify and meet the needs and requirements of the manager. This involves

the consultants developing a close rapport with the client.

The basic componants of the Carlsson work is Data Collection, Result Analysis and Planning.

Data collection and result analysis takes place immediately after individual crops (e.g. tomatoes) have finished and are presented to the grower as an ex-post gross margin calculation within four weeks. Also provided are efficiency measures like yield and labour used/unit area and labour used for harvesting and packing. These results are compared with previous years and other growers in the scheme. The emphasis is on management receiving the information as soon as possible so that it can be directly used for future planning. As well, the particular information requirements (both in quality and quantity) of clients are provided.

In relation to data collection, initially, the bare minimum of data is collected. As Carlsson notes, there is always a risk at the beginning that if data collection is too comprehensive, the people involved in it will get too tired. Once people have seen that data collected gives interesting and useful information to the firm, then one can move to a more detailed system. Only the exact data to be used is collected. Data recording forms are specifically designed to suit each individual firm. Hence different firms have different forms. Data collection can be increased as required without changing the whole system. Data is collected where it is most accessible and as well, data collecting routines are developed.

The planning techniques used by Carlsson depend on the problem. More informal than formal methods tend to be used. If informal methods are inadequate for the task, then Linear Programming and Monte Carlo programming is used. The MIS's developed are essentially manual mechanisms - little use of the computer is apparent.

Carlsson notes that in his approach to this consultancy work the neo-classical theory of the firm is not used as a frame of reference - rather psychology, sociology and behavioural theories of the firm are used to guide this work. These have been found to be more useful.

Critique

Obvious good points of the Carlsson approach include:

* the strong link between business and cultural advice
* a strong client orientation. This is highlighted by the particular attention given to identifying the growers actual information needs, the development of MIS's in close consultation with growers and according to their experiences and abilities, the careful attention to data collection, and an emphasis on getting growers to use improved managerial methods (such an emphasis on implementation has lead to a compromise in complexity. However as Carlsson notes with other workers in this area

  "economic perfectionism has sometimes been sought for at the expense of psychological realism").
* The approach has been widely accepted by growers and more are waiting to join. The size of the scheme has got so demanding that the consultancy service is now conducted by a private organisation under the guidance of Carlsson.

The major shortcomings of the approach are in a lack of forward planning and the frequency of feedback. There is a lack of use of budgetary control as a basis for management control - too much reliance is made on comparisons with previous years results.

7.2.2 Advancing the Swedish Experience in the United Kingdom:

Dempster (1978) in conducting a private horticultural advisory service in Guernsey has studied the Carlsson approach and developed it further. Guernsey has a large area under glasshouse crop production - particularly tomatoes.

Dempster commenced a pilot project in 1976 to get small growers interested in planning ahead and to simplify procedures sufficiently to enable effective plans to be prepared and understood by the grower.

The pilot project had the objective of helping more growers achieve higher yields and better profits through better management linked to better cultural methods.

The major differences from the Carlsson approach would appear to be more detailed and forward planning and improved monitoring frequencies incorporating monthly and quarterly feedback and comparison with the plan along with an annual review, i.e. more forward planning and use of frequent budgetary type control.

The specific details of the MIS shown in Figure 2.

Critique

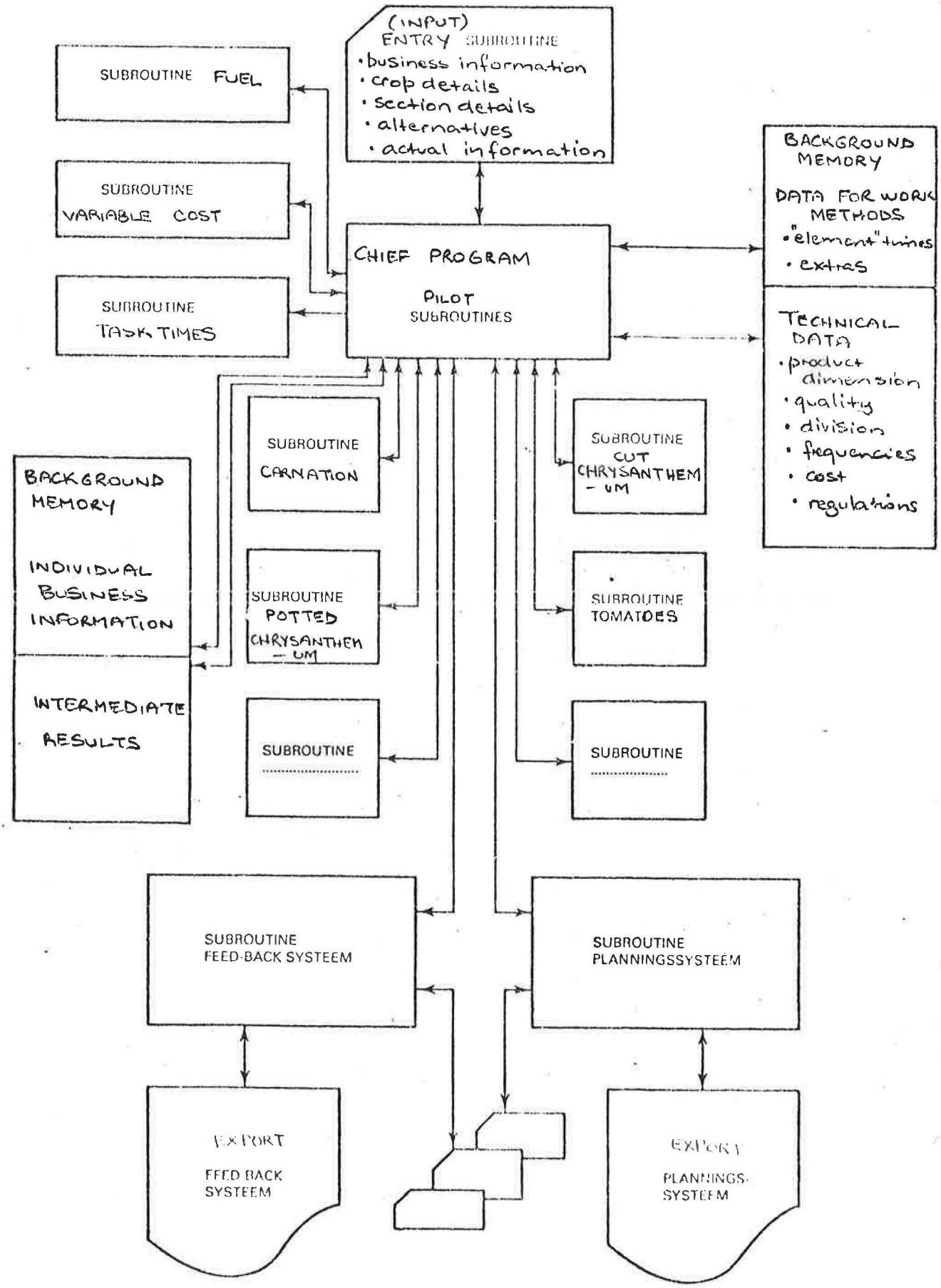
* More forward planning, monitoring and more regular feedback for control purposes - excellent.
* Success of the pilot scheme remains to be seen - it had only been going with 17 growers for six months at the time of the article. However, other growers had already contacted the consultancy service to join in the following season.
* Seems to be more formalised than the Carlsson approach with less emphasis on meeting individual needs and requirements. This may be a problem.

7.2.3 The Dutch Proposal:

The Dutch Institute of Agricultural Engineering (IMAG) at Wageningen in 1977, commenced the IMAG - DATA SERVICE for farmers (Anonymous, 1977). Currently it consists of 15 computer programs, five of which are designed specifically for horticulture. Of particular interest is the Horticultural Management Information System (MISTU) which is particularly designed for glasshouse cropping of flowers and tomatoes.

Krolis (1977) has described the system, although exact details are incomplete. Despite this, sufficient information has been provided to make some appraisal. The broad outline of MISTU is provided in Figure 3. MISTU consists of a main program with numerous subroutines relating to various crops, work task times, fuel, etc. These could be "skeleton type" sub-models. No details are provided about the subroutines. There would appear to be extensive use of data files for storage of information, up-dating and for use as required.

FIGURE 2 : The Structure of the Management Information System for Horticulture (MISTU).



SOURCE: Krolis, K.E. 1977: Het management informatie-systeem voor de tuinbouw (MISTU). Bedrifsontwikkeling 8(4) : 379-381.

The program incorporates a subroutine planning and feedback system.

No details of output are provided, but it would seem flexible. MISTU would appear to be an attempt at a whole property approach developed through the use of many sub-program modules. This is an approach advocated by Blackie (1974).

Krolis (1977) places particular emphasis on the MIS covering all stages of the management cycle and this is particularly laudable. One obvious shortcoming noted is the assumption that business firms only have a single goal. This is obviously misleading.

No details are available on the use of the scheme by growers. In the development of MISTU, Krolis comments that consultants, advisory officers and accountants of horticultural firms were involved. While this is a good start this approach does not guarantee to meet the requirements of all growers. MISTU is obviously a very promising and innovative development. However, it is too early to make a comprehensive critique of its operation.

7.3 General Farm MIS's for Use by Horticulturalists

Before looking at some of the generalised farm MIS s in operation, it is worth noting the cautionary comments of Hales (1966) in relation to assuming that horticultural management should be closely modelled on farm management services:

> "So far the development of horticultural management has been closely modelled on the Farm Management Service which has been in existence for about 15 years. While this has the obvious advantage in that the body of knowledge acquired by farm management can be drawn upon by horticulture, it is also

in danger of accepting a set of assumptions which classify horticulture and agriculture together both economically and sociologically.

These assumptions are:

(i) that the economic structure of the horticulture industry is so akin to agriculture that it lends itself to the same management techniques, recording methods and business report systems with little more than a casual adjustment of terminology.

(ii) that growers and farmers can be classified together as one sociological group, that they have the same background education and goals

(iii) that the horticulture industry is at the same stage as agriculture in its attitude towards management.

It is submitted that none of these assumptions is necessarily correct, and that more needs to be known about the economic and sociological structure of the industry before a management service can begin to function effectively."

Blackie (1976) considers there are currently advanced whole farm "mail in" systems which attempt to cover all stages of the management cycle and which provide regular and reasonably rapid exchange of information with the farm firm. These "integrated" MIS's are the CANFARM information system developed by the Canadian Department of Agriculture and the approach used by the Farm Management Service Laboratory at the University of Western Australia.

7.3.1 CANFARM Information System:

CANFARM has been developed with the objective of designing, building, and operating computerised farm management information systems to enable each and every Canadian farmer to make more effective decisions in relation to his economic goals (Thompson, 1976). CANFARM's two main services directly aimed at the farmer are

* Farm Records - involves the development and operation

of a service to sort farmers' data into meaningful information about their farm business, to diagnose problem areas, and to identify alternative opportunities. In particular this service involves cash, cost and production control (see Bauer, 1977).

* Farm Planning - this involves the development of computerised services that enable farmers to assess proposed financial and/or production plans and select options best suited to their individual goals.

A farm manager using CANFARM elects to use one of several options to select the level of information necessary for his business (Bauer, 1977). The system provides monthly, periodic and annual reports on historical data. Of the various planning packages available, none of these are related to horticulture (Thompson, 1978). In fact the whole CANFARM operation would not appear to be very attractive to horticulturists as is evidenced by only 260 horticulturists out of a total of 13000 farmers currently registered in its Farm Records Scheme (Thompson, 1978).

In looking at the CANFARM operation from the viewpoint of a MIS for farmers, one of CANFARM's claimed advantages could also be considered a shortcoming - the problem of trying to be all things to everybody without fully meeting the needs of any particular group of people.

Barry (1972) and Dyfri Jones (1975) have also provided a critique on the general aspects of the CANFARM operation. Their major points include:

* CANFARM's rapid turn around is an excellent feature.
* There seems to be too much emphasis on financial information. Not enough production information is provided.
* Too much recording is required by farmers.
* In the past not enough emphasis has been placed on forward planning. However planning packages are now being developed for livestock and cropping systems.
* Problems exist with initial recording of data (error prone) and too much data of questionable relevance being required.
* Reports to farmers being too numerous and detailed.
* Claims that the CANFARM organisation was too central, remote and impersonal.

7.3.2 Farm Management Service Laboratory, University of Western Australia:

The Laboratory has developed the "mail in" approach to include the concept of budgetary control (Mauldon et al., 1969). This system compares actual historical data on cash flows within the business with budgeted figures. Statements are provided on the sources and uses of funds, changes in equity and liquidity, asset transactions and farm profit, among other financial items. The cost of using the system is low and recording is simple and straightforward. Flows of funds statements appear monthly, physical enterprise reports are published quarterly and several annual statements are available.

Like the CANFARM system, the Western Australian system has been basically designed around the requirements of cereal and grazing farmers and hence horticulturists are likely to find that it does not meet their needs, particularly in relation to enterprises. No details are available on the Western Australian system's use by horticulturists. However, it is unlikely to be very significant.

8. CRITICAL ISSUES

8.1 Implementation

8.1.1 Introduction:

Recent literature suggests increased attention is now being devoted to the issue of implementation of computer based MIS's for corporate businesses. Concern has been widely expressed that while many excellent MIS's have been developed, their use by management has been disappointingly low. This concern is well based as Ackoff and Sasieni (1968) perceptively observe

> "implementation is always the ultimate - and sometimes the only - test of the value of a solution".

Ackoff and Sasieni comment further:

> "There is a common tendency to think of the implementation of a problem solution as an activity that is initiated after the research is completed and for which the researchers have no responsibility. In Operations Research, however, because the objective is to improve the performance of the system involved, the research is not completed until that improvement is obtained and unless it is maintained, that is, controlled.

In reveiwing, the world situation concerning use by farmers of MIS's (particularly computer based ones) in Canada, Australia and the United States, the picture is not very encouraging.

In Canada Thompson (1976) noted that the number of farmers using CANFARM's farm planning service was 4000 in 1975 versus a target of 7000. The use by farmers of CANFARM's farm records service has also failed targets (although Thompson doesn't say by how much) and has remained stagnant at 10000 from 1972 to 1975. However it has since increased to 13000 farmers (Thompson, 1978). With Canada having a population of about 22 million and assuming 5% of the population are farmers, this means that about 1% of farmers are using CANFARM services!

For Australia, Rowe (1971) estimates that about 1300 farmers (less than 1% of total) were involved with four EDP schemes that were in operation in 1971.

In the United States, Eisgruber (1973) in a survey of 497 Illinois and Indiana farmers (see Table 1) of their use, needs and sources of information, found that only 12% of all farmers surveyed had used a computer to help them make farm management decisions. These farmers in the main were those with large farms (as determined by gross income) and who had relatively more years of education.

Is this situation a cause for concern? It probably is because of the stated objectives of these MIS's to "be all things to everybody" (see, for example, 7.3.1).

8.1.2 Why Has Implementation of MIS's Been So Poor? (or The Need to Know More About the Farmer as the MIS User)

In looking at the low adoption rate of MIS throughout farming, too little attention has been focussed on determining the real facts (reasons) of the situation (see for example,

TABLE 1 : Percent Farmers who Have Used the Computer to Help Them Make Farm Management Decisions - 497 Illinois and Indiana Farmers.

Gross Income ($)	% Have used computers	Education (years)	% Have used computers
20000	2	0-8	7
20000 -39999	6	9-12	11
40000 -59999	16	13-15	15
60000	24	16	23
All farmers	12	All farmers	12

Source: Eisgruber, L.M. 1973 : Managerial Information and Decision Systems in the U.S.A. : Historical Developments, Current Status and Major Issues.
Am. Jnl. Ag. Econ. 55, 5 : 930-937.

Pugh, 1977). Ackoff and Sasieni (1968) reflect clearly the shortcomings in most current literature on farm MIS when they note that

> "..... discussions of implementation are primarily based on experience and therefore are likely to contain more opinion than fact".

Carlsson (1976) has attempted to establish his work on a sound theoretical basis drawing heavily on behavioural science developments in agricultural extension and operations research (e.g. Huysman, 1970, and Lucas and Plimton, 1972). As such Carlsson appears quite exceptional as far as developers of farm MIS's are concerned. More needs to be known about the farmer himself to better understand his needs, and his psycho - sociological make up in relation to MIS use.

In looking at reasons for the low adoption rate of MIS's throughout farming, the following pieces of research work may throw some light on this issue.

* Farmers values and goals:

  Gasson (1973) in a pilot survey of East Anglian farmers produced tentative conclusions that "farmers with larger businesses are more economically motivated, although expansion appears to be more salient than maximising present income. Smaller farmers put more stress on intrinsic aspects of work, particularly independence." Such findings may tend to fit in with Eisgruber's (1972) survey results of low computer use for planning by small farmers, i.e. an understanding of farmers' values and goals can be useful in explaining and predicting particular behaviour.

* Farmers' Intelligence:

Buggie (1977) in a forum article on intelligence, education and farming achievement, refers to work by Rogers and Shoemaker (1971) that "early adopters have more years of education than late adopters." On the basis of this Nelson and Phelps (1966) concluded

> "it is clear that the farmer with a relatively high level of education has tended to adopt productive innovations more than the farmer with little education. We submit that this is because the greater education of the more educated farmer has increased his ability to understand and evaluate the information on new products and processes disseminated by various agencies and media."

Buggie in suggesting an alternative reasoning notes that

: the evidence relating education to early adoption is not unequivocal. Rogers and Shoemaker reference 227 relevant studies - 205 (74%) support it and 72 (26%) do not support it.

: secondly, and more important, the causal inference by Nelson and Phelps may be incorrect. Another hypothesis of the relationship between education and innovation adoption could be - because the more intelligent tend to remain longer in the process of formal education, the relationship of education to innovativeness (or in our case, to adaptability to economic changes) is then significantly, though not wholely, a relationship between intelligence and innovativeness. As some support for this, Rogers and Shoemaker note that

> "earlier adopters have greater intelligence than late adopters".
>
> As a result Buggie sees intelligence as an important factor affecting adoption of innovations. Buggie's interpretation of Eisgrubers results would be that the existing computer planning models are most suited to the abilities of the more intelligent farmers and hence the adoption by them. He states:
>
> "..... there is a need for farm planning models that are more relevant to farmers. However, this does not necessarily imply a need to develop farm planning/farm recording models that are more sophisticated and more complex. As farmers have different levels of intellectual capacity, there is a need for a range of models. Indeed, I suggest that there are many farmers whose intellectual capacity and other attributes are such that they are not going to significantly benefit from attempts to teach them decision-making/record keeping procedures that are different to those they now use."

These two examples should not be considered as a basis for a substantive theory on which to consider MIS's and their implementation. Rather they are provided merely to indicate the complexity of the issue of non-implementation and the need for it to be considered more seriously than relying on "mere opinion".

Better knowledge based on research at the farmer level is relevant to the current trend in MIS where a common assumption is that the farmer chooses the type of information and the level of detail etc., according to his needs. However such an assumption assumes that

(a) the farmer knows the type of information he wants

(b) the farmer knows how to make good use of such information (i.e. he is well versed in the use of farm management techniques).

This may not be the case. A farmer may know in a broad sense what problems he's got (he might not also), but not the type of information he needs to solve these problems. It could be hypothesized however, that the more intelligent and better educated farmers may be assumed to know the type of information they want and how to make good use of such information.

Another aspect of MIS developments relevant to the preceding discussions is that farm MIS modellers frequently list the types of information considered necessary for farmers for managerial decision making. This is used in MIS design. While this may seem satisfactory, it assumes that the farmer also sees the value of such information in a similar light. This may not be so. His understanding and skills in the use of such information may be non-existant. Assuming he has the necessary but latent ability, a less ambitious approach is required to match his existing skills. As the value of such information is realised, so the amount of information collected and complexity of the system can be increased, if in fact this is necessary. This approach has been advocated by Carlsson and Johansson (1972) and Blackie (1974).

The important issue of whether a particular MIS is designed to be farmer operated (as proposed by Pugh, 1977) or consultant operated should not be taken lightly. It is also a complex issue involving such factors as the skills and abilities of the farmer to name just two.

In relation to farm MIS there is little evidence of user involvement in MIS development (an obvious exception being Carlsson's work) except perhaps at the validation stage and then the validation may have only taken place on a couple of farms that may be atypical.

Lack of user involvement (and hence orientation) in farming would appear to be a critical issue in explaining poor implementation. User involvement in MIS design would seem to be an essential pre-requisite for MIS implementation for a number of reasons:

* The user and systems developer have different conceptual frameworks and frames of reference. They are likely to have different perceptions of the MIS.
* The user needs to understand the MIS. He is unlikely to use something he doesn't understand (especially if computer-based).
* To better define and understand the user's information requirements.
* To get commitment of users to the new MIS. If the user is involved in the development of the MIS, he is likely to have a greater commitment to using it.
* To ensure user orientated input/output.

In recent years a lot of O.R. modellers attention has been devoted to ways of successfully involving the user in systems design. Lucas (1978) in particular, has focussed on this issue. He has proposed two alternative approaches that will bring about greater involvement. They would appear to be worth considering in relation to farm MIS. One approach

8.1.3 Involving farmers in MIS design - the answer?

The preceding discussion naturally leads onto the need to involve farmers more in the design of MIS.

Blackie (1974) considers the use of an MIS by farmers will be dependent on three main factors

* it must provide a source of relevant information that must be comprehensible to managers,
* the cost of using the system must not outweigh the expected benefits from the information generated by the system,
* managers must be able to understand the operation of the system.

Perhaps a fourth point is that managers must have confidence in the information provided by the MIS, i.e. it must have realism. This would especially be the case with the planning subsystem of the MIS.

While these points state the obvious, they tend to understate the importance of farmer involvement in MIS design as a basis for successful implementation. Tobin and Butfield (1973) and Ansoff and Hayes (1973) have highlighted the importance of involving the user in the model building process as a prerequisite for successful implementation. King and Cleland (1975) note

> "There is considerable evidence to suggest that the lack of involvement of managers in the design process - in the crucial phase of information requirements as well as in other phases - has been a significant factor contributing to the failure of many MIS to perform as expected."

is the "Creative Systems Design" which consists of three componants:

* User controlled design
* Special attention to the user interface (i.e. input/output)
* Evaluation of system quality on user criteria.

The important issue here is that the user is in charge of the design effort. Another approach is "Evolutionary Design" which can be combined with creative design, in many instances, to increase dramatically the likelihood of successful implementation (Lucas, 1978). Table 2 illustrates the combined approach.

8.1.4 A Pragmatic Approach to MIS Design With Growers:

In relation to horticultural MIS's, it would seem that successful development and implementation will lie in developing ways of involving groups of users with common needs and abilities, in the design process. Such groups would be growers with common enterprises (e.g. apples) and with similar needs and abilities. This would commonly be the case with grower discussion groups (certainly in Australia). It also would be possible for horticultural consultants with a large portfolio of clients to divide them up into sub-groups with "much in common".

The MIS designer could meet on a regular basis with the group. Initially, the information requirements and needs of the group would be defined, and then in follow up meetings, proposals would be put to the group by the MIS designer. These would probably be modified before being

Table 2: Evolutionary and Creative Design of an Information System.

Evolutionary Design Stages	Creative Design Components: User Control	Interface	User Criteria	Implementation
Inception	Suggest idea	Rough sketch	Beginning to develop	Begin commitment and ownership
Initial groping	Respond to first product and influence development	Becomes more clear	Understand problem	Interaction stimulates interest and understanding of problem and available tools for a solution
Mutual progress	User controls; constant feedback; responsive computer staff	User develops I/O formats, processing logic	Formulate standards against which system will be judged	User has knowledge of design and system; less reliance on external expertise, design process leads to psychological ownership
Conversion	Guide conversion and training of others	Users knowledgeable about I/O	Users can see benefit of system from their point of view	Knowledge, ownership, and commitment lead to easy transition to new system; users are already familiar with it
Maturity	New ideas for changes are stimulated because users know they can influence system	System can be used because interface is well designed	System is useful because it will be of high quality	System is highly regarded, interface good, quality high, and users committed to it; changes are suggested as system continues to evolve

SOURCE: Lucas, H.C. 1978: The Evolution of an Information System: From Key-Man to Every Person. Sloan Management Review 19: 39-52.

accepted by the group. Such a procedure would continue through MIS development and then validation. A continual two-way exchange would exist between the designer and the grower group. In fact the group would carry out tasks as well and so positively contribute to the whole exercise.

The MIS designer could meet with other grower groups involved with the same enterprise, but who had different needs and abilities. Skeleton models of the type developed by Blackie (1974) would appear to be suitable for use in horticulture. Assuming the skeleton model has been developed on a modular basis, the differing requirements of differing grower groups could be met without too much difficulty or cost once the skeleton model had been developed. While this approach is a time consuming and demanding one, it would appear to be the only way if computerised MIS's are ever to be used on a significant scale in horticulture. The approach would also involve education programmes in management so that the value and use of MIS's could be even further enhanced. In fact, the need for an MIS may develop out of management schools/ workshops for growers. Department of Agriculture Farm Management and Horticultural Extension Specialists would seem ideally placed to guide and develop appropriate MIS's with growers, along with good liaison with institutions like Lincoln College.

8.2 Enterprise Modelling For Planning or Forecasting

The horticultural MIS's reviewed have an obvious limitation in that they cannot be used in an exploratory role of assessing alternative management options (e.g. changing methods of production or determining the effects of particular enterprise combinations) because they lack a necessary planning or forecasting computer model of the particular enterprises concerned. The only exception to this would appear to be the Dutch IMAG MIS.

In other agricultural industries, particularly those involving intensive animal production, enterprise modelling based on 'skeleton models' have been developed for use in MIS's. This development would seem to have equal relevance to particular horticultural MIS's as has been mentioned elsewhere in this review.

The concept of skeleton modelling has been developed by Blackie and Dent (1974). A 'skeleton' model of an enterprise (or business) is one in which only those features common to all similar enterprises form the permanent structure of the model. The skeleton model represents the logical structure and contains only the basic parameters of the real system. As an example, Blackie and Dent have developed a skeleton model for the pig herd system. The skeleton is formed by the basic breeding and growth patterns of the pig. Such a model becomes functional only when 'coupled' with data from an individual farm and, in its 'coupled' state, is unique to that farm. The coupling data indicate the ways in which the particular farm modifies the basic pattern of enterprise behaviour. The model in its coupled state is capable of

detailed predictions of future outcomes of production systems and of providing guidelines for the implementation of individual business strategies.

The concept of an information system coordinates well with that of the skeleton model. The forecasting model (which is the skeleton model in its coupled state) provides the means whereby individual farm firms may plan the operation of their businesses and obtain targets specific to their selected strategy and circumstances. The overall information system allows for the comparison of actual results (both physical and financial) with targeted performance and a method of modifying the targets and plans as they become invalidated by time or management changes.

Blackie (1974) has highlighted the situations where skeleton modelling is likely to be valuable, viz.:

1. Enterprise modelling is more likely to prove a viable concept in practical terms than whole farm modelling since the variability within enterprises is less than between whole farm businesses.
2. Enterprises that typically operate under conditions which cause rapid flows of inputs and outputs and where small variations in these flows can effect the final profit from the enterprise. There is thus a need for rapid information feedback to the manager on these rates of flow.
3. The enterprise operates in a highly controlled environment with the whole system approaching that of a closed system.

Within horticulture, protected cropping (glasshouse or

greenhouse production) of vegetables, flowers and nursery plants would appear to be at such a stage and thus be particularly suitable candidates for skeleton modelling. Much glasshouse production is increasingly based on more automatic control of the plants growing environment (e.g. temperature, carbon dioxide levels, daylength, timing of irrigations) by the use of very expensive electronic equipment. With short growing periods of these annual crops, the critical nature over the control of the plants' growing environment, and the high cost of such an operation, this complex situation of many subsystems would seem ready-made for a computer based MIS incorporating skeleton models of the various enterprises if overall firm objectives are to be achieved. In tomatoes, for example, the skeleton model of the tomato enterprise could be used to assess the effects of changed crop growth and maturity as a result of differing temperature regimes, carbon dioxide levels and planting times (daylength).

Skeleton models of various enterprises (2-3) could be developed as compatable modules which can be linked together to form models of the complete horticultural enterprise. While this may appear somewhat futuristic, it would seem to be the approach being used in the Dutch IMAG MIS. It has the obvious advantage in forecasting, for example, cash flows and labour usage over a time scale. Such information can be invaluable for planning the intensive horticultural operations that we have discussed.

Other horticultural situations may be such that they warrant the development of enterprise skeleton models. This

could conceivably be the case for extensive vegetable production involving many plantings of particular crops and many different types of crops throughout a yearly period.

It is worth noting that the skeleton model operates in a 'decision-support' or so called 'if, then' capacity and thus is ideal for meeting the diverse and often unique requirements of particular firms. It is also obviously implied that the model is dynamic and stochastic in form to adequately mimic the particular bio-economic system under study. As such, a computer-based simulation model would most adequately meets these demands.

9. CONCLUSIONS

In recent years farm management information systems have become of increased interest and relevance due to a number of factors including:

* Rapid developments in computer technology. The development of the silicon chip as the basic componant of microelectronic systems is leading to minicomputers of lower costs than have hitherto been available. Thus the factor of cost as a major impediment to their use is being removed (Pugh, 1978).

* The increasing complexity of farm businesses and the socio-economic environment in which they exist. When combined with the rapid pace of change, this situation is likely to mean that past ways of managing farm businesses may no longer be adequate.

* The high cost and marginal profitability of many farm operations.

* The development of systems thinking.

To date little attention has been given to the development of specific MIS's for horticultural firms. This is reflected in the scarcity of documented cases in the literature. Sweden, Guernsey and Holland have developed specific horticultural MIS's for use by glasshouse crop growers in the main. These MIS's show particular promise in that two of them have not suffered from poor adoption (implementation) by farmers, as is commonly the case, while the other MIS is too recent to assess its adoption by growers. However this latter MIS developed in Holland does appear to be particularly innovative and show considerable promise. Thus while the resources allocated to developing horticultural MIS's have been particularly meagre, the systems developed to date have been of considerable quality. This augers well for the future.

General farm MIS's such as CANFARM, in their existing form would not seem to hold much potential at being widely used by horticultural firms.

From the experiences to date with horticultural MIS's and developments in other fields, the following factors would seem to be important in the design of horticultural MIS's for their successful use by growers:-

1. An accurate and comprehensive identification of the grower's management information needs and requirements (in some order of priority, and in

quantity, quality and frequency) bearing in mind the key decision processes of their business and the type of information that the manager is able to usefully use.

2. A deliberate involvement of growers in the development of the MIS. This could be on a group basis (growers with similar enterprises and needs).

3. Development initially of very simple, possibly manual MIS's that don't involve the grower in much effort in terms of data recording. Once the benefit of such information for managing the business is realised, then, and only if necessary, the development of more complex MIS's can take place. Greater emphasis needs to be given socio-psychological aspects of growers in relation to such factors as their speed of understanding and learning new tasks, their inherent abilities of analysis, their values, etc. That is, being very user orientated in the full sense of meaning of the word.

4. Attention needs to be given to developing planning or forecasting models of enterprises where a need is demonstrated as a basis for assessing alternative management strategies. This would seem best done using "skeleton modelling".

With computers being used increasingly in many walks of life, their increased role in farming and in particular horticulture, seems inevitable. The obvious area of use is

in MIS's. To the farmer, MIS's and computers may seem very complex innovations whose benefits may be obscure. However the preceding guidelines would seem to provide a reasonable basis for leading to an increased usage by growers of computer based MIS's to help them meet todays and tomorrows problems of farm management.

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