PROJECT ON MANAGEMENT FOR RURAL
DEVELOPMENT IN LATIN AMERICA
(PROPLAN/A)

COLLECTION OF CONTRIBUTIONS

Miscellaneous Publications Series No. 486
ISSN-0534-5391
PROPLAN Document 42

Microcomputers and agricultural organizations: management applications in developing countries.

Marcus D. Ingle
Kenneth A. Smith

IICA
INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
OFFICE OF THE ASSISTANT DEPUTY DIRECTOR GENERAL FOR OPERATIONS

San José, Costa Rica, 1984

PROJECT ON MANAGEMENT FOR RURAL DEVELOPMENT IN LATIN AMERICA (PROPLAN/A)

COLLECTION OF CONTRIBUTIONS

MICROCOMPUTERS AND AGRICULTURAL ORGANIZATIONS: MANAGEMENT APPLICATIONS IN DEVELOPING COUNTRIES

Prepared by:

Dr. Marcus D. Ingle, Coordinator

and

Kenneth A. Smith, Management Information Specialist

International Development Management Center
Office of International Programs
Division of Agricultural and Life Sciences
University of Maryland, College Park

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

PROPLAN Document 42
San José, Costa Rica. 1984

FOREWARD

This paper was prepared by Marcus Ingle, coordinator of the University of Maryland International Development Management Center, IDMC, and Kenneth A. Smith, IDMC information specialist. It was completed in December, 1983, for presentation in a seminar entitled "Information and Microcomputers in Planning and Management for Agricultural Development, organized by IICA's PROPLAN/A Project. This Seminar took place at IICA's Central Office in Costa Rica from December 5 to 7, 1983.

IICA works with several institutions active in the field of planning and management for rural development, within which know-how and experiences are exchanged through the PROPLAN/A Project. The purpose of publishing and distributing this paper, in the framework of the special IICA/IDMC cooperation, is to expand the general understanding of the use and potential of microcomputers for guiding the rural development process.

This publication is a part of the Collection of Contributions, and is provided free of charge as reference material to people attending IICA's training and information activities through the PROPLAN/A Project.

PREFACE AND ACKNOWLEDGEMENTS

In 1981 the Development Project Management Center (DPMC) of the U. S. Department of Agriculture, in cooperation with the Science and Technology Bureau of the Agency for International Development (AID), initiated a small research and development effort focusing on microcomputers and agriculture management in developing countries. This effort explored actual and potential uses of microcomputer technology for improving project and institutional management in a variety of development sectors and contexts. In 1982 a practitioner workshop was conducted to review the research results and to identify high potential areas for future study and development. The findings of this research regarding the acquisition, installation and use of microcomputers in developing country settings became the basis for a Manager's Guide on Acquiring and Using Microcomputers in Agricultural Development, published jointly by DPMC and the International Development Management Center (IDMC) at the University of Maryland in 1983. A revised version of this Guide has recently been published by Kumarian Press under the title of Microcomputers and Development: A Manager's Guide.

This paper is based on the earlier research and publications. However, it elaborates significantly on the subject of the impact of microcomputers—both positive and negative—in agricultural and rural development organizations. This topic is currently receiving in-depth research attention by IDMC through a Cooperative Agreement with USDA.

IDMC is a recently established research, technical cooperation, and training entity in the Office of International Programs, Division of Agricultural and Life Sciences, at the University of Maryland. IDMC's mission involves the rigorous development and dissemination of appropriate concepts and polices for managing programs and projects. Where beneficial to both parties, the IDMC enters into relationships with other international, regional and domestic entities, for activities such as this cooperative effort with IICA.

Dr. Marcus Ingle was responsible for DPMC's research on microcomputers and management from its outset. A staff member of DPMC from 1981 to 1983, Dr. Ingle recently was named Coordinator of the IDMC. Kenneth Smith has worked with IDMC since the Center's inception and directs the ongoing research on microcomputers and development management. In preparing this paper, Dr. Ingle was assisted by Morris Solomon and Dr. Merlyn Kettering of DPMC and Dr. Edwin Connerley of AID. Noel Berge of Micro People Incorporated in Virginia and Fred Knight of Bertman Corporation also made significant contributions. Artie Kennedy and Carol Cahall in IDMC assisted in preparing and editing the paper. The views expressed in the paper, however, are the sole responsibility of the authors and do not necessarily represent the position of the University of Maryland or other contributors.

TABLE OF CONTENTS

I. INTRODUCTION: THE SETTING AND ISSUES

The world is in the throes of a microelectronic revolution. In the area of microcomputers alone, numerous types and makes of hardware components and a plethora of software programs are being purchased by the tens of thousands and are proliferating quickly to individuals and organizations in the most remote areas of the earth. A microcomputer is a small computer, composed of several pieces of equipment (the HARDWARE components), that uses various programs (the SOFTWARE to perform numerous functions and tasks within an organizational setting (the ORGWARE* dimension). The microcomputer is a highly efficient and incredibly fast information processor for recording, manipulating, and storing data. Although a microcomputer is small enough to sit on top of a desk, its size does not belie its information processing capacity and the multiplicity of its applications.

The agricultural and rural development sector of developing countries is absorbing a substantial amount of this microcomputer technology. (Berge: 1982a) Microcomputer uses range from purely technical in scope, such as analyzing soil samples and processing survey data, to agricultural program management and institutional applications, such as assisting with project scheduling and financial accounting.

Several interrelated reasons underly the general appeal of microcomputers in the agricultural sector. First, microcomputers represent a new type of technology that claims to be unique in its "user-friendliness" and its ability to "work the way individuals and organizations do;" they also posses a certain subtle intrigue and seductive power. A second reason is that initial agriculture applications, although not without difficulties, have been quite encouraging in their results. The agricultural and rural development sector, due to its major importance and wide diversity in most developing countries, appears to present a variety of ready-made opportunities for using microcomputers. (Berge: 1982a; Berge and Ingle: 1982; Pinckney et. al.: 1982) Finally, the interest in microcomputers has been stimulated by their low cost and small size combined with their constantly expanding processing power. In this respect, all present indicators suggest that price and size will continue to decline while reliability, power, and versatility will increase. The current and projected proliferation of microcomputer technology raises a serious concern for the agricultural development profession, namely, whether or not this technology will be appropriately introduced and intelligently used! In short, will the proliferation of microcomputer systems facilitate productive, humanistic and equitable agricultural and rural development processes, or will it exacerbate inefficiencies, unjust practices, and inequality? Two dimensions of this issue deserve immediate attention:

- What are the likely promises and threats represented by the transfer of microcomputer technology to the agricultural sector in developing countries?

---

*ORGWARE refers to the organizational, human, and training issues involved in microcomputer systems. This dimension is sometimes referred to as the "WETWARE" or "slippery" component of the technology.

- How can agricultural organizations take full advantage of the benefits of microcomputer technology, and at the same time prevent or reduce its potential threats and negative consequences?

This paper will address both of these dimensions by presenting an overview of microcomputers and agricultural development from a management. The paper will then attempt an overall assessment of the promises and threats of microcomputer technology to development organizations, and offer several suggestions for agricultural professionals who are interested in acquiring and using this emerging technology.

SECTION II: MICROCOMPUTERS AND AGRICULTURAL ORGANIZATIONS: A MANAGEMENT IMPROVEMENT PERSPECTIVE

Management can be viewed as a human process in which resources are mobilized and productively combined to accomplish meaningful results under conditions of partial control and a constantly changing environment. It involves a continuous cycle of planning and replanning in which managers and technical staff work together to track expenditures and progress against planned results, respond to unexpected changes, and incorporate lessons learned from experience. In both planning and replanning, a continuous stream of information must be gathered, processed, and acted upon.

The management of development institutions and programs is particularly complex. In the agricultural and rural sector, development efforts are typically quite complicated and involve coordinated action by many different individuals, units, and institutions. To achieve their intended objectives in the face of the severe resource and time constraints that often characterize developing country (DC) contexts, programs and projects require careful management from their inception. This care must continue through activation, operation, institutionalization replication, with continuous reassessment and replanning along the way. It is little wonder, therefore, that poor management is frequently cited as a major factor obstructing successful development. (Paul: 1982; World Bank: 1983)

That there have been major deficiencies in the management of agricultural development efforts is readily apparent. During planning and design heavy emphasis is frequently given to economic and technical considerations. Often, the implementation requirements of development activities are underestimated or, sometimes, totally neglected. As a result, the management and technical staff responsible for implementing and replanning are frequently hard-pressed to do the work necessary to keep the effort on schedule and within budget.

There has been a recent turn toward the microcomputer as a tool that can play a significant role in improving and sustaining effective management in DC agriculture organizations. Microcomputers can assist executives, technicians and administrative staff by providing them quick access to information for making decisions; saving time in handling many routine office functions; and assisting with complicated—and heretofore not feasible—appraisals and analyses.

For our purposes, the management of development efforts is segmented into: (1) institutional or operations management, and (2) program or project management. The context and nature of institutional management differs from that of program management in several important ways:

- Institutional management typically attempts to improve or strengthen existing routine functions and operations (such as budgeting and financial management, personnel, inventory and resource control, etc.); whereas program management usually deals with the efficient and effective performance of new or recently tested time-bound development activities.

- Institutional management is usually confined to the context of one organization, sometimes including external technical assistance or advisory support; whereas project management frequently requires the integrated action of many organizations and echelons (including the donor organization, the project organization and contractors), each with its own internal operating procedures, information system requirements, and staff.

- Institutional management is typically concerned with administrative functions in support of development activities; whereas project management is more directly related to development as supported by institutional operations.

One way to classify and analyze the use microcomputers in agricultural organizations is to view the general management functions performed within these organizations in relationship to potential microcomputer applications and products. International experience in the field of development management over the last several decades has suggested that several generic functions—manifested in terms of specific managerial tasks — are directly associated with more successful development efforts. (Management Development Working Group: 1981; Ingle: 1981; Vaill: 1982; DPMC, IICA and IDMC: 1983) These management functions include the following:

- Arriving at a consensus and commitment to development objectives and strategies by key personnel;

- Developing realistic and agreed upon workplans, schedules, and resources;

- Defining clearly articulated and understood roles and rsponsibilities for executing activities and tasks;

- Developing contextually appropriate directive and control mechanisms for executing tasks in accordance with plans;

- Establishing suitable monitoring, evaluation, and adaptive learning mechanisms for assessing progress and responding to changes and lessons learned.

If these functions are present during a development effort, the probability of that effort's success in achieving its objectives on time and within budget limitations is greatly increased.

These generic functions and their corresponding management tasks provide a framework for reviewing the wide range of potential management uses (both positive and negative) that a microcomputer can serve. Table 1 details various management tasks related to the generic functions and describes possible microcomputer uses and products associated with the performance of each task. While the presence of the management functions mentioned above will apparently facilitate successful management even in the absence of a microcomputer system, in this paper we will use these functions and their corresponding tasks to frame and present a wide range of potential management uses that a microcomputer can serve within the context of an agricultural organization.

A warning is necessary before we proceed. While there is a widespread tendency to equate additional data processing capacity with improved management performance, this is a dangerous and frequently incorrect assumption. Just because microcomputer equipment exists and is being used does not mean that the appropriate data is being gathered, that it is being analyzed in a usable format, or that decisions are better. It is up to the development professional to make sure that the data going into the computer is relevant and accurate, and to use the information coming out of the computer in ways that lead to productive use of resources to accomplish desired development results. With this word of caution in mind, let us use the schema outlined in Table 1 to look at the way a microcomputer can and cannot help an agricultural organization improve its productivity and performance.

A. What a Microcomputer Can Do

The first generic management function associated with successful development efforts involves arriving at a consensus and commitment to agricultural development objectives and strategies on the part of key actors and personnel. This includes developing overall policy objectives and development strategies; identifying objectives for development programs and sectoral institutions based on policies, opportunities, and targeted beneficiaries; establishing measurable performance indicators and targets for specific projects based on detailed assessments of potential benefits, feasibility, and implementation costs; and employing appropriate processes for assuring that key actors clearly understand and are committed to the objectives and strategies that have been developed.

Microcomputers can facilitate these activities by assisting in the collection and analysis of sectoral, census, and survey data; doing feasibility studies and analyses of project costs and benefits; and by storing and presenting output information in the form of matrices, summaries, and narrative reports.

The second management function is to develop at realistic and agreed upon workplans, schedules, and resources. This involves developing descriptions of program and project activities, including input and output specifications and necessary external conditions; developing work breakdown tables and determining realistic personnel and resource requirements; creating a master program

Genetic Management Functions, Related Management Tasks, Typical Microcomputer Uses, and Microcomputer Products.

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
I. A consensus and commitment to development objectives and strategies by key actors and personnel.	A. Develop overall policy objectives and rural sector development strategies based on various macro and micro analyses.	A1. Store, process and analyze narrative accounts of policy statements and development objectives.	A1a. Narrative descriptions. A1b. Diagram of objectives.
		A2. Store, process and analyze agriculture and household census and survey data.	A2a. Descriptive statistics of physical, economic, social and political conditions. A2b. Bar charts, selected conditions over time.
	B. Identify objectives for development projects and rural sector institutions based on development policies, opportunities, and identification of major beneficiaries.	B1. Store, process and analyze sector and project specific problems and opportunities for improvement.	B1a. Narrative descriptions. B1b. Problem tree diagram.
		B2. Preliminary analysis of intended target groups "paying" and "receiving" benefits from the development activity.	B2a. Decriptive statistics of project target group. B2b. Stakeholder matrix of major project beneficiaries.
		B3. Initial estimates of socio-economic benefits, feasibility and costs.	B3a. Narrative list of key benefits and costs. B3b. Initial cost-effectiveness rations for various project alternatives.
	C. Establish measurable performance indicators and targets for development efforts based on detailed assessments of potential benefits, implementation, feasibility and costs	C1. Store formats and specifications for targetting indicators in terms of intended performance and time.	C1a. Project design matrix Narrative lists of benefits for each target group over time. C1b. Narrative lists of benefits for each target group over time.
	D. Employ an appropriate process for assuring that key development actors clearly understand and are committed to objectives and strategies.	D1. In meetings with key policy makers and project designers, microcomputer used to take process notes and provide immediate feedback on areas of consensus and divergence.	D1a. Narrative descriptive notes of meetings and planning sessions.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
II. Realistic and agreed upon workplans, schedules, and resources.	A. Develop descriptions of development activities including input and output specifications and necessary external conditions.	A1. Store formats and specifications for developing performance targets for development program inputs, outputs, and key external conditions.	A1a. Blank input/output templates.
		A2. Store, process, and organize input, output data in accordance with formatted specifications.	A2a. Completed input/output design templates.
	B. Develop work breakdown tables and create realistic personnel and resources requirements.	B1. Store and process task/work performance data associated with development efforts.	B1a. Narrative listing of key activities along with prior and subsequent events.
		B2. Allocate personnel and material resources by output category, work task, and sub-activities.	B2a. Resource allocation charts and diagrams.
	C. Create a master program schedule and special subschedules for important activities.	C1. Process and analyze timing and duration of project and organizational activities.	C1a. Critical path and network schedules. C1b. Bar chart schedules.
	D. Employ an appropriate process for assuring that key managerial and technical persons understand and agree on the detailed execution arrangements.	D1. Provide a fast, reliable and convenient means whereby managers and technicians can input and obtain consensus on activity, cost, and time data.	D1a. Activity workplans jointly developed by and agreed to by key actors.
		D2. Provide readily accessible means whereby supervisors and colleagues can quickly review planning data and suggest modifications/improvements.	D2a. Workplans revised quickly and efficiently.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
III. Clearly articulated and understood roles and responsibilities for executing activities and tasks.	A. Develop plans for the assignment and use of personnel, commodities, equipment, and supplies.	A1. Store, process and analyze data on characteristics of various institutions and individuals involved in and affected by the development activity.	A1a. Narrative profiles and diagrams of organizational structure and individual skills and competencies.
		A2. Store, process and analyze personnel, contracting, procurement, training, and procedural data.	A2a. Descriptive lists of key information, e.g., available contractors to perform a specific task.
	B. For each activity and sub-activity, identify responsible individual or units and assure there is a clear understanding of work and technical skills required to perform the task.	B1. Store, process and analyze current and project work loads of various units and individuals to ensure a proper balance and realistic allocation of responsibility and authority.	B1a. Descriptive and comparative statistics. B1b. Work load projections.
		B2. Prepare narrative and statistical plans on assignment of roles and responsibilities for executing specific tasks.	B2a. Narrative reports.
	C. Negotiate roles and responsibilities with various personnel involved in the development effort at multiple echelons and in interrelated operational units.	C1. Store formats and specifications for negotiating and making responsibility assignments for various tasks.	C1a. Blank responsibility charts. C1b. Narrative instructions for negotiating roles and responsibilities.
		C2. Provide a visual display of responsibility assignments to key actors for their reaction, modifications, and timely agreement.	C2a. Negotiated/modified responsibility charts.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
IV. Contextually appropriate directive and control mechanisms for executing tasks in accordance with plans.	A. Project and control work activities according to negotiated plans.	A1. Store and maintain information on procedures and specifications for activating development efforts including staffing, contracting, training, and management.	A1a. Narrative text of procedures. A1b. Various regulations, formats and criteria for specifications.
		A2. Prepare and edit directives, memoranda of understanding, and other action documents.	A2a. Policy directives. A2b. Action memoranda.
	B. Maitain programmatic and financial records, and produce summary reports for interested government, donor agency, and contract personnel.	B1. Document and file decisions and actions.	B1a. Narrative descriptions of implementation action.
		B2. Record and maintain files on actual expenditures, program activities, and observed results.	B2a. Narrative descriptions. B2b. Cost and expenditure data. B2c. Activity data. B2d. Time use data.
		B3. Prepare summary reports of program status following standardized formats.	B3a. Narrative reports.
	C. Take part in development activity reviews and evaluations to assess current and projected status and recommend improvement/major modifications in design and implementation.	C1. Provide up to date accounts of program status and supplementary analytical information useful in decision making.	C1a. Special narrative and statistical reports.
		C2. Permit rapid forecasts and projections of personnel work loads, cash flows, inventory, and other execution actions.	C2a. Program and financial projections. C2b. Program and financial analyses.
	D. Follow a collaborative process of execution that involves responsible actors and sponsors.	D1. Provide a fast and reliable means for documenting actions and results both individually and in team meetings.	D1a. Narrative accounts of rationals for and actual decisions taken.
		D2. Store procedures for information use and dissemination.	D2a. Narrative text of procedures.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
V. Suitable monitoring, evaluation and adaptive learning mechanisms for assessing progress and responding to changes and lessons learned.	A. Identify information needs, sources of data, and means for collection for all development activities and important external conditions.	A1. Create files of baseline information of programs to be monitored by cost, activity, products, objectives and key external conditions.	A1a. Baseline files by geographical area, functional category, target group, etc.
			A1b. Baseline descriptive statistics and tables.
		A2. Store and maintain formats and specifications for data collection and processing procedures and sources.	A2a. Narrative data collection procedures and guidelines.
	B. Monitor program progress, unexpected changes in external conditions and key lessons learned relative to plans and analyze/reassess plans based on this information.	B1. Store planned accounts of resource use, activity, and results and compare against actual progress over time.	B1a. Periodic status reports of planned versus actual progress-text & graphics.
			B1b. Special reports on problem areas or new opportunities.
		B2. File, maintain and analyze descriptive accounts, program changes, lessons learned, and unexpected events over time.	B2a. Narrative descriptions.
			B2b. Programatic and financial analyses.
	C. Explore implications of alternative action strategies and undertake calculations of benefits, feasibility, and costs associated with actual and potential changes.	C1. Store data for and assist in pursuing a series of "what if" senarios associated with changes in the initial program plans.	C1a. Statistical analyses of costs and benefits associated with alternative action strategies.
	D. Employ an appropriate process for assuring that relevant actors receive and understand high quality feedback -- both positive and negative -- on a timely basis.	D1. Store and maintain formats and specifications for a programs monitoring and reporting system.	D1a. Blank formats for use in monitoring and reporting.
			D1b. Narrative description of monitoring procedures.
		D2. Provide visual displays of current status to key development program actors.	D2a. Visual displays and hard copy of planned versus actual progress.

schedule and special sub-schedules for important activities; and employing an appropriate process for assuring that key managerial and technical persons understand and agree on the detailed execution of the plans.

Here, a microcomputer's analytic capabilities are particularly useful in facilitating the accomplishment of these tasks. A micro can store formats and specifications for performance targets, project inputs, outputs, and key external conditions, and can process data in accordance with the formatted specifications. A micro can also assist in the development of work breakdown diagrams and rapidly process and analyze timing and duration of project activities through the preparation of critical path, network, and bar chart schedules. It provides a fast, reliable, and convenient means whereby managers and technicians can jointly obtain consensus on activities, and quickly review planning data to suggest modifications for improvement.

The third function is to define clearly articulated and understood roles and responsibilities for executing activities and tasks. Relevant subtasks are: to develop plans for the assignment and use of personnel, commodities, equipment, and supplies; the identification of the individual or unit responsible for each activity involved in the effort and making sure that these understand the task and have the necessary skills; and, to negotiate the roles and responsibilities of the various personnel involved in the effort.

Microcomputers can facilitate this process by storing, processing, and analyzing data on selected characteristics of various institutions and individuals involved in and affected by the development activity, as well as procedural data pertaining to personnel, contracting, procurement, and training. They can keep track of the workload on various actors, review the balance of resource allocation between operational units, and prepare reports for the review of managerial decision makers.

The fourth management function is to develop contextually appropriate directive and control mechanisms for executing tasks. This involves controlling actual work activities according to the negotiated plans. Elements are the maintenance of programmatic and financial records, the provision of summary reports, and the periodic review and evaluation to assess current and projected status. This permits of improvements or modifications to the project design and implementation process.

While a microcomputer's capability for generating reports has already been mentioned, during program and project implementation the microcomputer facilitates up-to-date accounts of program status and allows for fast and reliable modeling of contingencies based upon changes in plans or resource availabilities.

The fifth and final function is the development and implementation of suitable monitoring, evaluation, and learning mechanisms for assessing progress and for responding to changes in the environment in the light of lessons learned. This includes the subtasks of: identifying information needs, sources of data, and means for collecting it; monitoring the program/project's progress; exploring the implications of alternative strategies and methods; and implementing an appropriate process whereby the relevant actors receive and comprehend high quality feedback. Microcomputers can facilitate these actions, again by serving

as the repository of program/project information, and as the means of manipulating the information thus stored according to various models and outputting the information in usable formats.

B. What a Microcomputer Cannot Do

Microcomputers can be highly efficient and, given their capabilities, it is not hard to understand why they might become indispensible to development professionals. However, simply introducing a microcomputer in an agricultural organization and expecting it to meet all of management's needs is setting the stage for early disappointment and eventual failure. While the micro can facilitate all of the tasks and processes listed above, there are many limitations to the technology. A microcomputer:

- o will not make one more organized;
- o will not make decisions on one's behalf;
- o will not improve one's basic data (i.e., garbage in, garbage out);
- o does not accept responsibility for anything;
- o does not of itself do forecasting or trend analysis (but it can help one do it);
- o cannot define a problem or set objectives.

The development professional is still the most important part of the system. No matter how fast the microcomputer can come up with data and information, it is still he or she who must decide what is to be done.

III. MICROCOMPUTERS, MANAGEMENT AND AGRICULTURAL ORGANIZATIONS; AN ANALYSIS OF PROMISES AND THREATS

In Section I, two dimensions of the microcomputer transfer and proliferation issue were raised:

- o What are the likely promises and threats represented by the transfer of microcomputer systems to agricultural organizations in developing countries?, and
- o What courses of action are emerging that can take advantage of the benefits of this transfer process, while preventing or reducing the potential negative consequences?

These dimensions are discussed below in light of several developing country case incidents and other recent experience. The data for this assessment comes from a review of two types of microcomputer applications: program management improvement efforts and institutional strengthening efforts. (For a full

description of the cases see Ingle, M. et. al: 1983) The program management experience includes a rural development project in Tanzania, an agriculture production program in Portugal, and several rural project microcomputer applications in Nepal. The agricultural institutional strengthening experience draws on a financial improvement effort in the Kenyan Ministry of Agriculture and Livestock, the agricultural census remote sensing activities in DC's by USDA, and several experiences with agricultural organizations in the Philippines.

A. The Promise of Microcomputers in Agricultural Organizations

In his opening statement to the US House of Representatives Subcommittee on Science, Research, and Technology in July 1982, Curtis Farrar of AID discussed the promising role of microcomputers in development by noting:

> The most important contribution that microcomputers will make to development will be the increased accessibility they provide to substantial computational power and analytical power. They are relatively cheap. They do not require sophisticated programming training. Their computational power and versatility is increasing every year. Where the data and analytical skills exist and where there is a demand for improved analysis, they provide the potential for substantially improved analytical and planning capacity in development institutions. More important, the micro permits substantial decentralization of this computing power to the field. (Farrar:1982).

Mr. Farrar also pointed out several additional contributions that microcomputers may make to development: increased access to information; more timely manipulation of information; the improvement of planning and problem solving situations; and finally, its ready acceptance —the ease of transfer— due to its ease of use and modular character. As Mr. Farrar summed it up, "The microcomputer can be thought of as a disaggregated general purpose system and provide the developing countries the flexibility of applying computer power to a wide range of development problems not possible with a large mainframe computer."

In marked contrast to the large mainframe computers, the microcomputers have several attractive attributes for agricultural organizations. They:

- are easier to comprehend and more friendly to use;
- have greater reliability and are constructed in a modular fashion that facilitates repair and maintenance;
- have substantial versatility and power in their applications including the ability to network with other microcomputers and larger computer systems that already exist;
- are fairly transportable (with little or no additional cost or trouble) domestically and internationally; and

- o are relatively inexpensive (ranging from $1,000 to $5,000) for a complete system including hardware and software.

Because of these positive attributes, the microcomputer is increasing in popularity over mini and mainframe computers.

To the busy and committed agricultural professional, the microcomputer also has a strong personal appeal. Microcomputer hardware and software components now have been developed to the point where they can immediately assist in carrying out technical and administrative tasks more efficiently and in accomplishing improved results. While the evidence (on microcomputer costs, feasibility, and benefits) in developing countries is not exclusively supportive, there is substantial reason to believe that microcomputers are (and should be) able to assist in the performance of tasks at the individual, unit, and organizational levels. Maybe the most obvious improvements will come in handling the routine, tedious, and time-consuming tasks associated with accounting, reporting, and filing. In this area, microcomputers can provide an alternative to hiring additional staff—an option that must be thoroughly considered in many situations.

The power, speed, and accuracy of microcomputers now makes it possible to carry out various routine support tasks in a low-cost manner. For example, personnel can use the micro to quickly prepare memos, complete workplans, and construct budgets. This frequently releases technical and administrative staff to assume additional responsibilities for actually guiding, monitoring, and reporting on development activities. Middle and top-level executive time can be freed by using the microcomputer for data manipulation, analyses, visual display preparation, document revision, file searching and merging, inventory control, personnel appraisals, and financial management. This saved time can be used productively to consider new strategic opportunities and options.

The microcomputer is also demonstrating its usefulness as a tool for strengthening development institutions through initiating, improving, and sustaining organizational performance. The case of the Kenya Ministry of Agriculture and Livestock Development demonstrates one way that microcomputers can be usefully applied to upgrade a budgeting and financial system. In addition, microcomputer technology may be instrumental in improving decentralization and participation. The use of microcomputers may allow decentralization and participatory operations to be initiated and sustained by providing local units with a low-cost means for assuring accountability and responsible decision making. Recent experience from Nepal and Portugal also indicates that the microcomputer can be used to accelerate managerial learning, increase the productivity of work teams, and improve the quality of the work environment. (Bertoli and Bertoli: 1981; Ingle et. al.: 1983.) Indeed, the initial empirical evidence suggests that, <u>if correctly introduced and intelligently used</u>, the microcomputer has the potential for improving agricultural organization performance across a wide variety of tasks and functions.

The promises of microcomputers in development management are greatly facilitated by the attribute of the technology referred to as "user-friendliness". User-friendliness of software and hardware facilitates the perceived and actual usefulness of microcomputers. Originally, to understand the computer one had to be be fluent in a software programming language (e.g., FORTRAN) or an

application language (e.g., SPSS) with its own syntax and structure. This software requirement isolated all but a handful of initiates from computer use; it still restricts accessibility to large computers. But this need not be the case with the microcomputer. Because of the user-friendliness designed into the software, people with relatively little training can tell the microcomputer to do what they want it to do. The microcomputer is programmed to speak the user's language. This change adds a unique, transparent quality to microcomputer technology, and accounts for much of its personal appeal.

Of equal importance is the user-friendliness of the hardware (the central processing unit, the disk drives, the keyboard, the printer, and the monitor, etc). While care of microcomputers is still required, the antiseptic conditions needed to sustain the large mainframes are no longer necessary. Nor does a certified technician stand between the user and the equipment. The ease of interaction between and among the components and the user makes access to the system quite simple.

B. Potential Threats of Microcomputers

Although the organizational appeal of the microcomputers is obvious and rapidly expanding, there are many potential drawbacks to microcomputer acquisition and use. The microcomputer is a powerful tool that, if some basic precautions are not taken, can be severely misused. From the perspective of agricultural development organizations, potential threats from introducing a microcomputer can be clustered in three categories: system costs, organizational processes, and development performance or results. A description of potential threats in each of these categories follows.

1. Microcomputer System Costs: In general, the cost associated with microcomputer systems — especially compared to larger computers — are extremely low. However, when viewed in the context of development organizations, over time, the cost factor changes. Complete microcomputer systems, including basic software programs, cost in the range of US $3,000-5,000 each. In developing countries these initial purchase costs can easily double or triple if: (a) redundant components are purchased for backup support; (b) special equipment is included to handle electrical power fluctuation considerations, and/or (c) programs need to be custom designed for special applications. Costs can double again if the natural desire "to keep up with technological improvements" is operative. As new components are added, system compatibility becomes a pressing concern. Imagine the consternation of a technician discovering that she/he has to learn a new statistical program because the current one "does not work exactly right" on the newest microcomputer model just purchased! Compatibility and maintenance costs are frequently hidden and over time can be substantial. These costs escalate in developing country contexts. Finally, there are various organizational or ORGWARE costs including staff time for learning, needed attention to new policies, and various revisions in procedures and routines. (Ingle et. al: 1983) ORGWARE costs are usually estimated to be at least double the combined costs of hardware and software.

2. Organizational Process: The threats in the area of organizational process are also several, and potentially quite severe. First, there is the

possibility that microcomputers will give staff the false impression that "objective data" and "formal lines of communication" need to be emphasized to the exclusion or neglect of subjective and informal information. Caught up in the "hype" that surrounds micros as the technology of the future, managers and technicians can be insidiously distracted from the inherently human nature of successful development efforts. Furthermore, the push for doing everything—communications, reports, acccounts—with the microcomputer might drive out other essential organizational tasks, such as strategic planning, networking, and learning by doing, that do not lend themselves readily to automation. Finally, while microcomputers offer the promise for more decentralization and delegation of responsibility around specific organizational tasks, they also bring the threat of non-integrative specialization and concentration of information processing power. This final threat is extremely prounounced in Third World countries where administrative power is already highly concentrated, and those holding public office are well positioned to benefit first and most from microcomputer transfer.

3. Development Results: In the category of development results, the potential negative effects associated with microcomputers are more diffuse and less certain. First, while microcomputers may help an organization increase its internal productivity, there is no reason to equate this with "doing what is needed developmentally!" Issues of effectiveness need to be addressed, and it is uncertain whether proponents of the microcomputer revolution are adequately addressing these issues (Servan-Schreiber and Negroponte: 1982; Shirkle and Fleuer: 1981). Second, there is a grave concern on many fronts for the labor displacement that may be associated with the microelectronic revolution, especially in Third World Countries. Leaders of the World Microcomputer Center in Paris estimate that microelectronic technology will cause displacement of millions of jobs in developing countries before the end of the century.

Finally, and possibly of most importance, given current trends, the threat exists that this new technology will further exacerbate development inequalities both between and within nations by allowing wealthier segments and countries to exploit the others.

C. Facilitating Microcomputer Transfer: Hints for Appropriate Acquisition and Intelligent Use

Based on our assessment, the appropriateness of a micrcomputer system rests first and foremost on the actual needs a system can meet, and secondly on the degree to which a system's use can be effectively sustained. By actual needs we refer to those current or potential management tasks in the agricultural organizational context that could be met effectively through the use of a microcomputer. The degree of system sustainability is a function of the operational environment and the probability that a given microcomputer will prove effective over the long term.

A flow model of the variables involved in microcomputer use and institutionalization is presented in Figure 1. This figure depicts the microcomputer transfer sequence over time, and sets out the importance of various factors in the short, medium, and long term. The chart is read from left to right, each column representing a phase of system sustainability. For example, if a needs assessment (Column I) is favorable towards acquiring a microcomputer, the factors listed under Column II are necessary to have minimum system sustainability in the short term. Continue reading to see the minimum set of factors associated with system sustainability over time, and when one should deal with them. For example, the dirty power (Factor #1) issue is something that one should take care of immediately. The need for documentation written in the local language. (Factor #4) is not of equal priority; however, in the long run, it should be considered. Thus, viewed as a process, the factors presented in Figure 1 determine the sustainability of the microcomputer as a viable tool for use in development management.

The final decision to acquire a personal computer hinges upon several inseparable factors, but, as least initially, the critical factor is the presence of tasks that need doing, that can be facilitated by a microcomputer. Once one determines that a computer can actually help, then ORGWARE factors become paramount. A list of practical Dos and Don'ts for introducing microcomputers into development settings is found in Table 2.

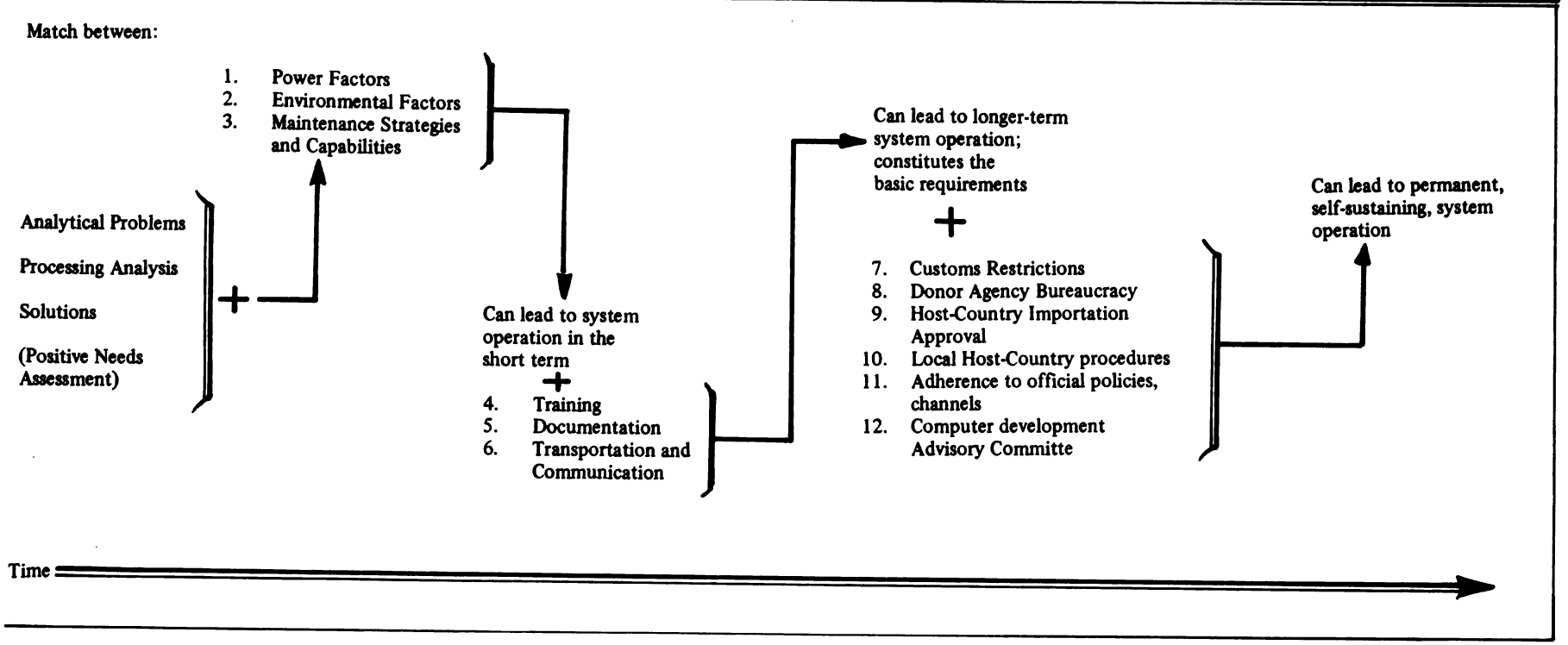
IV. OVERALL ASSESSMENT AND CONCLUDING THOUGHTS

Several common themes emerge from our assessment. One centers around the complex environment in which agricultural projects and institutions operate, including the lack of timely, relevant information that development professionals have available for use in decisionmaking. This general inaccessibility to relevant information separates organizational personnnel from the agricultural work context, and contributes to a distrust of the formal information that is available. Secondly, agricultural professionals are often not aware of complicated linkages existing between better organizational decisions and continuous to changes in the work setting. These factors help explain the widespread use of "management by blueprint" (a tendency to mechanically follow pre-existing plans even though initial conditions, upon which these plans were formulated, no longer exist). As a consequence there is a sluggish use of current information to modify operations and/or adjust the existing plans. When inadequacies finally become manifest, there is a tendency to focus on individual indictment rather than on system improvement or redesign. The use of microcomputers offers the potential to improve the timeliness of information flows, and give professionals at all organizational levels the information they need to take prompt corrective action.

Thus, a useful perspective on management is to view it as adaptive process. This implies: (1) an interaction between the identification of a problem situation and conditions for its betterment; (2) the ability to learn and adapt during planning-implementation; and (3) more effective involvement of all who have a stake in the development effort. Generation of operational data under the direct control of development actors will promote such an adaptive process.

Figure 1:

Ordering the Technical Factors Involved in Institutionalization of the use of Microcomputers



The Figure above was based on the list of critical issues involved in institutionalization generated by the participants at the Michigan State University conference on Microcomputers, May 1982, Working Group Two. The list that emerged was:

1. Needs Assessment
2. Power needs considerations
3. Environmental considerations
4. Maintenance strategies/capabilities
5. Software documentation (and in local language)
6. Training considerations
7. Transportation and communications
8. Customs restrictions
9. Donor agency bureaucracy
10. HC importation approval
11. Local host country procedures, regulations, etc.
12. Adherence to official policies/channels
13. Computer Development Advisory Committe

Table 1. Dos and Don'ts of Acquisition, Installation, and Use of Microcomputers

Planning

1. Determine what you need a mircocomputer to do for you. Then choose the software before you choose the hardware.

2. When considering the hardware, find out what others in your area are using and seriously consider purchasing that kind of equipment.

3. Have a plan for cleaning up the power supply.

4. Have a plan for training.

Purchasing

1. Explore your options. Talk to different dealers and have them show you how to set up the system and how to use it. Work with a friend or colleague.

2. Order all miscellaneous materials and supplies you need for one project year, especially extra documentation.

3. Purchase connector cables when you order the system.

4. When you first buy equipment, also buy the tools, spare parts, test equipment, and hardware manuals (with schematics).

Installation

1. Spend time with someone who has a similar system and learn how to put it together.

2. If possible, get assistance from someone who knows how to install the system.

3. Set up the whole system before plugging it in to the power supply. Plug in another piece of equipment (e.g., a lamp) into the outlet you intend to use for the system.

Power

1. Provide electrical protection:

   - based on local network experience or knowledge;
   - in the light of budget needs.

2. Consider the use of an Uninterupted Power Supply (UPS).

3. Provide a non-fluctuating source of power to the equipment.

4. Dedicate a single line to your equipment, one that is pre-conditioned.

5. Provide common "earth" ground between all system components.

6. Condition your power appropriately.

7. Power on/off switches can fail. Consider unplugging your system when you turn it off instead of using a switch.

Hardware

1. If possible, consider buying one extra system for use during system breakdown or for possible spare parts.

2. Consider buying a diagnostic testing board for troubleshooting. (The Apple II E has one already built in.)

3. In a central unit with built-in monitor and keyboard, you lose some maintenance flexibility. If you have to send an item away for repair, it is often convenient to send only the sub-unit needing repair instead of the entire unit.

4. 48K of memory is adequate for running the packaged software most used in development projects. For most systems, when and if you need more memory, you can buy a "chip" or another "board" that contains additional memory.

5. For the average development project, the size of the data base can be fairly easily determined and the size of disk drives properly selected. Disk drive size is not a major variable in system selection—only if you are using a program that requires 8" disk drives, or if you have a large data base, would you consider large disk drives or hard disks.

Software

1. If it is not built into the system, and if possible, buy a diagnostic software package to test your system problems.

2. Buy interactive software packages.

3. Buy "how to" packages and use them as well as the tutorials to learn how to use particular kinds of software.

4. Buy only the software packages you need.

5. Learn one or two software packages at a time.

6. If your work involves a substantial amount of writing, give serious thought to getting a word processing program.

7. Games programs are good for training and for breaking down some of the initial resistance frequently encountered in development project situations.

Diskettes

1. Keep diskettes in their jackets.

2. Have extra blank, formatted diskettes available.

3. Make back-up copies of all diskettes—update and recopy as necessary.

4. Keep a card catalogue of files that appear on each diskette, or some other form of external retrieval system (e.g., print outs of disk directories that are dated and kept in file folders).

5. Use only felt tip pen to write on diskette labels—pressure on diskettes from ball point pen may damage them.

6. Keep your diskettes and records with you if you and others share the equipment.

7. Keep archive copies of diskettes in another location for safeguarding.

8. Recopy diskettes over a year old.

Maintenance

1. Whenever the system is opened for modification or routine maintenance, it should be turned off at the mains.

2. Take off all jewelry and touch metal before going inside the "turned off" system.

3. Do regular monthly maintenance.

4. When someone else is doing maintenance, watch and take notes on exactly what s/he is doing.

5. Inform yourself about computer maintenance by reading articles, equipment manuals, etc, and learn to diagnose problems.

6. Keep a maintenance notebook.

7. Know the different tolerance levels (concerning power and frequency requirements) for each piece of hardware, e. g.:
   - electrical power 220, plus or minus 5% to remain operational.
   - 50 CPS (frequency), plus or minus 5% to remain operational.

8. The microcomputer industry is rapidly establishing sales and service facilities in developing countries which will eliminate the need for individuals and projects to provide their own maintenance capability.

Environment

1. Do not eat, drink or smoke near equipment.

2. Protect equipment from food, drink, tobacco smoke or any foreign matter by keeping it covered with a lint free cloth when not in use.

3. Keep equipment cool.

4. If the equipment is in an air conditioned room, seal all windows shut, have a back up air conditioner available, have a spring on the door to keep it closed, use a wet bulb humidity measure and, if necessary, a dehumidifier in the room or inside the computer itself.

5. Keep the computer away from the air conditioner.

6. Provide an environment without static electricity—rubber mats under the machine, static free carpeting.

7. Provide adequate ventilation, e.g., fan blowing on computer or in room.

Supplies

1. Stock all fuses (of proper amperage) for all equipment.

2. Stock all needed supplies including diskettes, ribbons, cables, print heads, paper, transformers, etc, for a minimum of one year to the maximum life of the project.

3. Stock chips and boards as part of your spares kit.

Microcomputer technology provides some of the means to address the needs of this type of adaptive management process. It facilitates the provision of user-oriented, low-cost and timely information. Microcomputers are allowing decisions to be made in days rather than months. In some settings professionals with access to microcomputers believe that they have gained more control of their actual work situation by being able to quickly identify alternatives, analyse them by asking a series of "what if?" questions, and thus understand the implications of particular decisions. However, fear and skepticism on the part of potential users are frequently encountered in organizational settings, so one must be prepared to face these attitudes and seek ways of overcoming the. Finally, there is as yet no articulated theory or understanding of how microcomputer technology can be employed to improve the performance of agricultural organizations. The whole process is new, dynamic and chaotic. Microcomputers bring with them the promise for improving our means of managing, and our views of management. But they also bring some serious threats. Those who intend to invest in microcomputer technology need to give careful attention to assuring that the benefits of microcomputer acquisition and use in agricultural organizations outweigh their negative consequences.

REFERENCES

1. Barley, K. S., and J. R. Driscoll, "A Survey of Data-Base Management Systems for Microcomputers, BYTE, November 1981.

2. Berge, N., "A Report on the Status of Microcomputers in Nepal", DPMC/OICD/USDA, Washington, DC, August 1982(a).

3. Berge, N., "Survey of Microcomputer Use by USAID and USDA Personnel Working in Developing Countries: A Preliminary Analysis", Paper presented in the International Conference on Microcomputers for Agricultural Research, Michigan State University, May 18-21, 1981(b).

4. Berge, N., and M. Ingle, "Microcomputers and Agriculture Management in Developing Countries: Workshop Proceedings Report", DPMC/OICD/USDA, Washington, DC, 1982.

5. Bertoli, F. and S. Bertoli, "The Utility and Potential Applications of Microcomputers in Data Processing and Analysis: A Report on Operational Support in Rabat, Morocco", USAID, Under AID/DSPE-C-0053, 1981.

6. DPMC/USDA, PROPLAN/IICA and IDMC/UMCP, "Guidance System Improvement: An Emerging Approach for Managing Agricultural Improvement and Rural Development", Internal Working Draft, 1983.

7. Farrar, C., "Statement of the Agency for International Development on Microcomputers and Developing Countries", Subcommittee on Investigations and Oversight and the Subcommittee on Science, Research and Technology of the Committee on Science and Technology, U.S. House of Representatives, July 15, 1982.

8. Flores, I. and C. Terry, Micrcomputer Systems, 1982.

9. Gotsch, C., "Final Report: Improving the Management of Food Security Systems", Final Report, Gotsch Associates, Inc., Palo Alto, California, 1982.

10. Ingle, M. D., "Appropriate Management Technology", Paper presented at the ASPA National Conference, Detroit, 1981.

11. Ingle, M. D., N. Berge and M. Teisan, Acquiring and Using Microcomputers in Agricultural Development: A Manager's Guide, Development Project Management Center, U.S. Department of Agriculture, April 1983.

12. Ingle, M. D., N. Berge and M. Hamilton, Microcomputers in Development: A Manager's Guide, Kumarian Press, 1983.

13. Kettering, M., "Some Uses of Microcomputers for Rural Development Projects: Reflections for the Thailand NERAD Project", USAID, Thailand, June 1982.

14. Kraemer, K. L., "Local Government, Information Systems, and Technology Transfer: Evaluating Some Common Assertions About Transfer of Computer Applications", Irvine, California: University of California, June 1976.

15. Lanpher, B. F., "Utilization of Stand-Alone Computer-Type Technology in Agricultural Decision-making and the Extension Service Role," Paper presented at the Symposium on Programmable Calculators and Minicomputers in Agricultural Decision-Making, Hot Springs, Arkansas, February6-7, 1980.

16. Management Development Working Group, "Management Development Strategy Paper: AID's Response to the Implementation Needs of the 1980's", S&T/MD, U.S. AID, Washington, DC, June 1981.

17. Mann, C., "Should We Throw The Man An Apple? Microcomputers in Tunesia" Paper presented at the International Conference on Microcomputers for Agricultural Research, Michigan State University, May 18-21, 1982.

18. Osborne, A., and D. Bunnell, Introduction to Microcomputers: The Beginner's Book, rev. 3rd ed., McGraw-Hill Book Co., 1982.

19. Papert, S., Mind-storms: Children, Computers, and Powerful Ideas, Basis Books, 1980.

20. Paul, S., Managing Development Programs: The Lessons of Success, Westview Press, 1982.

21. Pinckney, T. C., J. M. Cohen and D. K. Leonard, "Microcomputers and Financial Management in Development Ministries: Experience from Kenya", Development Discussion Paper No. 137, Harvard Institute for International Development, August 1982.

22. Rada, J. F., "The Microelectronics Revolution: Implications For the Third World," Development Dialogue, 1981.

23. Rogers, E. M., J. D. Eveland, and C. A. Klepper, "The Innovation Process in Public Organizations" Final Report, NSF Grant RDA75-17952, Executive Summary, March 1977.

24. Sadowsky, G., "The Introduction of Microcomputers in Develping Countries by the United Nations Secretariat: Some Initial Experience and Observations, Papers presented at International Conference on Microcomputers and Programmable Calculators for Agricultural Research in LDC's, Michigan State University, May 18-21, 1982.

25. Servan-Schreiber, J. J. and N. Negroponte, "World Center for Information and Human Resources: Missions and Programs (1982-1983)", Paris, France, 1982 (mimeographed).

26. Shirkie, R. and Jean-Marc Fleury, "Development in Miniature: Will developing countries use microelectronics—or be used by them?", The IDRC Reports, Vol. 10, No. 1, April 1981.

27. Slagle, L. B., R. C. Oman, and R. A. Dixon, "Organization Productivity: The Impact of Office Technology Change", Paper presented at the ASPA National Conference, Detroit, Michigan, April 1981.

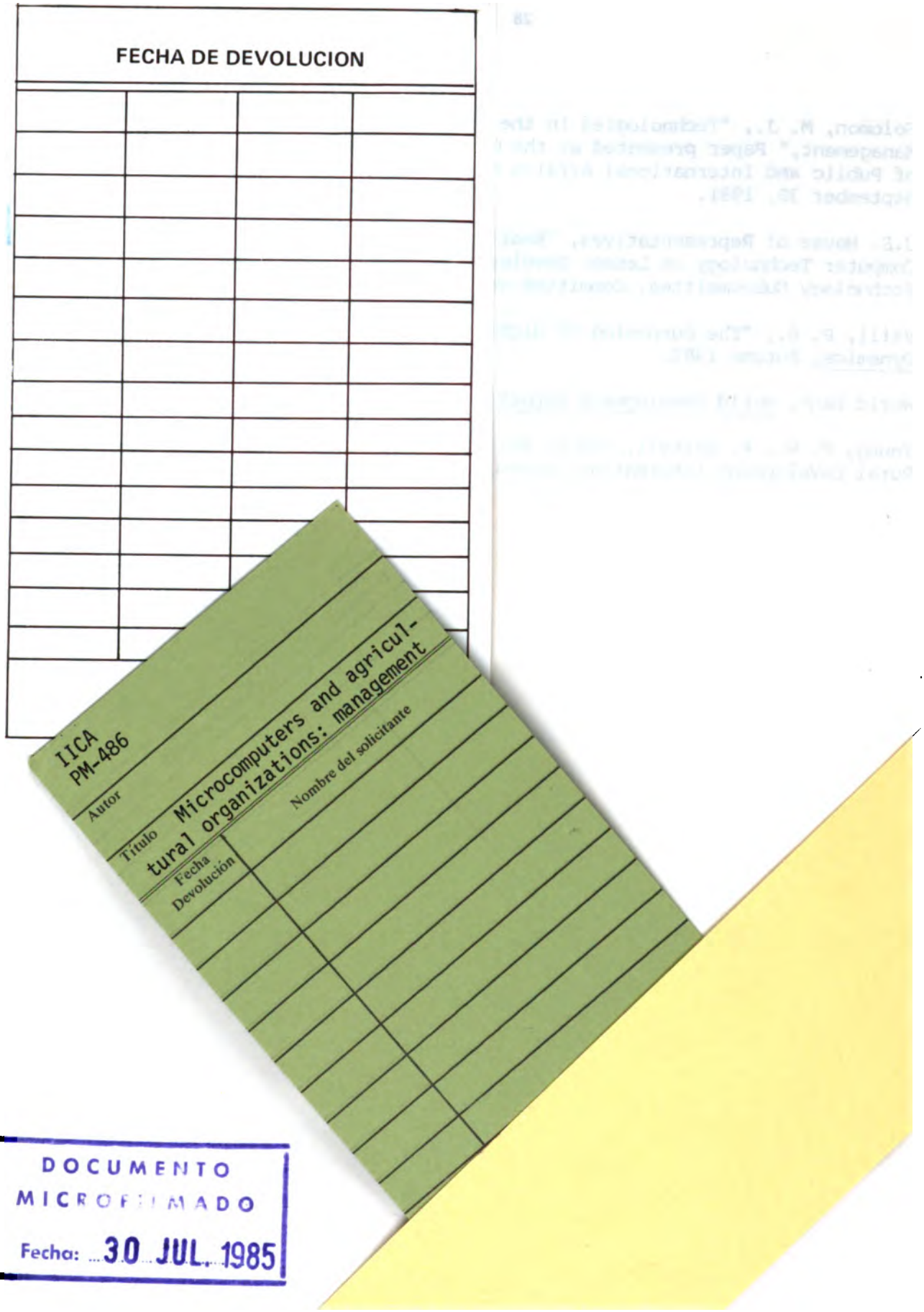
28. Solomon, M. J., "Technologies in the Improvement of Third World Management," Paper presented at the Graduate School of Public and International Affairs at the University of Pittsburg, September 30, 1981.

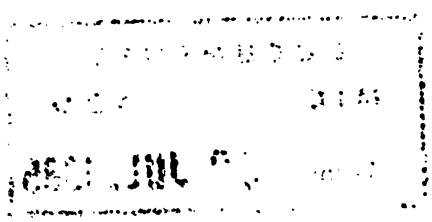
29. U.S. House of Representatives, "Hearings on Measures to Address Impact of Computer Technology on Lesser Developed Countries," Science, Research and Technology Subcommittee, Committee on Science and Technology, July 15, 1982

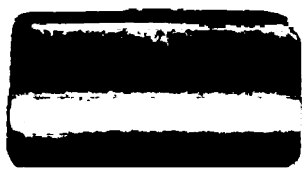
30. Vaill, P. B., "The Purposing of High-Performing Systems", Organizational Dynamics, Autumn 1982.

31. World Bank, World Development Report 1983, IBRD, Washington DC, 1983.

32. Young, F. W., F. Bertoli, and S. Bertoli, "Design for a Microcomputer-Based Rural Development Information System, Social Indicators Research, 1981.







The Project on Management for Rural Development in Latin America —PROPLAN/A— is a joint effort by IICA and the W. K. KELLOGG Foundation. This Project has a multinational scope, encompassing IICA's Member States throughout Latin America and the Caribbean. Its purpose is to upgrade the capabilities of public institutions, to make them more effective in detecting and responding appropriately to the needs of the low income rural population.

W.K.KELLOGG FOUNDATION