Future development of computers for farm decision support

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Abstract

Computers are becoming common as a decision support tool on the farm, and are also beginning to be useful as tools in agricultural extension. More advanced computing and communication technology will affect the way present tasks are performed. Later, new applications will be taken up which are far more profitable than present ones. Once computers are well established, major changes are possible in the scale of management of agriculture.

I have been asked to talk to you about future developments in computer systems that are likely to become available in the next ten to twenty years. This is an ambitious topic, seeing that for example the personal computer was invented only ten years ago, not many forecasters would have predicted the Apple Macintosh. I think there is some evidence that the pace of technological change is slowing, partly because the computer industry is reaching a position of diminishing returns in technology, partly because most of the easy applications have been already computerized, and partly due to the inertia of large investments in current architecture, software, data and the larger scale of computer networks. (Note that the basic architecture of the IBM mainframe computer has changed little in twenty years.) I will briefly outline the current situation, look at some technological advances which should become available in agriculture in the next few years and their impact on current applications, then look at possibilities for the more distant future.

The Present

Computers are becoming fairly common as aids to farm management. In earlier talks we heard about their use for financial management, record keeping, and something about their use as expert advisors. In Australia, we have pioneered in the latter area, in particular with the SIRATAC cotton pest management advisory system (Hearn. et al., 1986) which has been in commercial use since 1981 and presently is used to help manage about one-third of the Australian cotton crop. A number of projects are in various stages of production, including the SIRAGCROP system developed by CSIRO and the NSW and Victorian Departments of Agriculture, which is aimed at broadacre irrigation farmers in the Murrumbidgee Irrigation Area, and which will use Videotex as a delivery vehicle. Some issues in the engineering of such systems are discussed elsewhere (Colomb, 1987).

Decision support is a bit of computer jargon meaning provision of information to a decision maker ,something very familiar to agriculture. For example, agricultural extension can be viewed as providing information to farmers to assist them in making management decisions in their enterprises. Accountants help with financial decisions, while on-farm records are essential to agricultural decisions. Computerized decision support, including expert systems, provide a different way to perform a familiar function.

Extension officers use a number of sources of information in preparing advice: meteorological history, written descriptions of varieties with management recommendations, quantitative models frequently in the form of graphs or tables, and plain experience, usually the officer's own but sometimes that of a central expert. In decision support jargon, these are called knowledge sources. Accountants and the farm managers themselves have similar knowledge sources.

Computerized decision support systems make use of all these kinds of knowledge sources. (Belew, 1985, gives a good overview of the architecture of decision support systems.) Meteorological history is held in data bases. Information on varieties, etc., is usually held in text form with a number of indexes. Quantitative models are in the form of programs, sometimes with elaborate user interfaces as in spreadsheets, and frequently have graphical output capability. These kinds of knowledge sources have

been computerized for many years and are becoming available on videotex systems such as Elders Farmlink and the Perth-based Country-Wise. Experience, on the other hand, has only recently become computerizable using the technique of expert systems.

The typical hardware which delivers decision support consists largely of personal computers on the farm; large computers such as the DEC VAX run by the cooperatives, extension agencies, and information bureaus such as Viatel; and a limited capacity communication system. Communication is either by transfer of floppy disks or low speed modems (SIRATAC users will next year upgrade from 300 baud to 1200 baud modems, so that a full screen will be able to be sent from the VAX in less than 10 seconds.) User interfaces are usually primitive and require considerable learning for effective use, although such systems as the Macintosh and videotex are becoming available which are much easier to use.

Future Hardware

Major hardware advances which will affect decision support on the farm are:

- More powerful computer workstations available to the farmer or extension officer. These will have several megabytes of main memory, tens of megabytes of disk, and large high resolution colour screens. Most of the additional computer power will be used to drive the high quality graphics user interface, and to manage the software libraries. The user interface will work something like the present Macintosh.
- Very high capacity read-only storage using compact disks (CD-ROM). These units have a capacity of several hundred megabytes, which can be read by the computer, but not updated. They can be used for distributing information which does not change rapidly. High bandwidth communication. Telecom is planning to introduce Integrated Services Distribution Network (ISDN) exchanges which have 64,000 bits per second capacity using standard telephone lines. Satellite communication is becoming more available, and optical fibre links with extremely high capacity will be available in some areas.

Implications for Present Services

The main effect of more powerful workstations will be to make software very much easier to use. I know of more than one four year old child able to start up a Macintosh, play a game, then shut it down, all without being able to read. The computer will be much more closely matched to the everyday activity of those using it, so it will be seen as a natural tool in much the same way as a tractor or a chainsaw. The barrier to adopting new software will increasingly be lack of need rather than the difficulty of use. For example, I use the fairly simple package of MacWrite for my word processing needs. There is a much more powerful package available, called Word, which I have resisted learning as I don't need most of its features.

Reference material will become much cheaper and more accessible with the widespread use of the CD-ROM and other optical storage media. A twenty-dollar compact disk can replace thirty centimetres of books. Computer-assisted indexing and browsing capabilities will make it much easier to find needed information. Already there is an encyclopaedia, reference books such as Books in Print, and the 1981 Australian Census on the market. Maintenance manuals for complex machinery, agronomy encyclopaedias, statistical references (the Bureau of Statistics has 30,000 time series on its public database and 300,000 time series available internally), information derived from remote sensing such as Landsat or thematic maps, complex games and simulation models are all possible candidates for publication in CD-ROM. High quality powerful workstations will make these publications a pleasure to use.

The limiting factor will be cost, as the cost of collecting and organizing these data bases is significant, and limited market. Most individuals will not have great need of many such publications. Extension officers and regional planning bodies such as cooperatives and Departments of Agriculture will probably see more of these things.

Not all database will move into CD-ROM. In many cases, access to a central database via an improved videotext or similar interface will be preferable. Data used in smaller parts or infrequently, and data

subject to frequent updates for which the user needs the latest are more properly held centrally and distributed through a communication network. Many will probably be available in both forms.

High capacity communications links will make accessing central databases and other computing services cheaper and more convenient. The quality of user interface will lag behind those possible with personal workstations, but will improve greatly over those now in use. The major limiting factors will be the variety of workstations used in the community and the proportion of the potential user community connected. Further development of standard interfaces such as videotex will address the first problem, while time and the provision of attractive services at affordable prices will gradually increase market penetration.

Future Services

As I said at the beginning, my feeling is that the pace of technological innovation in computer hardware will slow. The big changes in the medium will be in software and communications infrastructure, particularly as the proportion of users in particular communities attached to the network increases.

We can expect to see applications developed which are much more beneficial to the users and their organizations than the first activities computerized. In more heavily computerized industries, the first applications were such things as accounts receivable which were well understood and already performed by well-organized groups of clerks. The initial justification was cost savings, which turned out to be elusive in practice.

It was not until organizations became familiar with computers and their possibilities through these early applications that the more creative and profitable applications emerged. Inventory control is a profitable application not because of the cost of doing it manually, but because the rapid processing of information allows much closer management of inventory levels and the consequent investment. A small company with which I worked was able to reduce inventory levels by $100,000 using a computer system costing about $30,000 which also did invoicing and accounts receivable. The convenience of on-line banking came along after the banks computerized their record keeping.

Not being involved in agriculture, I should not attempt to second guess the thousands of creative people who will develop the new applications. I have, had a little experience with expert decision support systems, however, so can sketch some possible directions for their development.

In Australia, with its very export-oriented agriculture, decision making on the farm is collaboration between the owner/manager, the marketing cooperatives and organizations, the extension officers of the Department of Agriculture, and the research groups in the Departments, Universities and CSIRO. Other important participants are private consultants, accountants, sales representatives from the major input industries, buyers, and the finance organizations.

The cotton industry is a good example. The SIRATAC project was set up in response to the serious threat to the industry presented by the insecticide resistance of the Heliothus caterpillar, after the industry had been forced out of the Ord River in the early 1970's. The computerized decision support system is used in direct management of one-third of the crop and its benefits have spread to the whole industry by many of its strategies becoming general practice. Decisions are ultimately made by the owner/manager, but with the benefit of the knowledge developed by the researchers. In turn, the researchers have access to the results of the use of their advice, giving them far more experience to work with than could possibly be derived from research trials alone.

Information available to the SIRATAC project covers the cotton growing areas sufficiently densely that the researchers are beginning to consider the possibility of regional pest management. The availability of other geographic data such as topography, soil types, forest cover, wind patterns, and various remote sense data, maintained by relevant agencies and made accessible through a good communications network could make it possible to develop realistic and practical models of such regional issues, with the resulting knowledge easily useable by the farm decision makers through the decision support system.

Such closely coupled farmer/extension officer/ researcher communities could be used to rapidly exploit new market opportunities and management methods as well as to combat environmental threats. The decision support system could allow growers to make detailed comparisons among themselves on various aspects of their operations, taking into account the different characteristics of their properties.

Related technology will make possible vastly improved training, possibly through the medium of optical disks, as well as reference books that perform as active assistants. Coupled with the improved communication networks, correspondence education will be transformed into nearly a classroom situation. Rural isolation could become a thing of the past.

Other technologies which may become important in this time frame are automated sensing and robotics. Some people are already using infrared sensors to indicate the irrigation requirements of a crop. One can imagine automating the neutron probes used to measure soil water. It should be possible to develop automated sensors for any number of crop characteristics, and for the presence of pests and other pathogens. Robotics may provide further automation of machinery intensive crops: it should be possible to build an automated tractor which would plow a wheat paddock on its own, for example. Robotics may provide more sensitive machinery to perform presently labour intensive tasks in the horticultural industries.

Conclusion

Agriculture is on the brink of computerization, at a time when the technology supports a widely distributed computation environment with a number of interdependent but autonomous centres. Unlike other industries, agriculture will not have to fit itself into a rigid mould to take advantage of the new opportunities, but will be able to develop in a natural way. It should be an exciting time.

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