or abroad and imported. The Swedish University of Agricultural Sciences has a key role in this process.

The computer hardware and the programming technology are developed outside the agricultural sector. The latest technology is used at the agricultural university in the development of knowledge about management. Decision support systems, management information systems, financial systems, monitoring systems etc. are developed as a part of the knowledge development. The agricultural university has no discipline of agro informatics, but it has a discipline of farm and business management that includes the use of information technology for management purposes. It has also a discipline of agricultural extension, which includes advisory methods and the transfer of knowledge from the university to empirical use.

The agricultural university has developed (or imported) many computerized models and methods for research purposes, and these models and methods form a research frontier. Some of them are too advanced to be used in practice, some are used by the advisors and in agribusiness, and a few are used by the farmers. The university does not have the resources needed to provide services and other support to the users. The researchers in question go on to the next research project and cannot devote too much time to support "old" models and methods.

The Agricultural EDP Centre has high competence in information technology and resources enough for a long term engagement. However, the alternative values of the resources are high and the costs have to be paid either directly by the farmers or by their organizations. The organizations are willing to pay only if it is profitable, or if they have other benefits that will cover the costs.
International cooperation in this field will facilitate the research and reduce the development costs. It is a way to increase the use of agro informatics and make the agriculture more efficient.

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Agro Informatics in the United Kingdom

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Introduction

In the UK the agricultural industry started to use computers in the mid-1960's mainly in those organisations which have a need to process large amounts of data. These organisations established data processing (dp) centres and included the Ministry of Agriculture, Fisheries and Food (MAFF) which processed a large volume of agricultural census data. Many other commercial and commodity organisations also had dp centres which were concerned with the internal operations of the organisation.

Some dp centres provided services to farmers on a post-in/post-out basis. In the main these were enterprise recording services covering the livestock sector. The management reports which were produced gave a month-by-month historical analysis of the performance of the enterprise. The introduction of the computerised analysis meant that many efficiency and performance indicators could be calculated. Later these services were developed to provide short term forecasts of future performance. The computers were also used to analyse farmers accounts and similarly to

provide a range of efficiency indicators and comparisons with groups of similar farmers. In the mid 1970's on-line terminal services were beginning to appear using printer terminals and very slow line speeds. Some fairly crude and difficult to use interactive software had been written for such purposes as ration formulation.
Also during the 1970's the size of these dp centres began to increase quite sharply but this was in response to the need for internal administrative systems such as payroll, sales order processing, invoicing and, in MAFF, some of the animal health activities and disease eradication schemes were computerised. This era also saw a marked growth in the use of on-line literature searching to survey the world's scientific literature through librarians.

Microcomputers

During the latter half of this decade micro computers became available and these were quickly used to process data in the local offices of these organisations. They were sufficiently cheap for a small number of innovative farmers to buy them and to develop software to help them run their farms. Many of these farmers established agricultural software businesses and whilst many fell by the wayside a number still remain in business today.

In the 1980's the computer became a means of storing and retrieving information rather than just processing data. More sophisticated network services appeared to exploit the facilities at remote dp centres and to allow users to communicate with each other.

Current situation

Following a few years of rapid progress in the late seventies and eighties agricultural information technology is today going through a period of consolidation and reappraisal. There has been no real growth in the number of microcomputers on farms over the past few years. In spite of significant drop in the prices of both hardware and software the market for PCs grows only very slowly.

Agricultural Software Market

There are some 8000 micros on farms of which about 5000 have been supplied as turn-key systems with commercial software. The balance are running standard software, eg spreadsheets, database packages etc. In some cases farmers have developed their own software.

The number of commercial agricultural software houses has dropped dramatically from a peak of 62 in 1984 to around 30 in 1991. Only 9 firms produce a full range of software, the rest either concentrate on very specialised areas or are very small.

A survey by ADAS in 1985 showed that the main penetration was on farms with more than 100 hectares of crops and grass and employing 5 or more staff. This survey also showed that the penetration of micros was associated with a large breeding livestock herd and with cereals rather than any other particular type of enterprise. The majority of users had purchased financial programs with dairy and payroll programs also important. The rest mainly covered breeding pigs, arable crops, beef and sheep enterprises.

Videotex Services

As for videotex terminals there are now less than 3000 in use in the UK with about 60% in use on farms. The Milk Marketing Board's Dairyfax service allows dairy farmers to check their milk quality results, to retrieve National Milk Records for individuals or groups of cows and to forecast future milk production. A home banking service is also available through Prestel and is brought to subscribers by the Bank of Scotland; it offers bill paying and balance checking.

The National Farmers' Union provides a comprehensive service for farmers with additional specialised services for cooperatives and private companies. The Meat and Livestock Commission provides daily market prices for cattle, sheep and pigs from over 90 auction marts.

New GEC software has led to the development of a novel videotex application in pig marketing. A company called TABROTEC in Humberside now conducts an electronic auction of 2000 pigs every week. Some 20 sellers and 5 - 6 buyers use the system and it has proved quite popular. The sellers have the details of the pigs entered for them and the buyers can check what is to be available in the forthcoming sale. Historical carcase quality data for each pig herd is also available. The sale takes place at a specific time of day and each buyer watches the price as it moves. The first buyer to press his bidding key stops the clock and pays at the price shown.

The ICI Agviser and Prestel Farmlink services were first amalgamated and then closed down two years ago. The National Farmers' Union, the Milk Marketing Board and the Meat & Livestock Commission continue to provide services to farmers and others in the agricultural industry on Prestel. ADAS withdrew from Prestel in 1990.

Organisations

The major organisations serving the agricultural industry all have vigorous information technology plans. These organisations are developing networks and are planning for the eventual connection of farmers and others to provide them with services directly. Examples include the advisory services, marketing and commodity organisations, suppliers, farmers unions, cooperatives and cattle breed societies.

ADAS has a vigorous IT strategy and has developed a number of database services, advisory applications and office automation facilities for its front-line advisers. These are provided by equipping advisers with lap-top micros and by the extension of the MAFF X.25 network to the local advisory centres. The network currently has over 30 computers attached to it, the majority being Prime minicomputers plus an Amdahl mainframe and an ICL mainframe.

The Agriculture and Food Research Service (AFRS) also operates an X.25 star network with Digital minicomputers. This network is mainly used for processing R & D data and model building. It is possible to connect the ADAS and AFRS networks to effect file transfers or to allow joint IT development work. Many organisations in the commercial and commodity sectors have recently established networks with IBM and ICL being the preferred mainframe supplier and with Digital the most common minicomputer supplier.

Agricultural Education

Tertiary level agricultural education in the UK is supplied by County Colleges of Agriculture, Polytechnics and Universities. All of these offer some training and education in the use of IT, mainly microcomputers.
There is a voluntary group called the National Computer Users Group in

Agricultural Education (NCGAE) which organises seminars and workshops, distributes a newsletter and provides a forum for exchange of ideas, experiences and software.

Recently a new Master of Science degree course in Information Technology for Agriculture and Rural Development has been started at the Silsoe Agricultural Engineering College.

Trade Association

In the UK, under the auspices of the Agricultural Engineers Association (AEA) a trade association for IT in agriculture has been operating for the past five years. It is called Agricultural Computing and Electronics (ACE). This was established with the help of ADAS and to date has concentrated mainly on the development of standards and on joint promotional activity.

Latest Developments

On the microcomputer front the price: performance ratio continues to be driven down by the computer industry through the element of competition. Equally software prices are falling so making the cost of a turnkey system justifiable on a wider range of farms. The major requirement now is to develop fully integrated suites of software to allow the exchange of data between programs dealing, say, with one enterprise eg dairying and the main financial programs for the whole farm. For those organisations serving the industry the rapid developments in the field of lap-top portables are of most interest at the micro end whilst the emergence and increasing importance of multi-vendor standards and open systems dominate issues as far as networks (LANs and WANs) are concerned.

Future Needs

Farmers are less concerned about the capital cost of investing in IT although uptake is still influenced by the profitability of farming. Farmers are however very concerned about the amount of time they personally have to invest:

- to learn how to use the hardware and software; and
- to load all the necessary back data on to the system. This is particularly true for large livestock enterprises.

Decision Making

Farmers like all businessmen have to make decisions and the basis of all sound decision making is relevant information. Farmers' businesses are increasingly under pressure and they have to manage their information resources as effectively as possible. The successful information manager will integrate on- and off-farm information in support of his decision making processes. Farmers have different kinds of decisions to make from simple to complex, from routine to one-off and to be effected over a wide range of time scales. Information Technology plays different roles in these decision making activities. Information Technology systems are capable of helping farmers to make decisions and include such tools as sensors, calculation programs, databases, models, expert systems, electronic mail and other communication aids.

Integrated Systems

In many agricultural businesses, especially in horticulture and intensive livestock (including dairying), there have been many applications of micro-electronic technology concerned with the day-to-day management of these enterprises. This has mainly centred around the automation of controlled environments and the capture of physical data eg milk yields, fuel consumption etc. What is required now is to integrate these 'systems management' or 'process control' computers with the 'information management' or 'business control' computers. What this will ultimately lead to is a comprehensive knowledge base consisting of data collected on the farm through a system of monitors and loggers controlled by local microprocessors under the overall guidance of a farm business computer. External knowledge bases will also be accessed by the farm computer.

As for remote systems such as videotex these will have to become much more capable of reflecting the information needs of the individual. Most farms have their own particular information requirements but existing videotex services aim to provide a broad service not tailored to any particular individual or group. The indexes of such systems are the same whether the farmer user is a dairy farmer, a pig farmer, in arable or horticulture. Videotex services must segment their market and differentiate the information needs of each segment in order to provide a more attractive package.

Information Delivery

In future videotex systems must aim to reduce the level of active searching users have to undertake to find a precise piece of information. Keywords are a help here but it is clear that where a farmer or grower has identified a need to have information on a regular basis in the same format then this information should be delivered to him personally through an extension of the mailbox facility. Another possibility is to use the data broadcasting facilities of the television companies using the teletext format to broadcast relevant data to groups of subscriber terminals. The terminal can be an adapted television and/or printer which can be individually addressed if necessary. This allows information and data, which can be encrypted for security purposes, to be sent only to terminals which should receive those data ie where a subscription has been paid. The terminals can thus be remotely enabled. If necessary, satellite technology could be used as an alternative to a terrestrial network.

The kinds of information which should be delivered regularly to users are those which are already popular on videotex systems namely markets, weather, crop pests and diseases and other volatile information. Other less volatile but perhaps more complex pieces of information can be stored on database systems for on-line retrieval when necessary.

Electronic Data Interchange

In the past videotex systems have not allowed users to establish and maintain their own files on the host computer but this is now rapidly changing. Many of the new applications require farmers to input data over time and to build up a profile or record of activity. Whilst videotex is not a cost-effective solution when large amounts of data have to be entered on-line there are other ways of overcoming the data loading problem. Small amounts of data can quite easily be loaded by farmers on a regular basis especially if in the same session some useful information can be passed back to the user. The use of micros to pass information up to the larger systems and to download information in the other direction is already a possibility and could be carried out automatically. The downloaded data could be displayed on request or loaded into the micro software for analysis and/or processing. Increasingly farmers will be transacting

their business electronically with both buyers and suppliers.

Conclusion

The agricultural industry in the UK has a proud record for innovativeness and the adoption of new technology. At a time in Europe when overproduction will bring even more in the way of restrictions on volumes of production and hence output, and on production practices and hence efficiency of production, it is vital for farmers to manage their businesses more effectively. In this situation information, knowledge, communication and the ability to model live systems and to use decision support aids all assume a much higher degree of importance.
Increasingly business between farmers and their buyers and suppliers will be conducted electronically and this will allow important business information to be captured and used. This is where information technology comes into its own as a tool which farmers and growers can use to survive in the future.

Agro Informatics in Italy: a survey

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Foreword

Agro informatics could be defined as the complex of software procedures designed to be used specifically by public and private individuals and organizations operating in the agro-food sector. If we widen the definition to include the people and physical structures involved, the agro informatics business becomes quite large in economic terms and at the same time it becomes more difficult to depict and estimate the complex as a whole.
To analyze the heterogeneous agro informatics sector in Italy, a description was made of the main organizations involved in the developmental and implemental processes. The role of each organization and its main software production was defined. The picture depicted is sufficiently complete but definitely not exhaustive.
Detailed information of agri-software production in Italy, that has long been unavailable, can now be found in two catalogues comprising public bodies (INEA, 1991b) and private (INEA, 1991a) companies; although not complete, lacking for example programs not specifically developed for Personal Computers or process control software, this initiative shows how research and business forces present in this field are active and dynamic and that significant advances have been realized in the sector.
The prospects for development of agro informatics have also been considered, taking account of the effects of three main factors: the end user, software and hardware technology and regulations.
In interpreting this survey, the reader should know that the author's knowledge of agro informatics is mostly related to managerial applications of computer science in farming rather than to process control, hence the scope of the report will be somewhat limited. In reality it is debatable whether process control software, developed for agro-food sector activities, should be included in agro informatics or not, given that it necessarily forms part of the hardware components.
Moreover, it should be pointed out that the sections dealing with agro informatics at local level are largely restricted to the Veneto Region, the area where the author works and which is best known to him.

Public Organizations

Italian agricultural policy issues are regulated by the Ministry of Agriculture and Forestry and by the country's 21 administrative Regions. The main role played by the Italian Ministry of Agriculture and Forestry (MAF) is in guiding and co-ordinating agricultural policy activities. SIAN (the National Agricultural Information System) (AGRISIEL, 1988) was set up in 1984 (Act 194 of June 4) as a support for the Ministry in carrying out this work.

- SIAN consists of nine subsystems and it represents the aggregation point of all the economic, financial, productive and legislative databases related to the Ministry of Agriculture and Regions. It is accessible through the Ministry itself, the