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COMPUTER SYSTEMS FOR MANAGEMENT INFORMATION IN PRIMARY PRODUCTION

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SUMMARY

Some examples of management problems for forestry are given. These are used to illustrate the thesis that computer systems to provide information for these problems do not fall clearly into the definitions of "scientific" or "commercial" computing. It is suggested that such systems based on primary production data are best developed in a research environment.

IN a recent paper on the potential role of computers in the government services, Lythgoe (1970) drew a distinction between the use of computers for accounting and management on the one hand and for scientific and engineering purposes on the other. The former usually require a large input-output while the latter require large or complex computation. This division is a normally accepted one in the computing world and has a considerable effect on planning organizations and on the training of staff. Lythgoe also notes that the most efficient use of many of the modern types of computer which can do a number of jobs at one time, is to use them for both commercial and scientific programming.

As with Lythgoe's paper, the views in this paper are my own and do not represent any completely accepted policy.

It is the thesis of this paper that the provision of management information for primary production requires concepts which combine both scientific and commercial approaches to computing. Attempts to separate them could hold up the development of reliable systems which are now urgently needed. The need for this approach is apparent for problems in forestry and these problems have many parallels in animal production. It arises from the variation inherent in the biological bases of these primary industries compared with the more "exact" nature of manufacturing or economic statistics.

This point will be illustrated by some examples of management problems. A brief description of the computer facilities likely to be available and the possible organization to make the best use of these facilities to provide reliable information for management will follow.

MANAGEMENT INFORMATION

Major Policy Information

Management information systems in industry often mean the supplying of summarized data to top management to form a basis for their decisions. At present the main use for computers in this area is their ability to digest and summarize large quantities of data at high speed. Examples of this approach in forestry are given by Grevatt (1970). While this means that decisions are made on up-to-date information, it does not necessarily make use of such techniques as simulation or linear programming and the so-called operation research approaches. However, these techniques are being quite widely used in industry and the Ministry of Works for specific problems but tend to come under the heading of "scientific".

An example from the past of major policy information comes from the Agricultural Development Conference (Anon., 1965). The recommendations made were based on certain assumed values for such parameters as wool price and production. No alternatives were considered (or at least reported) nor the possible consequences of variation in these parameters. The wool price parameter for 1964-74 was 47 cents in our present currency (42d 1964 currency).

The consequences of variation in this parameter are now obvious, particularly to those farmers who increased stock numbers and topdressing on credit.

Figure 1 illustrates a flow chart for a simulation program of a type which could have given some idea of the consequences of wool price variation. It is to illustrate a computer application only and is not meant to be an economic or management study. It would, however, indicate the importance of given price variations, which could be input to the program to give the effects on income for farms of different sizes and stocking rates. Clearly a system of this type must be initially set up by a specialist in farm management and economics who is aware of the relationships involved and also the user must be awere of the assumptions underlying the information obtained.

Programs of this type (Naylor *et al.*, 1968), while not providing exact forecasts, would give the policy-makers some idea of the possible consequences of alternative assumptions. Such information would not make policy decisions easier but might make them more realistic.

A second example concerns decisions on the commercial exploitation of a forest. These decisions depend initially

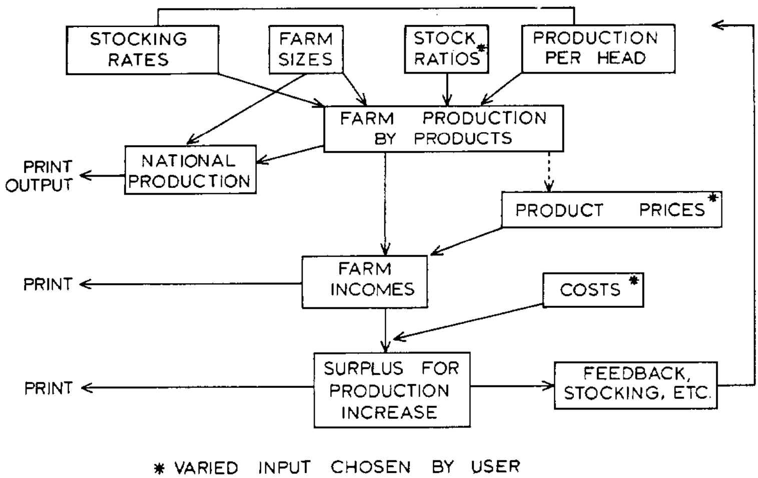

Fig. 1: Simulation of price effects.

on the amount of timber of various kinds which will be available over a period of time. The estimation of this resource from a large area requires sampling and estimation techniques and some knowledge of their applicability. This inventory requirement is discussed under field management decisions.

However, even if the timber available at a point in time is known, it will not all be felled at once. Unfelled trees will continue to grow at rates depending on their age and the site on which they are growing. These growth rates will vary so that the order of cutting the different compartments of the forest will determine the total timber obtained over a period of years. This can be further complicated over a long period of time by the species and management methods used in replanting after felling. Thus the economic rotation and thinning returns may be different for pulpwood or sawlogs. The outline of the problem is given in the form of a system in Fig. 2.

The decision-makers require only the overall figures for possible different forms of production, but in these cases such overall figures may be based on a large amount of data, some fairly complex biometrical techniques, and simulation models to determine alternatives. Linear programming could also be used to optimize returns. Thus in this case management information is based on scientific methods in which biological knowledge of tree growth and its variation are essential links in the chain.

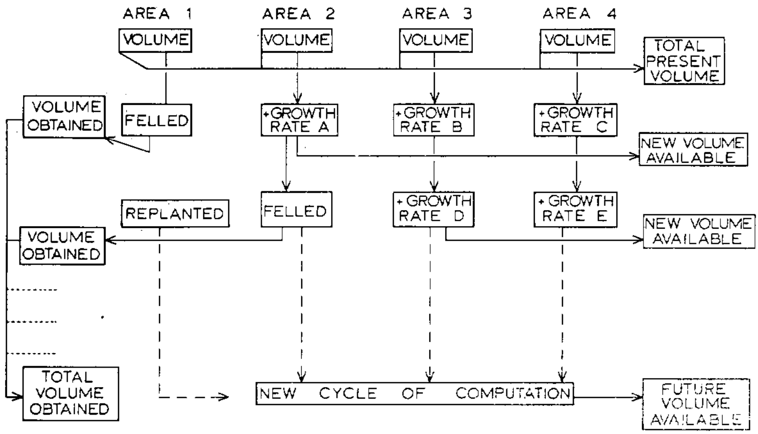

Fig. 2: Elements of the cutting schedule problem.

Information for Field Decisions

In the Forest Service the local forester and the conservancy office make the majority of decisions concerned with a particular forest. It is they who would decide the final details of the cutting schedule described above and would require the same information but in more detail.

In terms of agriculture they would be the equivalent of the farmer who might obtain information from the extension officer, his accountant and any other source. However, he would use this information in the light of his own special knowledge of his farm. For example, a farmer could use computer-based information for selection in animal breeding and for the economic results of management alternatives. In general, he knows what is happening on his farm and how his stock is doing. This is possible with 1,000 acres and 5 sheep per acre. It is not easy with 200,000 acres with 100 to 500 trees to the acre.

Thus a first requirement of forest management is an inventory system which will give details of the timber resource in small areas — *e.g.*, setting contract rates for felling — and in larger areas for management policy decisions. Some projections based on growth rates and the results of treatments such as thinning are also required. Figure 3 gives the outline of some of the factors involved in a computer system to give this type of information. It is based in part on the system already run by the Forest

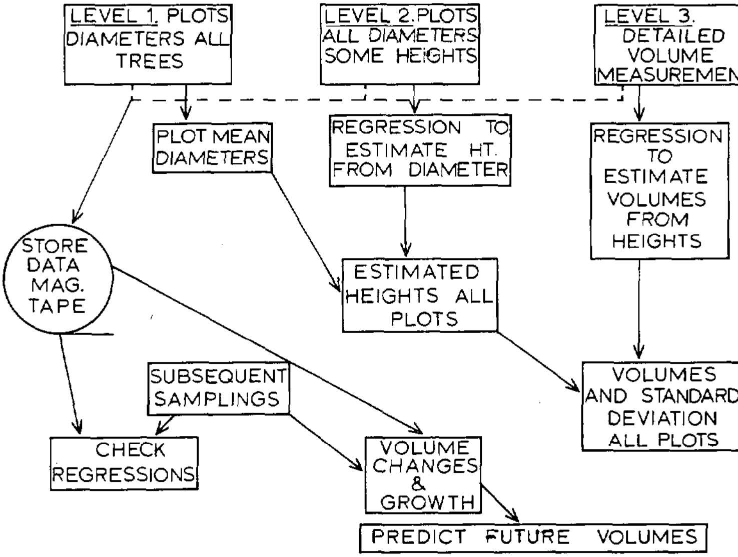

Fig. 3: Simplified design of the approach to forest inventory.

Service on the Elliott 503 at DSIR (Lees, 1967; Whyte, 1969). Such a system requires "commercial" programming techniques for the handling, checking, storage and retrieval of large amounts of data. It also requires a number of techniques, such as regression comparisons, sampling and prediction, which at present are mainly used by research scientists.

The reliability of the results returned to the forester will depend on the applicability of the methods being used and the appropriate built-in checks on these methods.

There are many more requirements similar to these examples but sufficient have been given to illustrate the main points. The person who makes the final decision will bring in factors besides those provided by the computer system. But to make full use of the information provided by a system, he must also be given some knowledge of the system, have some say in its design, and there must be some justification of the methods used and details of their limitations must be available. Some of the methods require specialist technical knowledge and it is essential that they should be well referenced and have been subjected to the normal critical appraisal given to research publication. Thus errors in present methods which could be built in to computer programs have been discussed by Whyte (1968).

ORGANIZATION FOR DESIGN AND DEVELOPMENT OF SYSTEMS

As agriculture and forestry are largely within the state services, there are a number of restraints to consider. One of these is that the hardware facilities available are the result of overall policy. These facilities will be a central 1904S computer with magnetic tape and disc storage facilities. This computer is equally efficient for large-scale data handling or high-speed computation (Lythgoe, 1970). It will have multi-programming and multi-access facilities controlled by an operating system (Cuttle and Robinson, 1970) and also terminals with complete input/output peripherals. Because of the geographically widespread nature of both forestry and agriculture, advantage can be taken of this centralization. Thus all data files and systems on the one computer should be available eventually to any organization which can be linked to the computer through a remote terminal, teletypewriter or visual display unit. The development, programming and testing of systems can take place through one terminal and the system will then be available to all the others. This means that the systems development does not have to be adjacent to the main computer. It does mean that the organization *must* be carefully controlled with respect to file or program changes and identification.

For systems development there is a problem of finding what is required by top or local management, co-ordinating these requirements, and determining the practical possibilities of data collection. This is the job of a systems planner who would be a forester or extension worker with some computer knowledge. The resulting plan would be given to the computer specialist who would determine the file systems, program modules and so on. This specialist is the systems analyst who produces a system which is then ready for coding and testing by the programmer.

This is the usual type of organization in which the computational requirements may be small — *e.g.*, tax rates. However, for the systems illustrated in this paper, the user, the systems planner and the systems analyst may not have the complete knowledge required for the biometrical or other mathematical techniques used. In addition, there may be other specialities involved, such as breeding or disease control, which require some research before they can be incorporated into a system. It is also worth pointing out at this stage that the systems approach was used and developed by biologists some time before computers were developed (Waterman, 1968; Price, 1970).

These considerations, together with the availability of the remote terminals, suggest that the sytsems design and programming section should be part of a research organization, provided this research organization has close links both with top management and the field requirements.

From the point of view of the research scientists, there should also be a feed-back in terms of problems and also in the services available to them. Thus a biometrical system of programs now being developed at Forest Research Institute will not only be available to the scientists but should also provide the program and subroutine modules for the management systems. Furthermore, the large amounts of routine forest data on the computer files should be available for research purposes.

To sum up, the argument is that information systems based on primary production are best developed in a scientific environment, which includes economics, with staff trained for this purpose and who also know the techniques for handling considerable data.

REFERENCES

Anon., 1965: *Rep. Agric. Develop. Conf. 1963-64.* N.Z. Govt. Printer, Wellington, 346 pp.

Cuttle, G.; Robinson, P. B., 1970: *Executive Programs and Operating Systems.* MacDonald/Elsevier Computer Monographs.

Grevatt, J. G., 1970: *Forestry, 43:* 17.

Lees, H. M. N., 1967: *Standard Methods for Inventory and Growtn Measurements of Exotic Forests.* N.Z. Forest Service, Wellington.

Lythgoe, I. G., 1970: *Proc. 2nd Nat. Conf. N.Z. Computer Soc., 4:* 41.

Naylor, T. H.; Balintfy, J. L.; Burdick, D. S.; Kong Chu, 1968: *Computer Simulation Techniques.* Wiley, New York.

Price, J. D., 1970: *Ann. appl. Biol., 66:* 179.

Waterman, T. H., 1968: In *Systems Theory and Biology:* 1-37. Springer-Verlag, New York.

Whyte, A. G. D., 1968: *N.Z. Jl For., 13:* 184.

——— 1969: *N.Z. For. Res. Inst., Res. Leafl. No. 25.*