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IMPACT OF MICROELECTRONICS ON AGRICULTURE AS RELATED TO RESEARCH AND DEVELOPMENT AND EXTENSION

R.M. Josephson[1]

Overview:

In January of 1985 the Canadian Agricultural Research council initiated a study to prepare recommendations regarding the activities/programs the CARC should encourage in relation to research, development, extension and transfer of technology as affected by the application of microelectronics in agriculture.

A working group was established to examine the impact that the increasing use of microelectronics in agriculture has on the communication of agricultural research and development results to the end user. The examination included a literature review, interviews with microelectronic suppliers and surveys of farmers, extension workers, directors of extension, agricultural researchers, farmer organizations and farm input and service suppliers.

The study focussed on issues concerning: (1) the current state of affairs with regard to microelectronics in agriculture, (2) the factors that inhibit or facilitate further development and use of microelectronics in agriculture, and (3) the future use of microelectronics and the kind of system that would be appropriate to communicate research results to farmers. The surveys confirmed many of the tentative statements advanced by the working group and provided further information on the issues in those three areas.

Recommendations were developed in six areas of concern: training, compatibility of telecommunications hardware, transmission facilities, exchange and sharing of experience, software issues, and areas for further study.

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[1]Associate Professor, Department of Agricultural Economics and Farm Management, University of Manitoba. The author gratefully acknowledges contributions of Lars Brink and other members of the Working Group of the study discussed in this paper. July 7, 1986.

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Background:

The past decade has seen rapid developments in microelectronics. Many of the new technologies have application in agriculture and are beginning to be adopted to many segments of the industry. Microcomputers have become affordable to many farmers and some software has been developed that provides farmers with new farm management tools. Videotex has been developed in Canada for some years and is now accessible to a number of groups in the agricultural industry. The microprocessing chip has found an application in the monitoring, sensing or control of many agricultural processes. The ability to access and interact with main frame computers and huge data bases through videotex, cable and telephone systems has resulted in new potential to gather, store, transmit and utililize information. Recognizing these rapid and profound changes, the Canadian Agricultural Research Council (CARC)undertook to examine the impact of microelectronics in agriculture as related to research and development (R&D) and extension.

Changes that bring about more rapid communication and greater access to information are bound to have an effect on both public and private agricultural extension. The traditional extension functions include gathering, evaluating and presenting information to farmer clients. The way in which these functions are carried out may change dramatically if microelectronics technology brings about efficiencies and eliminates previously time-consuming tasks and, perhaps more important, makes available an increased quantity of more current information. Furthermore, the agricultural extension system may require modifications to accommodate different methods of carrying out extension activities and provide the necessary technical skills and support to develop and use microelectronic delivery methods.

Changes in the way information is transferred to the farmer may also have an impact on the research and development system. This system may need to adjust the way it prepares, presents and communicates the results of research and development, in order to take advantage of changing technology or changing delivery systems. One type of information which is transferred by extension workers and agri-businesses is the findings of research.

Purpose:

The purpose of this study was to prepare recommendations for the consideration of CARC regarding the activities/programs CASCC should encourage in relation to research, development, extension and transfer of technology as affected by the application of microelectronics in agriculture. These recommendations should be based on an examination of what impact the increasing use of microelectronics in agriculture has on the communication of agricultural R&D results to the end user.

Microelectronics was taken to include software and hardware used in microcomputers, microprocessors, and terminals, and the facility to gain access to information and data bases through such equipment and through telecommunications. It was assumed that the technology in this area would continue to develop and that agriculture will have access to and will use the same technology as other sectors. In addition, special solutions may be developed for problems that are specific to agriculture. The study did not consider television, video tape and video disk techniques for communication.

Applications of microelectronics in agriculture was understood to include farming applications, such as production and business management. They also include applications where individuals, firms and institutions with whom farmers deal require or make available data or information by means of microelectronics. Some examples of this group are buyers of farmers' products, suppliers of farm inputs, production and business advisors, governments, community groups and farmers themselves.

Method:

The method followed in the study was to identify the major current uses of microelectronic systems, examine the effects these uses have on the communication of research results, outline the major uses of microelectronic systems that are anticipated for the next ten years, and identify the anticipated effects of these systems on the communication of research results. On the basis of this background work, recommendations were developed concerning those issues in microelectronics that should be addressed in order to strengthen the communication of agricultural R&D results.

Information relevant to the background work was obtained through the individuals participating in the working group established for this study (members are listed in Appendix A), including the study contractor, through a literature review, and through surveys of several groups who participate in the communication of R&D results in agriculture. These groups include farmers, extension workers, directors of extension, agricultural researchers, farmer organizations, farm input and service suppliers (major companies and local dealers), and suppliers of microelectronic hardware, programs and data bases. The function of the surveys was to complement the working group's experience of and insight into microelectronics, in order to more thoroughly reflect in the study the ideas of major groups dealing with microelectronics.

The working group met on three occasions. At the first meeting, the overall method of the study was devised. It was concluded that the study should emphasize the impact of microelectronics on the communication of research findings and technology transfer throughout the communications chain to the farmer. Other aspects of microelectronics in agriculture would emerge during the course of the

study but would be regarded as secondary to the main purpose of this study. The next meeting was mostly devoted to reviewing questions for the surveys, in line with the issues working group members hypothesized being important. Guidelines for the selection of individuals, firms, and organizations to be surveyed were discussed. In the final meeting, the findings of the survey and interviews were reviewed.

Selection of User Groups:

To assist in the exploration of these issues, several categories of uses of microelectronics were surveyed. The purpose of the survey was to identify the current use of microelectronics, factors that are considered problematic or helpful in current and future use of microelectronics, and expectations on what should or should not be done to influence the future use of microelectronics. The survey focussed on the communication of research results, but it also included other uses of microelectronics, such as administrative tasks and operations control.

The questions were designed to elicit information on the respondents' use, awareness, and expectations of microelectronic technology. Most questions were of a qualitative nature, such that the respondent indicated yes or no, or rated his perception of an issue on a simple scale (such as "much, moderately, slightly, not al all"). Open-ended questions designed to capture the respondents' own ideas over and beyond the identified issues were also designed.

There were seven categories of respondents, each with a separate questionnaire:

1. Farmers
2. Agricultural extension workers
3. Directors or executive directors of extension (a general and a detailed questionnaire)
4. Farm input and service suppliers (separate questionnaires for major companies and local dealers)
5. Farmer organizations
6. Agricultural researchers
7. Various individuals with an interest in the subject (microelectronic hardware and software suppliers, agricultural consultants, government and industry research administrators).

In the case of farmers and extension workers, the individuals selected for the survey were those with some experience of, and insight into, the use of microelectronics. These individuals were identified for the study by the provincial extension administrator (such as a director of extension) participating in the Canadian Agricultural Extension Council. Farmers and extension workers from

all provinces participated in the survey. There was no attempt to seek representation from each province in proportion to such variables as number of farmers, size of agricultural sector, or commodity specialization. As the microelectronic technology is relatively new, it was believed that such an approach would not be workable.

Also in the case of farm input and service suppliers and farmer organizations, one of the criteria for inclusion in the survey was that the firm or organization was believed to have some experience with microelectronics or to have considered the use of microelectronics for communication. In addition, firms and organizations were chosen so as to cover a diversity of commodity specializations and geographic locations.

In the case of directors of extension, the survey was directed to the provincial representative on the Canadian Agricultural Extension Council. The response was, in some instances, prepared by some other provincial department of agricultural official. A general questionnaire was developed for all provinces, and a more detailed questionnaire was designed for those provinces who indicated that an agricultural extension computer network was in place or in some phase of planning.

With regard to agricultural researchers, the Chairmen of Expert Committees under the Canadian Agricultural Services Coordinating Committee were chosen to represent the variety of subject matter and because of familiarity with research communication issues.

It cannot be overemphasized that, except for extension directors and agricultural researchers, the respondents were chosen from among those who had shown an interest in microelectronics and usually had some experience in using it. This was done in order to benefit from those individuals' experience. The respondents do not constitute a random sample even among those individuals who have experience in using microelectronics. Consequently, it is not appropriate to draw inferences from the survey responses to larger groups, such as all farmers in a province or all extension workers who have access to a microcomputer. The usefulness of the survey is in its ability to gauge, in a qualitative way, the extent to which microelectronics is used in certain groups, and how these groups view the future.

Summary of Survey Responses:

The purpose of the compilation and analysis of responses was to identify issues where the answers confirmed or contradicted the presumptions made about the issues. However, this could not be done quantitatively and the issues were not subjected to statistical test of significance. Rather, the analysis revealed general response patterns and identified concerns, themes, trends and ideas that were common or that conflicted among groups of respondents.

This summary is presented in point form to highlight areas where respondents showed consistent observations and ideas.

Survey of Farmers:

Surveyed farmers generally believe that less than 2 percent of farmers in their area own or have access to a microcomputer and that most farmers do not own or have access to Grassroots or other information systems.

Surveyed farmers' two main uses of microcomputers are for production management and financial management purposes.

Surveyed farmers are using microelectronics to collect information from outside the farm for production and marketing decisions. However, they see little or no general use of this among farmers in their region.

Surveyed farmers are aware that microelectronics can be used in applications of robots on the farm and a majority see some potential use on their own farms.

Surveyed farmers rated most important future uses of microelectronics on the farm to be in the areas of production, marketing and financial decision making and gathering current information about the farming environment (e.g., prices and weather). They rated learning about research, technology and economic trends as a much less important future use of microelectronics.

Surveyed farmers rated (1) farmers' lack of computer aptitude and (2) the difficulty in obtaining information to make decisions about investing in a microelectronics system as the most frustrating problems that inhibit further use of microelectronics.

Surveyed farmers identified several cost concerns they believed inhibited further use of microelectronics. The cost of satisfactory software was of greatest concern, followed by information transmission and hardware costs. Most surveyed farmers believed perceived costs exceeded perceived benefits.

Surveyed farmers strongly identified lack of agricultural and commodity specific software as inhibiting further use of microelectronics on the farm.

Surveyed farmers saw lack of software and hardware standardization, complexity of data management systems, and poorly written instruction manuals as overall system problems that inhibit further use of microelectronics on the farm.

Surveyed farmers strongly suggested public initiatives are required to resolve some of these problems. They also disagreed

strongly with the suggestion that they were losing interest in microelectronic technology.

In response to open-ended questions, surveyed farmers emphasized a need for farmer training to use computers, a need for evaluation of software and development of agriculture software, and better and less costly information transmission facilities.

Survey of Extension Workers:

Extension workers identified high potential use of microelectronics by extension workers in all the functions specified in the questionnaire.

Greatest potential use in gathering and processing information, as expressed by extension workers, was in the area of farm analysis and planning. The least potential use was in obtaining and processing biological, engineering and economic research results.

Extension workers also noted potential use of microelectronics in disseminating information to farmers. Videotex received the highest rating along with extension meetings.

Extension workers gave high rating to many of the problem areas specified in the questionnaire. They felt they needed more training and more support staff; they noted that few farmers have computers or have access to Grassroots. The unavailability of suitable software and the information transmission problems associated with rural areas were also noted.

Extension workers were almost unanimous in identifying lack of support personnel to develop local or regional data and systems as a problem restricting further use. They suggested extension staff needed to be reorganized and coordinated to meet the needs.

In response to open-ended questions, extension workers emphasized need for training for themselves, and need for government commitment and support. They noted lack of agricultural software and need for software for extension purposes. They identified a need for regionalized software.

Survey of Directors of Extension:

Directors of Extension reported 362 computer terminals used for extension purposes across the country in the summer of 1985. Two hundred and seven were in field offices and fifty-five in head office. The majority were IBM.

Extension branches used computers mainly for analyzing information to assist farmers in farm management activities, and for internal administrative purposes.

There was a general low level of satisfaction with current computer based activities and the two highest rated associated problems were (1) that software was not suitable for needs, and (2) that technology turnover was too fast.

Additional software, staff training and additional hardware were identified as priorities for future expansion in the use of this technology. Four respondents gave reorganization of existing resources a high priority.

All respondents predicted their ministry would expand its use of computers. There were mixed views on federal and provincial government roles except for supporting the general statements that both should actively facilitate data transmission for agricultural computer systems.

Survey of Expert Committee Chairmen:

Researchers, as represented by Expert Committee Chairmen, rated highest potential use of microelectronics in agricultural communication in communicating the extension workers, and in presenting and interpreting research results so they are more easily understood.

Researchers also saw this technology as a means of monitoring on-farm conditions and collecting on-farm data.

Researchers did not see microelectronics as a likely means to extend and provide information to farmers.

In response to open-ended questions, researchers were emphatic in the time and cost saving associated with their research, resulting in more or more efficient research. They reinforced the important role they saw for extension people to use this technology as a means to extend the research results to farmers.

Survey of Farmer Organizations:

Farmer organizations are using computers for administrative purposes and anticipate continued and expanded use.

Farmer organizations use microelectonics in a limited way to provide service to members. This includes some use of electronic mail and distribution of market information.

Farmer organizations have some expectations to expand this service but do not yet have specific plans developed.

Some plans under consideration include statistical information and forecasting, market research results, and a data bank accessible to all members.

Farmer organizations see a role for government in such areas a regulating, funding and co-ordinating microelectronic technology for agricultural communications, and in research and development of data bases.

Survey of Input and Service Suppliers (Companies):

Supply companies are currently making most use of microelectronics as a means to assist product distribution and inventory control., with some use in identifying input market characteristics and farm conditions. Many other functions were seen to have some potential application of microelectronics.

Supply companies generally see microelectronic collecting and dissemination of information being achieved through their agents rather than directly between company and farmer. Supply companies note incompatibility of computer configurations between researchers, suppliers, farmers, government and others in the industry as the most inhibiting factor to potential use in their sector.

Supply companies also see lack of software and hardware on farms as an inhibiting factor.

A high proportion of respondents expressed concern over data base ownership (confidentiality) on public data bases but a relatively low proportion expressed concern over appropriate cost-sharing user fee structures.

Responses to open-ended questions recognized government roles to educate and promote the use of microelectronics. Companies did not believe that standards and regulation should be imposed, but were generally in favour of government leadership and support.

Survey of Input and Service Suppliers (Local Dealers):

All dealers surveyed are using microelectronics for their own administrative purposes.

Most are using microelectronics to provide services to customers. This ranges from providing general information through Grassroots to collecting and analyzing specific information about a customer's own farm.

They feel that microelectronics is an effective way to inform farmers about research results and new technology and this may be practical in areas like chemical information and weed control. These farm dealer respondents had mixed reactions to government involvement.

Table 1

Summary of Respondent Groups

Respondent Group	Number of Questionnaires sent	Number of Usable Responses	Response Rate
			%
Farmers	97	52	54
Extension Workers	71	61	86
Extension Directors - general	10	9	90
Extension Directors - detailed	10	8	80
Expert Committee Chairmen	31	29	94
Farmer Organizations	21	11	52
Input & Service Suppliers (companies)	28	15	54
Input and Service Suppliers (dealers)	7	5	71
TOTAL	275	190	69

Recommendations:

1. Training in the Use of Microelectronics: In general, there is a demand for improved skills in how to use microelectronic tools, particularly among farmers and extension workers. The training needs are diverse and depend on how the individual is going to use the improved skills. IT IS RECOMMENDED THAT CASCC ENCOURAGE (A) PROVINCIAL AGRICULTURAL EXTENSION BRANCHES TO EXPAND THE TRAINING OPPORTUNITIES AVAILABLE TO EXTENSION STAFF AND FARMERS AND (B) THE INSTITUTIONS PROVIDING TRAINING IN AGRICULTURE TO INCLUDE IN THE CURRICULUM TRAINING IN THE USE OF MICROELECTRONICS FOR VARIOUS PURPOSES INCLUDING ON-FARM APPLICATIONS.

2. Compatibility of Telecommunications Hardware: In the transmission of information using videotex technology, there is a choice to be made between two standards: NAPLPS and ASCII. Virtually all NAPLPS decoders can access both ASCII and NAPLPS data bases, but straight ASCII decoders lose the colour and graphic information used on NAPLPS. IT IS RECOMMENDED THAT CASCC ENCOURAGE THOSE WHO INSTALL VIDEOTEX DECODERS (SUCH AS TERMINALS AND MICRO-COMPUTERS) TO ENSURE THAT THE SYSTEM IS COMPATIBLE WITH THE NAPLPS STANDARD.

3. Transmission Facilities: The availability and cost of facilities to transmit information over significant distances are important factors affecting the use of microelectronics in agriculture. IT IS RECOMMENDED THAT CASCC ENCOURAGE GOVERNMENTS AND COMMUNICATIONS AGENCIES (SUCH AS TELEPHONE COMPANIES AND SATELLITE COMMUNICATION COMPANIES) TO DEVELOP, PUT IN PLACE AND MAINTAIN CHANNELS FOR MICROELECTRONIC COMMUNICATION THAT ALLOW RURAL USERS EFFECTIVE, RELIABLE AND LOW-COST ACCESS TO MICROELECTRONIC INTERACTION WITH PROGRAMS AND DATA SOURCES.

4. Exchange and Sharing of Experience: As different levels of government and different government departments respond to, or attempt to influence, the increasing use of microelectronics, it is to be expected that some initiates are successful and others less so. IT IS RECOMMENDED THAT CASCC ENCOURAGE ALL INSTITUTIONS, PARTICULARLY FEDERAL AND PROVINCIAL GOVERNMENT DEPARTMENTS, TO PUT A HIGH PRIORITY ON REGULAR EXCHANGE OF INFORMATION ON AND EXPERIENCE FROM INITIATIVES THAT GOVERNMENTS AND OTHER INSTITUTIONS TAKE TO USE MICROELECTRONICS. Specifically, this might be done through initiatives by Expert Committees and by professional associations.

5. Issues Related to Programs and Data Bases: There is a perceived problem with regard to the availability of programs and data base information. Initiatives are needed to ensure that the emerging demand for programs and data base information is clearly identified and adequately met.

(a) IT IS RECOMMENDED THAT CASCC ENCOURAGE EXTENSION AND EDUCATION INSTITUTIONS TO MAKE THEIR INTERPRETATION OF RESEARCH RESULTS AVAILABLE THROUGH MICROELECTRONIC MEANS AS REQUIRED BY USERS OF THE INFORMATION.

(b) IT IS RECOMMENDED THAT CASCC ENCOURAGE FEDERAL, PROVINCIAL, UNIVERSITY AND PRIVATE RESEARCH INSTITUTIONS TO MEET THE DEMAND FOR INFORMATION BY INCORPORATING, WHERE APPROPRIATE, THE RESULTS OF THEIR WORK INTO PROGRAMS AND DATA BASES TO WHICH USERS HAVE ACCESS THROUGH MICROELECTRONICS.

(c) IT IS RECOMMENDED THAT CASCC ENCOURAGE FARMER AND COMMODITY ASSOCIATIONS TO TAKE THE INITIATIVE, ALONG WITH COMMERCIAL SUPPLIERS OF PROGRAMS AND DATA BASES, TO INCORPORATE APPROPRIATE RESEARCH RESULTS IN PROGRAMS AND DATA BASES AND MAKE HIGH QUALITY PROGRAMS AND DATA BASES AVAILABLE TO THEIR MEMBERS.

(d) IT IS RECOMMENDED THAT CASCC ENCOURAGE THE DEVELOPMENT OF A STANDARDIZED FORMAT WHICH MIGHT BE USED IN GAINING ACCESS TO DATA FROM MICROELECTRONIC DATA BASES, CORRESPONDING TO THE AGDEX SYSTEM.

Specifically, this could be done through initiatives by the institutions that carry out research.

6. Areas for Further Study: Information should be incorporated in programs and data bases according to the needs of he users. These needs are not well known.

(a) IT IS RECOMMENDED THAT CASCC ENCOURAGE FEDERAL AND PROVINCIAL GOVERNMENTS AND UNIVERSITIES TO ALLOCATE RESOURCES TO THE UNDERTAKING OF STUDIES FOR IDENTIFYING PRIORITIES FOR DEMAND-ORIENTED PROGRAMS AND DATA BASES.

The increasing use of microelectronics in agriculture represents a major change in the ways information is acquired and used in the sector. The effects of this on the structure of agriculture are not known.

(b) IT IS RECOMMENDED THAT CASCC ENCOURAGE AGRICULTURE CANADA AND UNIVERSITIES TO ALLOCATE RESOURCES TO THE UNDERTAKING OF RESEARCH ON THE CONDITIONS UNDER WHICH PARTICULAR TYPES OF MICROELECTRONIC TOOLS AND COMMUNICATION CHANNELS IMPROVE THE ECONOMIC VIABILITY OF THE FARM BUSINESS AND THE LONGER TERM EFFECTS ON THE STRUCTURE OF CANADIAN AGRICULTURE.

The following issues are also brought to the attention of cascc:

- the future role of extension workers and the organizational environment in which they work,
- the cost to the user of microelectronic information
- the relatively low priority that may be put on inventory and evaluation of programs and data bases.

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Appendix A

Working Group on the Impact of Microelectronics in Agriculture as Related to R&D and Extension

Mr. Don Taylor, Principal
Chairman of Working Group
Ridgetown College of Agricultural Technology
Ridgetown, Ontario
N0P 2C0 (519) 674-5456

Professor Robert Brack, Director
Division of Extension and Community Relations
University of Saskatchewan
Saskatoon, Saskatchewan
S70 0W0 (306) 966-5536

Monsieur Daniel Chez
Directeur de secretariat administratif
Ministere de l'Agriculture, des Pecheries
et de l'Alimentation du Quebec
200-A, chemin Sainte-Foy
Quebec (Quebec)
G1R 4X6 (418) 643-1229

Mr. Rea Josephson
Dept. of Agricultural Economics and
Farm Management
University of Manitoba
403 Agric. Bldg., 66 Dafoe Road
Winnipeg, Manitoba
R3T 2N2 (204) 474-9713

Dr. Jim McKenzie, Director
Inputs and Technology Analysis Division
Agriculture Canada
Ottawa, Ontario
K1A 0C5 (613) 995-9554

Mr. David Hagborg, Manager
Micro-Computer Centre
Systems and Consulting Directorate
Agriculture Canada
Ottawa, Ontario
K1A 0C5 (613) 993-7791

Mr. Roger C. Buxton
Box 456
Consort, Alberta
T0C 1B0 (403) 577-2139

Dr. Lars Brink, Secretary
Canada Committee on Socio-Economic
Services
Regional Development Branch
Agriculture Canada
Ottawa, Ontario
K1A 0C5 (613) 995-9554

Mr. John Duvenaud
Western Regional Manager
Grassroots
511 - 1661 Portage Avenue
Winnipeg, Manitoba
R3J 3T7 (204) 772-9453

Associated with the Working Group was:

Mr. Nick Roller
Economics and Policy Coordination Branch
Ontario Ministry of Agriculture and Food
Toronto, Ontario
M7A 1B6