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A RESEARCH-DEVELOPMENT PROCESS FOR IMPROVEMENT OF ON-FARM WATER MANAGEMENT

By Wayne Clyma,
Max K. Lowdermilk,
and Gilbert L. Corey

Colorado State University
Fort Collins, Colorado

June 1977

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A RESEARCH-DEVELOPMENT PROCESS
FOR IMPROVEMENT OF ON-FARM WATER MANAGEMENT

Water Management Technical Report No. 47

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Prepared by

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Gilbert L. Corey

Water Management Research Project
Engineering Research Center
Colorado State University
Fort Collins, Colorado

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A RESEARCH-DEVELOPMENT PROCESS
FOR IMPROVEMENT OF ON-FARM WATER MANAGEMENT

Table of Contents

PREFACE

The basis for this report is the combined experience of the authors in a water management research project in Pakistan. This report does not represent a finished product but will provide a structured procedure for continued improvement of research-development activities for the future. A larger team will be applying and improving these procedures through continuing water management research programs and will be using this material and improvements to conduct a graduate seminar. Comments and suggestions from the readers on this report will be welcomed and should be sent to the following address:

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A RESEARCH-DEVELOPMENT PROCESS FOR IMPROVEMENT OF ON-FARM WATER MANAGEMENT[1/]

Wayne Clyma, Max K. Lowdermilk
and Gilbert L. Corey[2/]

ABSTRACT

A research-development process for rapid improvement of on-farm water management through technology transfer is described. The process focuses on systematic research to identify problems, develop and assess solutions, and implement development programs at the farm level. An interdisciplinary team executes the research-development process with farmers.

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1/Prepared under support of the United States Agency for International Development Contract AID/ta-C-1411, Department of State, Washington, D.C.

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A RESEARCH-DEVELOPMENT PROCESS FOR IMPROVEMENT OF ON-FARM WATER MANAGEMENT

Wayne Clyma, Max K. Lowdermilk
and Gilbert L. Corey

> Concern for man and his fate must always form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations.
>
> Albert Einstein

Concern for man's fate is the primary motivation for the evolvement of the research-development process presented in this paper. Given past experiences in development and present critical food shortages, new approaches are necessary for rapid transfer of appropriate technology to food deficient nations. A major challenge for the next decade is the development and implementation of workable methods to increase food production in low income nations.

INTRODUCTION

Irrigated agriculture provides an opportunity for making rapid increases in crop production. Improvements in irrigation can result in higher levels of living in low income nations because they have approximately 80 percent of the world's irrigated land.3/ In many countries, irrigation projects designed originally to increase food production radically and to benefit all classes of farmers have failed to meet objectives because of their low levels of crop production in contrast to their apparent potential.

3/President's Science Advisory Commission Report. 1967. World Food Problem, The White House, May, Ch. 7 and 8.

Development of irrigation systems has traditionally meant the construction of new projects or the enlargement of existing projects. The emphasis has been on capital-intensive components such as dams, hydraulic structures and water delivery systems.

Water management in agriculture is the process by which water is manipulated and used in the production of food and fiber. Water management is not water resources, irrigation facilities, laws, farmers, institutions, procedures, or soil and cropping systems. Water management is manifest in how these tools and resources are used to provide water for plant growth. It encompasses all water used for that purpose; not just irrigation, but rainfed as well.

Large financial resources are being directed to solving the problems of irrigation water management. Previously, few systematic approaches to evaluate existing irrigation systems, analyze weaknesses and failures, and prescribe technologies for improvement have been developed. Usually, each system that is evaluated becomes a case study in itself. Improvement programs are developed within a short time period utilizing little more than the experience of the project developer. Most frequently these improvements treat symptoms rather than real problems. Such conventional approaches generally ignore the farmer, his attitudes, his knowledge, and his constraints. They have not resulted, therefore, in sufficient improvements at the farm level.[4/] Water management improvement is important because there are an estimated 200 million acres of land

4/Wiener, Aaron. 1972. The Role of Water in Development. McGraw-Hill Book Co., New York, p. 422.

presently under irrigation. New areas are being added at the rate of less than 10 million acres annually. Most irrigation systems in low income countries, or anywhere for that matter, operate at relatively low levels of water use efficiency and at low levels of production.[5/] Thus, a major need is for the improvement of existing systems. The reasons for focusing on improvement of existing systems are as follows:

1. Conserve water supplies by improved management for rapid increases in food production;
2. Improve the return on investments of existing systems;
3. Reduce the costly waterlogging and salinity problems which are often mere symptoms of poor management;
4. Reduce the need for large capital investments in new systems;
5. Gain knowledge which can provide new criteria for the development and management of other systems.

A concerted effort to improve irrigated agriculture, if focused at helping the small farmer solve his problems, could bring improved income and living conditions to a substantial percentage of the world's disadvantaged.

> The cost of expanding the present 85 million irrigated hectares by 90 million acres is estimated at $130,000 million. This is not only exceedingly costly but also a slow process because projects from design to completion often take 10 to 12 years. Investments in new projects will continue but more quick yielding programs are needed to help the small farmer. These new programs seldom improve the efficiency of farm water use, therefore the focus

5/Bos, M. G. and Nugteren, J. 1974. International Institute On Irrigation Efficiencies, Pub. No. 19, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

> in the years ahead must be given to farm-level problems. There is much exciting drama in building large structures but we must not forget the small and often tragic dramas that take place daily on millions of small holders' farms where water conservation is a matter of success and failure and even life and death.[6/]

A transfer process which results in rapid adoption of appropriate technologies, is generally applicable, saves time, money and resources, and produces documented positive results is of immense value in attacking the problem of food production.

Purpose

The purpose of this paper is to describe a research-development process for rapid improvement of on-farm water management. The process focuses on systematic research to identify problems, develop and assess solutions, and implement development programs at the farm level. An interdisciplinary team executes the research-development process. Farmers are members of the team.

This paper discusses the background for the evolution of the research-development process. The overall process is described with its key concepts and essential elements. Recommendations for using the process are also included.[7/] The assumption can not be made that a government has recognized farm water management as a major problem. As research-development proceeds, however, this recognition will hopefully come with the understanding of the problems identified.

6/World Bank. 1975. The Assault on World Poverty, John Hopkins University Press, pp. 95-96.

7/This paper does not include detailed procedures for implementing the process. Subsequent papers will describe procedures.

Background

Experiences in an on-farm water management research program in Pakistan form the basis for this research-development process. A research process has evolved in Pakistan which has helped formulate relevant technical and socio-economic specifications in five major areas:

1. On-farm water management improvement programs with farmer involvement;
2. Empirical field data for policy-planning decisions on water and farm production questions;
3. Training of host country personnel and institution building;
4. Information transfer processes which make research results immediately available to farmers;
5. A research-development process for use in other countries.

Pilot programs in Pakistan have demonstrated that with limited capital and much farmer participation, watercourse improvements can be made.[8/] Farm water losses have been reduced by half or more. These low cost improvements are relatively easy to implement, highly visible, and economical. Farmers are enthusiastic because they are able to increase both cropping intensities and crop yields with the water saved from the improved practices. The Government of Pakistan and

8/Bowers, S.A. et al. 1977. Watercourse Improvement in Pakistan: Pilot Study in Cooperatio- with Farmers at Tubewell 56L. Water Management Tech. Rept. No. 45, Colorado State Univ., Fort Collins, CO. May.

donor agencies are developing programs to extend the research findings. An Agency for International Development loan program will extend the new technologies to 60,000 farms and a World Bank program proposes to develop a strategy to improve water management within the entire 30 million acre system.

The possibility of transfer of the research-development process to other countries is viable. Egypt and Sri Lanka have initiated on-farm water management projects to essentially replicate the Pakistan experience. Given the experience gained in the Pakistan field laboratory, a systematic approach has been developed which can advance on-farm water management in the irrigated regions of the world.

PROCESS OVERVIEW[9/]

The research-development process is initiated with the assumption that prior procedures[10/] have identified an irrigated area where a potential for improvement of on-farm water management exists. The process is initiated by nationals of the country, in some combination of nationals and expatriates but not by expatriates alone.

9/This section presents a summary of the process. In the appendix, the rationale, emphases and activities for each phase are presented.

10/Lowdermilk, M. K., W. Clyma, S. A. Bowers and W. D. Kemper. 1978. Planning and Implementing Procedures for Contracting Agricultural-Related Research Programs in Low Income Nations. Water Management Tech. Rept. No. 46, Colorado State University, Fort Collins, CO.

The process consists of four overlapping phases as follows (Table 1):

I. Priority Problem Identification

II. Search for Problem Solutions

III. Assessment of Solutions

IV. Program Implementation

When a set of technologies has been adopted successfully, the new system operation may be further improved by the transfer and adoption of additional technologies. This process is capable of continuously improving the operation of water management systems by further iterations through the four phases.

The time frame for process execution will vary widely dependent on resources of trained manpower, finances available, and the particular conditions of the irrigated region. Problem identification is continuous but a systematic study of any irrigation system should identify major problems within a matter of months. Solutions to the problems may be identified immediately from known technology or require several years of careful research. Assessment of the solution usually involves at least one full cropping season and may require a continuing long term effort. Implementation can be initiated as soon as solutions are defined and while building the appropriate requisite infrastructures. Several months to several years are then required for one complete cycle of the research-development process.

Table 1. Phases and Major Characteristics of the Research-Development Process.

Key Concepts for All Phases	Essential Components for All Phases
1. Systems approach	1. Client involvement
2. Interdisciplinary research	2. Communication
3. On-farm client focus	3. Team collaboration
4. Host-country involvement	4. Training (selection and evaluation)
5. Management oriented	5. Institutional building and linkages
6. Action research	6. Monitering and evaluation

Phased Sequences for Transfer Process	Major Emphases*	Major Activities
Phase I Priority Problem Identification	Clinical approach Understanding the system Integrated system operation System constraints	Reconnaissance and field surveys Delineation of the system Preliminary and formal field investigations Quantitative system description Priority problem identification
Phase II Search for Problem Solutions	Applied research Adaptive research Evaluative research Farmer conditions Farmer interest Trial and adoption	Experiments, trials and demonstrations on-farm with various types of technologies
Phase III Assessment of Solutions	Farmer acceptance Evaluative research Transfer vehicles Institutional linkages Diffusion requirements	Adoption-diffusion studies Evaluation of communication systems Farmer linkage with organizations Farmer linkage with organizations
Phase IV Program Implementation	Farmer-client and management oriented, integrated planning protective research	Implementation, planning, training, monitoring and evaluation

*These major emphases are derived from the key concepts and essential components listed above.

The unique feature of problem identification and perhaps the process itself is the interdisciplinary approach with farmer participation to achieve an understanding of system operation. This results in an objective, quantitative definition of priority problems. It also permits the traditional system to appropriately and systematically impact the country's research and development efforts. Systemic mapping including a clinical approach to the farmer-client are used to diagnose physical, socio-economic and institutional problems in Phase I (Table 1). Because all problems can not be solved initially, priority problems, from which highly visible solutions can be evolved, are defined.

Phase II in Table 1 is the search for problem solutions which produce results highly visible to farmers. Direct solutions from known principles and experiences are sought first and adapted to specific farmer problems and resources. On-farm testing or demonstrations of known technology is the next priority approach to developing solutions. Applied research at the experiment station is reserved for evaluating complex alternative solutions to high priority problems which require more careful study. The interdisciplinary team combines knowledge and experience with systematic research to develop solutions which farmers can use to priority farm problems.

A systematic, quantitative assessment of each solution is made to assure farmer acceptance, determine complementary inputs and supporting services, and evaluate socio-economic and environmental impacts in a unique framework. Applied, adaptive, and evaluative research methods are used under farmer conditions in Phase III for the assessment of solutions. These results are used to redefine problems and improve their solutions but are primarily for the selection of a package of practices for implementation. These assessments are used to determine resource communication and institutional needs of farmers to assure continued adoption. Farmers' trial and adoption experiences are evaluated over time to select a technology package for the implementation program. Socio-economic and environmental impacts are also monitored for long term projections.

An institutionalized development program evolves with program implementation. Trained personnel use the carefully designed technological package to work directly with the farmers to solve their problems. Many authors have observed that known technologies for irrigation improvements are available.[11/] A major constraint is the lack of effective transfer of technology to farmers because institutions do not have the necessary capabilities. The focus in Phase IV is on the development of selected organizational capabilities for effective transfer of technology through carefully designed training and evaluative strategies. At the beginning of the program implementation phase, the institutional capability and appropriate technologies are evolved into an effective development program.

The following sections discuss the key concepts, essential components and important aspects of the overall process. In

11/Wiener, op. cit. and World Bank, op. cit., pp. 95-96.

the appendix presented under each phase, the rationale, emphases and activities for each phase are discussed in more detail.

Key Concepts

While each phase of the process emphasizes particular concepts and components, the overall process has certain key concepts and essential components that are vital to every phase. The key concepts for the process as given in Table 1 are as follows:

1. A systems approach which includes the socio-economic, institutional and physical aspects of the irrigation system.
2. An interdisciplinary team plans and executes the program.
3. The farmer, as the manager and beneficiary of improvement, is the primary concern and focal point.
4. The program is a host-country program and must be accepted and executed by host-country personnel.
5. The process is management-oriented and focuses on management improvement.
6. The research approach is action or problem oriented.

Systems Approach

Farmers manage a system composed of many components. Agricultural research, however, has traditionally focused on single factors or restricted components of the farm system. As long ago as 1931, a researcher of the Ontario Research Foundation drew attention to a method of agricultural research, management, and production that would view the whole agricultural system.[12/] In 1961, Bradfield[12/] gave special emphasis again to this "new approach" to research and development.

The plight of the small farmer, the food and population crisis, and lack of institutional development are all critical problems today in part because of the lack of an adequate systems approach. Ronninger[13/] suggests that valuable time and opportunities have been lost in environmental system problems such as animal wastes, nitrate and pesticide pollution as well as in evolving the high yielding varieties. Millikan and Hapgood[14/] and others[15/] have also concluded that insufficient and inadequate system-type field studies have been conducted to improve traditional farming systems.

The traditional research model in agriculture is the research station with experimental plots. The unstated, but usual primary objective of such research is refereed journal articles or reports. In contrast, at all phases of this

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12/Bradfield, Richard. 1961. In International Congress of Soil Science, Transactions of the 7th International Congress of Soil Science, Madison, Wisconsin, Volume I, Official Communications, p. XXXII. (See Richard Bradfield's "Opportunities of Soil Scientist in Freeing the World from Hunger" -- presidential address.)

13/Ronninger, T. S. 1968. "Systems Research in Agriculture," Agricultural Science Review, Vol. 6, No. 1, Cooperative Research Service, Washington, pp. 102.

14/Millikan, Max F. and David Hapgood. 1967. No Easy Harvest: The Dilemma of Agriculture in Underdeveloped Countries, Little, Brown and Co., Boston.

15/See Mellor, John W. 1966. The Economics of Agricultural Development, Cornell University Press, p. 357, and Dalrymple, Dana G. 1969. Technological Change in Agriculture, International Development, Foreign Agriculture Service, Washington, D.C.

research-development process, the focus is on understanding problems, developing and assessing the solutions, and implementing the development programs in the context of the total on-farm system. This focus suggests the importance of the next concept, the interdisciplinary team.

Interdisciplinary Research

An effective interdisciplinary research team is a necessary condition for solving problems in complex systems. The key concept for an effective interdisciplinary research team is that it has all the essential disciplines necessary to adequately understand the operation of a system. This provides the corresponding ability to define priority system problems. The essential elements of an effective interdisciplinary team are: (1) respect for the contributions that each discipline can make; and (2) desire to establish effective communication between the various disciplines.

Disciplinary respect is fraught with many difficulties. In academic environments, disciplinary pride and arrogance are fostered to such a degree that professionals in a discipline act as members of a caste. This causes the professional to pursue narrow disciplinary goals without considering the contributions of other disciplines.

Respect for other disciplines and team members is basic to effective communication. While it is essential that team members be technically qualified, experienced professionals in their disciplines, they must also be able to communicate effectively.

A strategy for executing an effective interdisciplinary program is as follows:

1. The team defines the parameters of the system to be studied.
2. The primary variables to quantitatively describe the system are identified.
3. A strategy for describing the operation of a system with the defined variables is then evolved.
4. A research program is executed to collect data which quantitatively describe the operation of the system.

In some instances, variables must be measured in a coordinated, carefully-planned manner to relate certain variables in the context of management. For example, physical variables must be related to farmer perceptions of the physical system to evolve an effective strategy for improvement.

On-Farm Client Focus

Strong farm and farmer focus is essential in all phases of the process. Actions in any phase of the process are developed from farm level data without allowing prior assumptions about farm problems dictate research or development programs. Farmers, researchers, trainees, and all other personnel, both expatriate and host country, are involved as a team. This is a unique aspect of the research-development process. In the past, both in research and in development, inadequate focus has been given to the primary beneficiary, the farmer.

Host-Country Involvement

While the circumstances under which a water management program is initiated in given countries will vary, it must be the program of the host country--executed by the people and for the people of the country. If expatriate advisory leadership is involved early in the program, explicit program strategies and training must be planned in order that leadership is transferred to the host country at the earliest possible date.

Host country personnel includes farmers, senior researchers, field party members, and governmental administrators. Moreover, program involvement, from the field party to the head of the government, provides better articulation of problems, alternative solutions, knowledge of institutional constraints, and greater credibility for the program. This integrated involvement also insures that the program is fully a host-country program. Programs suggested by expatriates must be articulated by host country personnel who believe in and participate in the program.

Host countries should evaluate their ability to supply technically qualified, experienced personnel as team members. If this is an initial constraint, an expatriate team can provide leadership early in the program until host country personnel are trained.

Management Oriented

Water management with its biological, physical, socio-economic, and institutional components is a complex process. Social, economic and institutional factors usually outweigh the technical ones. Farmers must make complex decisions before change occurs. These are not on/off or use/not use decisions. They are management decisions involving risk and uncertainty of farmer relationships with the physical system, fellow farmers, and governmental institutions. Therefore, efficient utilization cannot be achieved by simply presenting a single technology, e.g., seed, fertilizer, more water, improved implements. A definite management process is involved. Management is important because a change in one component of a dynamic system causes a chain of interactions. For example, when increased irrigation water is made available to the soil-crop complex, much more than water is involved. Changes are made in other factors which may require new management approaches, new crop mixes, new markets, new forms of collective action with other farmers, improved means of credit, or additional services. This illustrates the chain of interactions that the manipulation of one component of the farm system can set in motion.

Action Research

Action research involves the concept that systematic, investigative approaches are used to solve problems as they occur throughout all phases of the process. Research does not start at the experiment station but on the farm. Research does not stop at the research station but goes on to the farm. Research does not stop at the farm but builds the institutional capability to transfer the solution to other farmers. The solution of a problem has not been accomplished until there is an institutionalized procedure to facilitate wide scale use by farmers.

Essential Components

Embodied in the key concepts above and throughout the four phases are certain essential components (Table 1). The essential components for each phase are:

1. Farmer participation and involvement in all phases.
2. Communication and feedback between farmers and researchers.
3. Effective, interdisciplinary team collaboration in planning and executing the process.
4. Careful selection, training and evaluation of all personnel--expatriate and nationals.
5. Institutions developed to serve farmers.
6. Monitoring and evaluation of all aspects and phases.

Involvement of the farmer is the first priority. The results of his actions must be measured. His explanation of his actions must also be obtained. Before his actions can be changed, his trust is essential. Farmer participation is essential in problem identification, in searching and assessing solutions and in implementing the solutions.

Farmer participation can not be obtained without effective communication. The evolvement of program goals and procedures for the host country requires careful planning but also effective communication. Training is a formalized transfer of ideas and skills through visual, written and manual procedures. Team collaboration requires effective communication and was listed as an essential component for interdisciplinary research.

Building an organizational capability for each phase of the program and linking the phases together is essential for a successful program. In some instances old organizations may be modified or new ones developed. Until the organizations are institutionalized, the transfer process is not complete.

Monitoring and evaluation begins at the formation of an interdisciplinary team. Team effectiveness, research accomplishments, training, and other administrative aspects should be monitored, evaluated for performance and continually improved. Field programs as research or implementation programs should be planned and evaluated according to written criteria. This emphasis on evaluation is to improve program effectiveness and not for the purpose of fault-finding.

Important Aspects

The research-development process described in this paper will seem familiar to many researchers. It involves the conceptual steps in most formalized research procedures in which the problem is defined, a solution is sought and the final product is evaluated. There are several important aspects in the process not included in present research programs. These important aspects are as follows:

1. Formalized problem identification;
2. Assessment of solutions at the user (farmer) level;

3. Project implementation including institutional building as a part of the research process;
4. A focus at the farm level with the farmers;
5. Research as a mode of operation throughout the process;
6. An interdisciplinary integrated research-development process;
7. As a development process it is continuous;
8. The process can be adapted to system problems other than irrigation.

SUMMARY AND RECOMMENDATIONS

An irrigated area that has significant potential for improvement of yields and water management is selected. An interdisciplinary research team quantitatively measures the variables that describe system operation such as water inputs and outputs, agronomic inputs and outputs, and costs and returns of various cropping systems. Institutional and social constraints, such as legal restrictions and organizational problems which restrict proper water use, are quantified. Priority problems are identified and ranked by their potential for improvement and the expected effectiveness of their solution.

A solution or set of solutions is identified. Assessment of the solution will be conducted under farmer conditions and evaluated to determine costs, benefits, institutional and resource needs for successful adoption. A strategy for institutional implementation of the solution will then be devised. For example, delivery channel improvements can involve capital or labor intensive approaches, be executed by agriculture or irrigation departments (or both), and involve service, development or research personnel. Knowledge of the benefits and costs of such a program are provided both to the farmer and government officials by the executing agency. Particular strategies for implementing each technology or set of technologies are devised as well as procedures which insure farmer acceptance.

The last emphasis is on assisting a particular organization to implement technology transfer with the farmers. Perhaps training of personnel must be provided. Specific materials for the organization and farmers may also be needed. A policy paper may be needed to influence public attitudes or to effect new laws and change old laws. The emphasis here is on insuring that technology which solves farm problems effectively <u>is</u> transfered.

This technology transfer process is recommended for application to irrigation systems in low or high income nations. The systematic, systems oriented, management improvement, interdisciplinary team approach can be applied effectively to the improvement of any complex agricultural system such as animal and dryland-cropping systems.

This framework also has relevance to the general field of rural development. In fact the authors' position is that the improvement of farm irrigation systems provides the cutting edge or lead innovations which can make rural development successful. Water management touches all facets of life and programs of improvement can become one of the vehicles for the transformation of village life.

This process is recommended as appropriate for use in improving other complex systems such as municipal transportation systems, educational systems, and even industrial and governmental research systems.

APPENDIX

PHASE I: PRIORITY PROBLEM IDENTIFICATION

The goal of problem identification is to understand the traditional farming system and to isolate the major constraints or inhibitors to increased agricultural production. This section describes the rationale, key concepts, and basic assumptions of the problem identification phase. Major benefits and the sequence of steps necessary for its implementation will also be discussed.

Rationale

There are several important reasons why attention must be given to problem identification in low income nations. These include the following:

1. Little is known about the content and structure of traditional farming systems.
2. A lack of accurate empirical farm-level data for planning and research.
3. The likelihood of lost opportunities in development due to piecemeal approaches and neglect of systematic problem identification.
4. The danger of treating problem symptoms rather than causes

Little is known about the dynamics of these traditional farming systems and their capabilities over many centuries to sustain life albeit often at a low subsistence level. While there are many reasons for lack of knowledge, two major ones are the highly advanced stage of agricultural modernization of high income nations and the highly specialized departments of land grant universities which serve agriculture. Other contributing factors are the lack of experience of staff members in agricultural universities with traditional systems and the absence of sufficient interdisciplinary training of students in agricultural development.

Problem identification at the farm level is necessary because of the lack of accurate empirical farm-level data. In the absence of such data, agricultural policies and programs are often implemented which place further constraints on production improvement by farmers.[1/]

Lack of success of many haphazard and piece-meal development programs in the 1960's, which neglected problem identification at the farm level, suggests another reason for its importance today. In the past there have often been pressures to continue solving problems even before the real problems have been identified. Therefore, solutions of "assumed problems" are often not acceptable or usable by the farmer-client system.

Another reason for problem identification is to reduce the danger of development programs that treat symptoms rather than the problems. For example, the desalination plant on the Colorado River treats the symptom, salinity, rather than its cause which is excessive application of irrigation water.

1/Mellor, John, "Developing Science and Technology Systems: Experiences and Lessons from Agriculture," Occasional Paper No. 63, Department of Agricultural Economics, Cornell University, May 1973.

Another example is the costly research and development program in Pakistan to control the twin menace of waterlogging and salinity.[2] Researchers[3,4] had assumed that farm conveyance efficiencies were 90 percent when in fact they were near 50 percent. For the previous decade, no study had been made of farm irrigation conveyance efficiencies until about 1972. As a result of the lack of farm-level problem identification, this false assumption guided the thinking of policy makers for years. In terms of lack of attention to the real problem, hundreds of millions of dollars were lost because of the neglect of a major problem. Low income nations cannot afford to allow this to happen because time itself is as scarce as foreign exchange.

Major Emphases

In addition to the key concepts and essential components of the entire research development process, there are several major emphases that are particularly important in the first phase of the process. These include use of a clinical approach, understanding of the farm system, integrated

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2/This does not mean that the SCARP Program did not greatly reduce waterlogging. It made a substantial contribution, but it was not realized that part of the problem was related to farmers' irrigation practices.

3/Clyma, W. and G. L. Corey. 1975. The Importance of Farm Water Management in Pakistan. Water Mgt. Tech. Rept. No. 38, Colorado State University, Fort Collins, CO.

4/World Bank. 1976. Pakistan Special Agriculture Sector Review, Volume III: Annex on Water Management, January 28. This report states that a 1 percent error in the efficiency of the system is equivalent to 1.4 MAF of water which in terms of the cost of Tarbela Dam in storage costs is equivalent to $1 billion.

operation of the system, and system constraints (see Table 1).

First, the clinical approach describes the way the farming system and the farmer-client are viewed. Richard Bradfield, former president of the International Congress of Soil Science, suggested that many agricultural and medical sciences are facing a problem with overspecialization often leading to the neglect of the total system or the total patient.5/ Bradfield called for more respectability for the applied researcher who, like the family doctor, listens to and understands his patient; and only after a careful and complete medical diagnosis, he provides the proper prescriptions or calls in a specialist.

Special focus is given to listening to the farmer-client, understanding his needs, and perceptions of major farm constraints. This procedure helps to build credibility with the farmer by increasing his awareness and interest in solving farm problems. The farmer's perceptions often provide useful insights into the nature of farm problems. Second, its purpose is to provide an understanding of the farming system. If development programs are to be successful, more understanding of how traditional farming systems work is necessary.6/ The

5/Bradfield, Richard. 1961. In International Congress of Soil Science, Transactions of the 7th International Congress of Soil Science, Madison, Wisconsin. Volume I, Official Communications, p. XXXII. (See Richard Bradfield's, "Opportunities of Soil Scientist in Freeing the World from Hunger," presidential address.)

6/Millikan, M. F. and D. Hapgood. 1967. No Easy Harvest: The Dilemma of Agriculture in Underdeveloped Countries. Little, Brown and Co., Boston, Preface and pp. 13-27.

farm irrigation system is viewed differently by engineers, agronomists, economists, hydrologists and sociologists.[7] For example, the engineer views the irrigation system as one for the collection, storage, distribution, and drainage of water. The agronomist views the system as one for the supply and control of water for plant growth. The economist, on the other hand, often views the system in terms of benefits and costs of alternative water uses. The hydrologist views the system as part of a broad environment which includes groundwater, surface water, precipitation, and the exchanges between each. The sociologist often thinks of systems primarily in terms of social processes and organizations for water distribution and control, and for conflict resolution.

These differing views demonstrate the point that no single discipline can expect to gain an adequate understanding of the farm irrigation system. Likewise, no individual can expect to have the necessary expertise to adequately describe the total system. Therefore, it is essential that members of various disciplines work together and learn to describe system operation including the different points of views. It is no easy task to view a problem from the viewpoints of all of the interests and parties involved. Consideration, however, of other viewpoints often leads to better solutions to problems.

The third concept that is important for problem identification is that of an integrated system operation where there

7/Chambers, Robert. 1975. Water Management and Paddy Production in the Dry Zone of Sri Lanka. Agrarian Research and Training Institute, Occasional Publication Series No. 8, Sri Lanka, January, pp. 6-7.

are complex and interdependent interactions between system components. Kellogg[8/] in his article on interactions in agricultural development has indicated that "Failure to grasp the vital principle of interaction of system components is the greatest present technical handicap to agricultural development in the newly developing countries." This principle of interaction must be kept in mind throughout the problem identification process. It not only relates to crop production but to the institutional and infrastructure requisites for agricultural modernization. For example, the tenure arrangements, credit and extension service, supplies of inputs, market incentives, and the farmer's knowledge and skills are important for agricultural progress. Therefore, a systematic approach is made in the problem identification phase to identify those system constraints which inhibit improvement in crop yields.

Basic Assumptions

The following assumptions are basic to problem identification:

1. The farmer is considered the basic building block of the irrigation system.
2. The farmer is rational in his decision making within the limits of his constraints.
3. The village social system places more emphasis on group decisions for some types of collective actions than on individual decisions.

8/Kellogg, Charles E. 1973. Interactions in Agricultural Development, Volume III, Agriculture, Science, Technology and Development Series, U.S. Superintendent of Documents, Washington.

4. Traditional farmers will respond positively to improved technologies which are technically sound, economically profitable, and culturally compatible.

Major Benefits

The major benefits of systematic problem identification prior to planning or executing a major research-development program are as follows:

1. Understanding the system as a system and the relationships of the system components.
2. Objective identification and ranking of major problems using specified criteria.
3. Provisions of empirical data for input in Phase II to Phase IV of the process.
4. Provision of sound benchmark data for use in evaluation of improvements on selected areas as experiments or in the Program Implementation, Phase IV, of the process.
5. Participation of the farmer-client in the process.
6. Designed approaches for building up farmer awareness and interest in problem identification to build credibility between the researcher and farmer.
7. Opportunity for training host country personnel.
8. Long run savings of time and resources while providing increased potential for success.

A major benefit derived from problem identification is the understanding of the system as a complex of many interdependent factors. Answers must be found for such questions as: What are the system boundaries? What is the system supposed to do? How well does it function? What are the critical components of the system and how do they interact? What components are not functioning adequately? Since the farmer is an important aspect of the system, information must be obtained about what he does, why he does it, and with what results.

A second benefit is the objective identification of major problems which inhibit increased crop production based on empirical field data. All problems cannot be included; therefore, it is necessary to focus upon significant crop production problems. Stated criteria are used for ranking problems in relationship to their importance in limiting crop production. Both quantitative and qualitative methods of ranking are used.

Other benefits include provision of empirical data for input into the solution phase, provision of data for use in evaluation of program(s), participation of the farmers, procedures for developing and maintaining credibility with farmers, opportunity to train host country personnel in interdisciplinary procedures for problem identification, and savings of time and other scarce resources.

In the short run there are always understandable pressures to move fast in research and development programs to provide results for anxious host country officials and donors. Time spent in problem identification is time saved in problem solution, as one researcher has suggested:[9/]

[9/]Adams, J. L. 1974. <u>Conceptional Blockbusting: A Guide to Better Ideas</u>. W. H. Freeman and Co., San Francisco, p. 14.

> Difficulty in isolating the problem is often due to the tendency to spend a minimum of effort on problem definition in order to get on to the important matter of solving it. Inadequately defining the problem is a tendency that is downright foolish on an important and extensive problem-solving task. A relatively small time spent in carefully isolating and defining the problem can be extremely valuable both in illuminating possible simple solutions and in ensuring that a great deal of effort is not spent only to find that the difficulty still exists--perhaps in greater magnitude.

In Pakistan, if adequate problem identification research had been done in the 1960's when many irrigation studies were made by international consultants, remedial measures could have been made earlier.[10/] Ten years of neglect probably has cost Pakistan resources equivalent to those required to construct several Tarbella Dams.

Sequence of Activities

As shown in Table 1 (p. 8), the major activities to implement problem identification studies are the following:

1. General overview of the system
2. Farm-level reconnaissance
3. Selected field investigations
4. Design and testing of survey instruments and methodologies for formal study
5. Implementation of formal investigation
6. Analyses, interpretation and explanation of findings for Phase II
7. Criteria for and selection of most significant problems for solution.

10/Clyma, W. and G. L. Corey. 1974. The Importance of Farm Water Management in Pakistan. Water Management Technical Report No. 38, Colorado State Univ., Fort Collins, Colo.

The idealized list above is not a hard and fast sequence of activities because some overlap with others. The process begins at the farm irrigation system and systematically generates information needed for problem solutions.

First, a general overview of the system can usually be obtained by a review of available records and literature from previous research and discussions with host-country officials. The relevant previous research should be put into a usable ready-reference form. As a result of the information gained, check lists of problem areas and additional questions to explore in further contacts should be maintained systematically.11/ Most often this is not done and valuable time is wasted.

Second, to supplement the general overview, a reconnaissance of on-farm systems should be made in selected areas where team members have an opportunity to observe the systems to be studied and to ask questions of farmers. Ample time should be provided for direct observation of physical problems and farmers' cropping practices. Check-lists of problems arising from direct observation and information gained from carefully selected key informants should be prepared. Gaps will appear in the information acquired; therefore, these gaps should be documented so that additional information can be obtained. Nonstructured interviews with individuals who know farmers and their problems are also essential at this stage.

11/Lowdermilk, M. K., W. Clyma, S. A. Bowers and W. D. Kemper. 1977. Planning and Implementing Procedures for Contracting Agricultural-Related Research Programs in Low Income Nations. Water Mgt. Tech. Rept. No. 46, Colorado State Univ., Fort Collins, CO.

These may include extension workers, storekeepers, local officials, and fertilizer agents.

Third, after team members have become acquainted with broad problem areas of the systems to be investigated, several sites should be chosen for more in-depth acquaintance with problem areas identified. For example, if waterlosses in conveyance channels are suspected to be substantial, spot measurement over a short period for several farm systems should be made. Other team members, such as the agronomist, or the rural sociologist might want to conduct mini-studies of system related problems to gain additional information. Initially, the problem areas should not be narrowly defined. Otherwise, major problems in the system may be excluded.

Mini-studies of selected sites are given low priority in most conventional research programs. They are necessary before beginning a large, costly, formal investigation to insure relevance to important problems. These initial mini-studies are a means of quickly sensitizing researchers to the problems of the farm environment. Equally important, they provide useful inputs for the design of the formal problem identification study.

Fourth, a preliminary design for data collection is developed and carefully pretested in the field for validity and reliability. The information gained and recorded systematically from available literature, officials, farmers, and the selective mini-investigations is used for the preliminary design of the formal problem identification study. After data collection procedures are carefully revised, detailed planning of the study takes place. This includes logistics, time frames, and the final orientation of all team members of their specific responsibilities in the formal problem identification survey.

Fifth, data are analyzed and relationships computed for statistical interpretation. The data are reported in a manner that defines significant problem areas for which solutions are sought. This requires specific ranking criteria.

Sixth, ranking criteria are developed for the selection of priority problems for solution in Phase II, Search for Problem Solutions.

If the goal is to improve agricultural production, then each problem or set of problems must be ranked in relationship to the estimated impact they have on crop yields and crop production. If welfare criteria are included, such as the concern for small farmers, each problem must be evaluated in terms of which class and how many of each class of farmers are the problems significant inhibitors of increased production. When other criteria are added, the ranking or weighting problems in relationship to significance is made much more complex.

PHASE II: SEARCH FOR PROBLEM SOLUTIONS

Problem identification determines the key problems which inhibit agricultural production. When a key problem has been defined, Phase II, which consists of searching for a solution, is initiated. In this section, the rationale of the procedure, major emphases, and the sequence of activities in searching for a solution will be discussed.

Rationale

Technologies for solving a wide range of irrigation problems are presently available; therefore, the major emphasis will be on the adaptation of known technologies to on-farm conditions. Taking known technology and applying it directly to the problem can save both time and money. Careful identification of priority problems and understanding system operation from Phase I enhance the capability of the technically competent, experienced team to provide direct solutions to the defined problems.

Applied, or problem-oriented research, is utilized to test or demonstrate the usefulness to farmers of a problem solution. The use of on-farm tests or demonstrations reduces the risk of the time lag and the uncertain transfer process from the experiment station to the farmer's field.

An applied research focus is needed today in both high and low income countries. Researchers' perceptions of their professional goals should include the goal of having their research results adopted by farmers. Researchers, therefore, should be evaluated more by their usefulness in helping farmers rather than by their "scientific" reports as suggested by Gardner[12/] and quoted from Dubos:[13/]

12/Gardner, W. R. 1972. Criteria for Determining the Aims and Directions of Research in Soil Physics and Technology. In D. Hillel (Ed.), Optimizing the Soil Physical Environment Toward Greater Crop Yields. Academic Press, N.Y., pp.1-9.

13/Dubos, R. 1970. Quality of Life: Earth Dependent. Agricultural Science Review, 8(1) (Editorial).

> .... academic scientists are becoming more and more oriented toward theoretical problems which, even when they are directly relevant to agriculture, are not likely to exert a significant effect on its course.

The on-farm focus of the researcher attempts a direct transfer of research knowledge to the farm. The technically qualified, experienced researcher attempts to use his knowledge for immediate, direct solutions to priority problems. This focus provides more rapid transfer mechanisms as well as an ideal setting for the training of research and extension personnel.

Another justification for solving problems on-farm is that contrary to high income country conditions, most transfer mechanisms for technology in low income countries involve interpersonal means. Thus, the farmer sees the technology being practiced or he obtains it directly from another knowledgeable, experienced person. Placing the technology on-farm where its benefits can be observed initiates the transfer process.

Major Emphases

Applied research is used to develop answers to specific problems. Such search and research efforts to find solutions may take the form of experiments, tests, or demonstrations. The emphasis is on finding solutions to real farm problems.

Farmer conditions are important to the search for a solution. Tests or demonstrations usually will be conducted under farmer conditions. This helps to assure not only the appropriate solution, but also to create farmer interest. This interest may lead to trial and adoption by the farmer.

Evaluative and adaptive research in the form of tests or demonstrations are used under farmer conditions to rapidly develop solutions. Evaluative research of farmer adopted solutions is used to understand better how farmers have adopted other technologies.

Sequence of Activities

Applied research in agriculture is traditionally the search for a solution to a defined problem. After the problem has been defined, the research team members utilize their knowledge and experience to search and select one or more known solutions which appear appropriate. The proposed solutions are evaluated based on the knowledge of the problem and on understanding of system operation by the team. The decision is then made to attempt a direct solution of the problem, evaluate the appropriateness of the solution(s) by testing or a demonstration, or initiate an applied research program to further refine the proposed solution(s).

Many attempts at technology transfer have failed in the past. The selection of proposed solutions to the defined problem is a critical process. An understanding of the farmer's perception of the problem is used to present the technology as the solution to <u>his</u> problem. The solution must produce highly visible results which the farmer can perceive. The resources necessary to adopt the solution must be available at a cost the farmer can pay. Institutional and complimentary services must be available as needed or be provided as a part of the solution. Social and cultural constraints are evaluated and provision for their solution arranged. For example, if the farmers must organize to effect a solution, methods and incentives are provided for their organization. The impact of the technology on cultural values and environmental conditions is also considered. With positive factors in favor of the technology, a solution to the problem is attempted.

The sequence of activities followed in the action research phase are illustrated in Figure 1. Using the criteria and sequence previously described a direct solution to the problem is attempted. The solution to the defined problem is presented directly to the farmer with sufficient resources and understanding for him to adopt or try the solution. For example, the problem of excessive or unnecessary operation of a government-owned tubewell to supply irrigation water is identified. The government offers to make a bonus allotment against water taxes if specific farmers request that the tubewell be stopped when not needed. After an announcement of the policy, wastage of water by unneeded operation of the tubewell is reduced by 90 percent. Other direct solutions of identified problems are equally likely.

When some aspect of the solution is insufficiently understood, then a test or demonstration under farmer conditions is attempted. For example, a demonstration of improved agronomic practices or a test of some improved water control structure may be necessary. Both solutions would be tested, however, under farmer conditions. The farmer's interest and

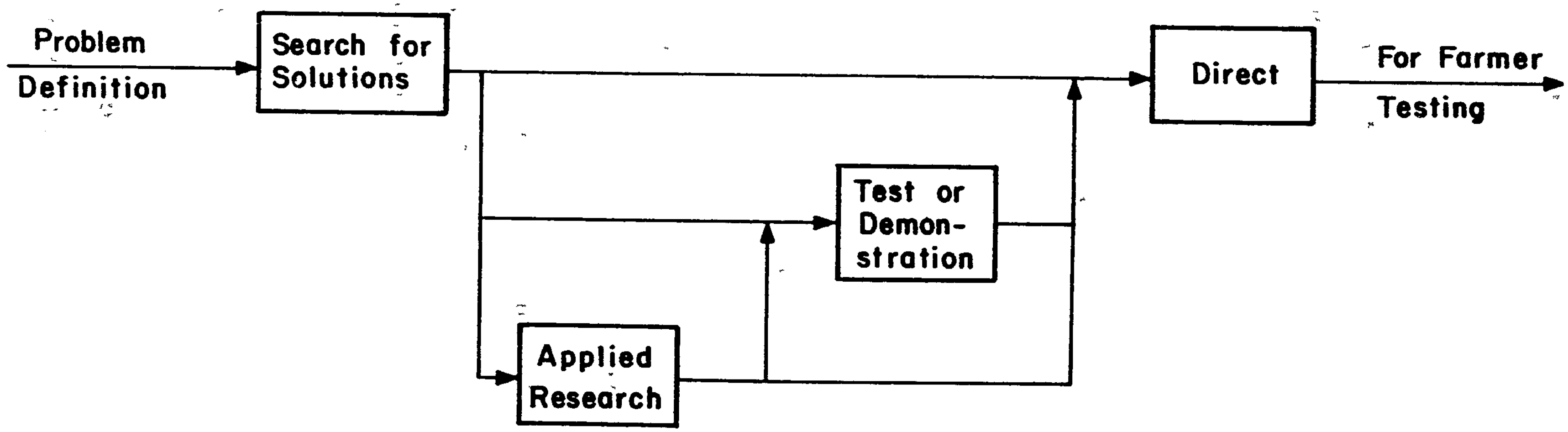

Figure 1. Sequences for searching for a solution to a defined problem.

willingness to try the solution himself may be a direct result of the research.

When the problem or solution is more complex or presents a high risk to the farmer, an applied research program at an experiment station is initiated. The solutions developed from the applied research will be presented directly to the farmer if feasible (Figure 1). If additional refinement of the innovation is needed, a demonstration or an on-farm test can be made. Given the time and resources involved in experiment station research, only complex, high priority problems will be taken to research stations. The transfer of the research results back on-farm as soon as they are available should assure the usefulness of the research.

Solutions presented to the farmer for further trial and adoption initiates Phase III. Assessment of these solutions provides the basis for selecting the technologies for adoption on a wide scale in program implementation.

PHASE III: ASSESSMENT OF SOLUTIONS

The purpose of a formal assessment of technologies derived from Phase II is to assure that the innovations are both acceptable and useful for the selected classes of farmers. It is not sufficient to assume that innovations will have either equal or only positive consequences for farmer clients, for society, and for the environment. Nor is it sufficient to assume that, because farmers need new technologies, their impacts are not important. Structured, evaluative research procedures are used for assessment purposes. These evaluations are used to identify ways the technical packages can be improved to help farmers increase their levels of production to benefit their families and society.

Rationale

Technologies should be carefully evaluated for the following reasons:

1. To provide insight into how the innovations or transfer mechanisms can be improved for wider and more rapid diffusion among farmers.
2. To determine the technical, economic, and cultural feasibility of the technologies for various classes of farmers.
3. To estimate the socio-economic and environmental impacts or consequences of the new technologies.
4. To determine institutional requirements for facilitating diffusion of the innovations (Phase IV).

As problems of unsuccessful adoption are identified, feedback from the farmer is essential for refinement of the technology. It is important for researchers to examine the complexity of each practice in terms of the special skills and knowledge required by the clients. Likewise, the congruence of the innovations with the practice they replace is important. Economic feasibility in terms of relative advantage over present practices, other innovations, and divisibility are also important. For example, unless the relative economic advantage is 40 to 50 percent or greater, farmers will seldom perceive sufficient potential gain. Peasant farmers use a heavy discount factor and perceive a less potential profit than researchers.[14/]

Divisibility of innovations is an important consideration. Indivisible technologies usually can be acquired only by large farmers or collectives of farmers. Many of the water management improvements are indivisible public goods such as irrigation conveyance systems, large tubewells, and lift pumps. Since much more is known about the adoption behaviors of individual farmers than that of groups, the processes involved require careful evaluation.

Compatibility of new technology with existing values or past experience must be examined. This often reveals inhibitors to change. For example, in some countries certain types of farm work and certain crops are cultivated only by certain social classes. In several irrigated regions of the world, for instance, farmers refuse to irrigate at night.[15/] Researchers and change agents have given little attention to evaluation of the impact of new technologies in the past.[16/] This is probably because the common assumption has been that new technologies have only positive effects. In recent years, however, it is evident that there are differential impacts on various groups of people however "good" the technology. Even the Green Revolution helped to create socio-economic dualism

14/See Whorton, Clifton R. 1968. Risk, Uncertainty and the Subsistent Farmer. Agricultural Development Council, New York.

15/See Rogers, Everett M. and F. Floyd Shoemaker. 1972. Communication of Innovations: A Cross Cultural Approach, The Free Press, New York. pp. 145-148.

16/Rogers and Shoemaker, op. cit., p. 319.

in many agricultural sectors. Many improved irrigation practices have positive impacts on the environment such as the reduction of salinity, waterlogging, nitrate leaching, and the incidence of malaria. In contrast, some irrigation practices, such as overirrigation, result in serious degradation of the environment.

It is necessary to document the institutional and infrastructure needed to support the diffusion of new technologies. However feasible or valuable an innovation, if credit facilities, intensive extension services, or other required inputs are not available, farmers cannot make use of the practice. The evaluation of the adoption behaviors of farmers must include an examination of institutional services required. This provides input to plan the implementation of the pilot project. Also, both institutional and individual problems in successful adoption of the new technology provide input useful in the formal training program to prepare field staff for the pilot program implementation phase.

Major Emphases

Special attention in this phase is given to client involvement with two-way communication. The purpose is to carefully assess how farmers utilize new technologies. Focus, then, is on the assessment of both individual and group adoption behavior of farmers. Two-way communication is necessary to gain feedback from farmers about how the technologies can be improved for wider diffusion. Communication is also important because the adoption-decision process can be best understood as a communication model. The process is conceptualized by some as involving awareness, interest, trial, evaluation and adoption stages on the part of the farmers.[17/] Under certain conditions, farmers often skip one or more stages. The adoption-decision process can also be viewed as one involving farmer knowledge, farmer persuasion, farmer decision, and farmer confirmation. Whatever the mental process, good communication between researchers and farmer clients is necessary to effectively evaluate the technologies introduced.

Other important emphases are as follows:

1. Farmer acceptance is the most important criterion for technological assessment. Research efforts are not judged as successful until farmers have accepted the technology in large numbers. The researcher, therefore, is responsible for transfer of innovations to the farmer. In this process, the researcher learns ways to refine and improve the technology. This is similar to the concept in industry where the researcher is linked closely with development. As in industry, the demand for the innovation by customers is a solid test of worth. In our philosophy, the value of the problem solutions are judged by the acceptability of the technology by farmers.

2. Evaluative research is used to assess the technologies developed. Special criteria or standards are

17/Rogers and Shoemaker, op. cit. pp. 100-104.

used for these evaluations. For example, one criterion might be the degree of acceptance of an innovation by a particular class of farmers.

3. Transfer vehicles are the ways technologies are transferred from the source to the end-receiver. The source is the individual or institution that originates the innovation or message and a transfer vehicle is the means by which the message reaches the receiver.
4. Institutional linkages. Adequate intrastructure from government and private businesses is essential to provide farmers with incentives to adopt and utilize new technologies. Often this will require new organizations and/or improved coordination and integration of existing organizations.
5. Diffusion requirements define the resources and conditions necessary for widespread adoption of innovations. These requirements may relate to the divisibility, relative advantage, compatibility, complexity, congruence, trialability, or visibility of the innovation. Other requirements could include price policy, market facilities, credit availability, extension services, fertilizer agencies or other institutional inputs.

Suggested criteria for evaluation of technology are standards which are often country-specific because they are usually related to policy decisions derived through the political process. The following criteria, therefore, are only illustrative and make the value judgment that special concern is given to the small farmer.

1. Visibility of Innovations[18/]

   a) Highly visible benefits.

   b) Trial and adoption can be done easily and immediately.

   c) All classes of farmers can be benefited.

   d) Communication to other farmers can be done easily.

2. Economic Advantage

   a) Substantial relative economic benefits over other practices.

   b) Initial investment within farmer resources.

   c) If indivisible and a collective good, farmers will cooperate to secure the innovation.

   d) Sufficient incentives such as markets and price policy to maintain economic advantage.

   e) Sufficient assurance that economic benefits will not be captured by only large landlords.

3. Technical Aspects

   a) Level of complexity of adopting the technology not too great for clients.

   b) Congruence with innovations replaced and the complementarity with other innovations in a package.

   c) Trialability of the innovation.

18/Little research has been done related to "lead innovations." However, experience shows that the initial innovations should immediately create creditability with the adopter group.

4. Requisite Infrastructure for Widespread Adoption

   a) Institutional government services.

      1) Continuing research capacity.

      2) Sufficient farm level advisory services.

      3) Sufficient mass media and information services.

      4) Credit and market facilities.

      5) Price incentives or other incentives.

      6) High level government support.

   b) Agro-business supplies and services.

      1) Necessary inputs.

      2) Credit facilities.

      3) Repair and replacement facilities.

      4) Incentives for private businesses.

5. Social and Environmental Impact Estimates[19/]

   a) Related to land, water and health.

   b) Related to authority, tradition, cohesion and conflict.

   c) Equity of benefits.

   d) Cumulative impacts of scale.

   e) Reversibility of impacts.

6. Cultural Compatibility

   a) Present value system.

   b) Past experience.

19/For specific approaches to social impact assessment see: Freeman, D. M. 1974. Technology and Society--Issues in Assessment, Conflict and Chance, Rand McNally, Chicago, pp. 67-142. Also: Hetnon, F. 1973. Society and the Assessment of Technology. OECD, Paris.

c) Felt needs or perceived needs.

d) Division of labor.

This list of criteria above reflects the importance of a careful evaluation of technologies which are to be introduced on a large scale.

Sequence of Activities

Assessment is a continuous process that begins when various technical solutions to problems are first considered. The researchers have been sensitized to local needs and resources from their team effort in problem identification studies. While there is no required sequence for assessment activities, the following is an idealized approach.

1. Team members collaborate to discuss the technical solutions to be put on trial.
2. At the time of trial and demonstration, team members are open to farmer feedback.
3. Team members formally select a panel of key informants for a review of innovations to be introduced.
4. Adoption-diffusion studies are made over time with a carefully selected sample of farmers.
5. A formal assessment is made of institutional and resource-supply capabilities and needs.
6. Benchmark studies of some sites surveyed in the problem identification study to ascertain the impact of the technologies introduced.

Selection of the Program

To find solutions for problems and make assessments of their impacts does not constitute a development program. Careful selection of a package of complimentary practices that produce highly visible results and which have been successfully adopted during solution selection research is essential. This package of practices should be presented to an organization of farmers in a manner similar to an anticipated development program. This process will be used to evolve the final package of practices, the personnel needed for such a program, the resources which will need to be supplied for a successful program, demonstratably prove that the program is viable, and further data on the costs and benefits of such a program.

Selection of the final package of practices to insure adoption requires the evolvement of a compromise between complexity of the new technology and resource support. Literature to assist in adoption, training requirements of personnel who will assist the farmer, number of personnel required, and modifications of the technologies for final adoption should be considered. The concept is that this is a research phase of a pilot development program where program requirements are evolved by trial on an experimental basis. An evaluation of resource needs would include factors such as credit, subsidy, transportation, marketing, related production services (seed, fertilizer, equipment, etc.), and institutional requirements. Institutional facilities are most important because they provide the means by which the problem solutions are delivered to farmers. An hypothesis is that more programs fail through institutional difficiencies than because of basic inappropriate technology.[20/] Fertilizer, for example, is an appropriate technology, but research has shown that lack of adequate delivery systems (convenient outlets) and easily available credit, both frequently supplied by government institutions, are primary factors in low fertilizer use.[21/]

An experimental program, when adopted successfully by farmers, provides a sound basis for planning the program and for making the necessary institutional changes. Documented benefits and costs also expedite approval of the program by host country bureaucracies not familiar with the technologies. It may also provide the means for foreign donor loan documentation for host country generated and planned programs while approving donor generated programs when only an idea. With demonstrated success, farmers and government officials can plan the program to be executed in the next phase as a pilot development program.

PHASE IV: PROGRAM IMPLEMENTATION

The three previous phases have resulted in the development of a package of technologies which solve priority problems of farmers. The primary goal of Phase IV is to present this package to farmers by implementation of the program. Adoption results in agricultural development with increased food

20/ Whyte, William Foote. 1975. Organization for Agricultural Development. Transaction Books, New Brunswick, New Jersey, p. 38.

21/ Lowdermilk, M. K. 1972. Diffusion of Dwarf Wheat Production Technology in Pakistan's Punjab. Ph.D. Dissertation, Cornell University Library, Ithaca, N.Y.

production and improved living conditions. Since every country has an institution with the responsibility of assisting farmers to improve agriculture, an important emphasis in this phase is on developing an institutionalized system for effective assistance to the farmer. Providing training to personnel who will administer and execute the program is another major emphasis.

Rationale

Problems can be defined, solutions developed, and their value assessed. Without organizations with institutionalized procedures for implementing new technologies little progress can be realized.[22/] Thus, a major focus must be on the development of institutionalized transfer mechanisms that deliver knowledge, resources, and technical assistance to farmers.

Careful linking of the organization that delivers the technology to the organization that develops the technology has many advantages. Both training of personnel for effective on-farm delivery and feedback from the implementing phase to the solution development phase can be facilitated. The gap between known technology and implementation of the technology hopefully can be reduced or eliminated. The success of Phase IV in providing solutions to problems that inhibit the production of farmers is the final criterion for measuring the success of the technology transfer process.

22/For a more in-depth consideration of the problems of program implementation see: Montgomery, J. D. 1974. Technology and Civil Life--Making and Implementing Development Decisions. MIT Press, Cambridge.

Major Emphases

The major focus in the implementation phase is still on the farmer client. Management orientation, management improvement, emphasis on planning, and program execution are essential. There is the necessity for protective research to maintain both the institution and the improved on-farm system. Team planning for program execution is still essential in order to address problems in a systems context. Strategies and procedures for executing the program are discussed in the next section.

Sequence and Activities for Implementation

The technologies developed in Phase II were solutions to priority problems in Phase I. In Phase III they were evaluated under farm conditions as solutions to farmer problems. This package of technologies is now available for adoption by farmers on an operational basis.

A program for implementation is planned and executed in Phase IV where the necessary organization is developed, the personnel trained, resources made available, and the organization tested while implementing the package of technologies with farmers. The focus is still on solving farmer problems, but the emphasis is on building an institutionalized capability to deliver the solutions to farmers and have them adopted.

The evolvement of organizations to execute the program is critical to the success of the program. There are three basic strategies for providing organizations and each has both advantages and disadvantages.

1. Working through existing organizations.
2. Reforming existing organizations.
3. Setting up new organizations.

Existing organizations have a power base and method of operation in the system. Negative effects are generated when the function of an existing organization is eliminated or transferred. In an existing organization old loyalties and obligations may preclude acceptance and successful operation of the program. If an existing organization is used, training must be provided to assure acceptance and capability to execute the program.

The second approach is to redefine the programs and institutionalized structures of an existing organization. Providing a period of training is equally important in this approach. The problem identification and problem solution phases may be used to provide such training.

The last alternative, that of establishing a new organization, may also generate jealousies or may be staffed with people from an existing organization. Provision of the needed skills and attitudes must again be assured. A successful solution to the problem of institution building is to attempt to arrange a program that will result in significant benefits to the personnel in the organization. Personnel involved in the problem identification phase or the problem solution phase will usually have definite vested interests in the success of the program.

Training

Personnel from the highest administrator to the lowest field member of the organization should receive orientation and training. The importance of the administrator in perceiving the problems and understanding the importance of implementing the proper solutions cannot be overemphasized. The attitudes and commitment of higher level personnel in the organization will have significant influence on the performance of the field staff. Thus, it is imperative that field personnel feel their efforts are appreciated.

Training must be focused on the field staff where the acquisition of skills and personal attitudes are needed. Technically competent personnel are necessary to inspire confidence in themselves and their institution as well as to develop trust from the farmer by doing an effective job. A knowledge of how to communicate and work effectively with farmers is as necessary as technical skills. Trainees should be shown how to perform a skill and given assistance in acquiring the skill. Then the trainee should be given an opportunity to demonstrate the skill. Many potentially successful solutions to problems fail because the implementing organization is not technically competent to implement the solution. Thus, in Pakistan where government land leveling services have been in existence for about 20 years, farmers on a large scale still reject the program. The major reason for rejection is that field conditions after leveling are frequently worse than before leveling. However, the initial

<u>concept</u> of providing land leveling assistance to farmers was a viable and important concept. The organization providing the implementation, however, did not utilize properly trained personnel nor select the appropriate technology. The program by most criteria is a failure.[23/]

Training content must be oriented to the execution of a field program. Successful execution of a field program can provide tests of adequate training. If field programs are not available, a research program, involving Phase III, must be the basis for training program content. If only general principles are covered without a focus on the execution of a field program, the person will not be capable of executing particular high priority programs. All the problems can not be solved. Neither can all the solutions be implemented by personnel from a training program. If the particular activities have not been identified, then selecting the activities, training personnel to implement them, and evaluating the benefits through research seems to be an appropriate approach.

Another important aspect of the institution-building process is to provide visible incentives for excellent work and a system of censure for poor work. Incentives might be in the form of increases in pay or promotions. (Also, the ultimate reward for poor work is the discharge of the person from the organization.) Such criteria should apply to both expatriates and nationals involved in the program.

23/Land leveling was done with catepillars using front blades and no surveying; therefore fields were seldom level.

One objective in training is to help personnel internalize concepts such as high standards of professionalism and professional commitment to farm clients. Special attention must be given to the importance of personal integrity in such activities as collection of data, reporting of data, and implementation of activities. Also, personality conflicts must be minimized with personnel encouraged to develop an interpersonal trust in order to insure a proper team effort. The attitude that service to the farmer is the highest priority of the program should be encouraged. Guidelines for all personnel should be provided to insure that the farmer develops trust in the personnel and the organization.

Program Execution

The organization-building program must have a balance between providing for adequate training to execute the field program and building a proper institutional framework for the orderly development and operation of the program. There must be a provision for orderly development of the organization, including operational training of personnel. Personnel must be allowed time to adjust attitudes and develop a belief in the program.

There also must be flexibility in the operation and administration of the program in order to insure a properly functioning structure. For example, personnel involved in problem identification and problem solution phases may be utilized effectively to develop a monitoring and evaluation section within the organization. This evaluation unit could identify problems and recommend solutions as the program develops. Such a functional group may be known as a program planning group, a research and evaluation group, or by other appropriate titles. The evaluation section's function, however, is to review field programs and ascertain benefits which accrue from program impacts. Special care must be exercised in the selection of personnel involved in evaluation in order to avoid personality problems between evaluators and administrators.

Outside evaluation teams especially directed at organization and administration may improve the functioning of the program. Independent technical evaluation of the pilot program benefits is necessary before converting the pilot program into a national program.

As the pilot program becomes functional, planning should be initiated for a full-scale implementation program. Caution must be exercised to insure that the program does not grow faster than the availability of fully-trained personnel or the program will fail, not because of its appropriateness, but because of institutional factors. Organization building at best is a slow process, and it is always advisable to proceed with care.

The final test of success for any agricultural organization is the degree of both the quantity and quality of services made available to farmer clients which solve farm problems. While the farmer is willing to invest his resources in and accept the benefits of the program, there are benefits from the program. If farmers are not helped, then the institution becomes a nonfunctioning bureaucracy which can be of continuing detriment to the country.