Developing Irrigated Agriculture: A Socio-Technical Approach

Water Management Synthesis II
Project Report

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In the Beginning....

The generally poor performance of Third World irrigation and the accompanying low performance of its irrigated agriculture, underlie the current emphasis by donors, lending agencies and host governments on improving irrigation water management. This phenomenon is not new; the United States Agency for International Development (USAID) has long been concerned with this low performance as well as efforts to achieve better allocation, distribution and use of irrigation water resources at the field level. These efforts began in the 1960s as part of the Agency's assistance program to Turkey. This thrust was continued in the 1970s with expanded efforts in Pakistan and Egypt which included field studies aimed at gathering information and gaining an understanding of the management aspects of irrigation design, development, and operation. However, while helpful to the direct recepients, these early projects lacked a way to capture what was learned and to put it in a form that could be disseminated, adapted and used in similar situations in other countries.

Water Management Synthesis Project

The Water Management Synthesis Projects (WMSI and WMSII) were conceived to help remedy this shortcoming by reviewing and analyzing USAID's earlier efforts as well as those of other donor organizations, to synthesize these findings and what has been learned, and to make these findings available to both the Agency and others working in irrigation water management.

During the early years, the main focus was on developing and conducting field-based training courses for irrigation professionals and the dissemination of the collected information. While interdisciplinary training programs were conducted in both India and Sri Lanka under WMSI (1978-83), which was implemented by Colorado State and Utah State Universities, only minor attention was given to technical assistance. This, however, became a major component under WMSII (1982-88), which included assisting USAID missions and host countries with project design and evaluation, irrigation sector analysis, action research, field studies and the assessment of training needs. Cornell University joined with Colorado State and Utah State to take lead responsibility for implementation during this followup phase. This phase also continued the earlier emphasis on the synthesis of knowledge and its dissemination, including workshops and conferences.

The United States Agency for International Development

USAID administers the U.S. Government's foreign assistance program, which focuses on helping people in developing countries acquire the knowledge and resources to build the social, economic and political institutions necessary for a better life. USAID believes that the way to combat poverty is to encourage change in policies that are detrimental to economic development, to support the development of institutions (schools, colleges, ministries) that contribute to economic development, and to transfer appropriate technology, necessary to bring this about.

Increased food production and a higher standard of living has been the goal of the Water Management Synthesis projects .

WMSII represents USAID's first attempt to combine the resources of separate offices within the Agency to fund and manage an assistance project. WMSII has not only fostered collaboration and cooperation among the AID missions, the geographic bureaus, and the Bureau of Science and Technology, but it also has been effective in accessing the best technical expertise in irrigation/water management and making this expertise available to the Agency's irrigation program.

To date, the combined effort has begun to substantially affect the Agency's irrigation development strategies. It has also led to better coordination and to focused reviews of project papers to better overall project design and to formulate a more consistant and effective overall program in the irrigated sector.

The Consortium for International Development

The Consortium for International Development (CID), which was selected to implement the Water Management Synthesis II Project, is a nonprofit organization of 10 western universities. Utah State and Colorado State, along with Cornell University, jointly led the Water Management Synthesis II Project. Cornell University is not a member of CID, but because of its expertise in irrigation development, cooperated with CID in this project.

The Water Management Synthesis II Approach

"By the completion of WMSII (1988), interdisciplinary analysis of irrigation projects in developing countries had become the rule rather than the exception.... International donor agencies and specialized international institutions had adopted, or were moving toward, interdisciplinary approaches to irrigation."

These conclusions were drawn by the external WMSII review and assessment team in the draft of their executive summary. This was not the situation that existed in October 1982 when the project began.

"To develop and disseminate more efficient water management technologies and practices to increase agricultural production and rural equity" has been the objective of WMSII. To accomplish this objective, irrigation issues must be dealt with as an interrelated set of socio-technical issues. To do this effectively, **the approach of WMSII has been to rely on the use of joint interdisciplinary teams which concentrate their effort at the field level.** Joint teams of expatriate and host country professionals were initially required if both the interdisciplinary process and the local institutional issues were to be understood. An emphasis on field-level investigations is needed if the site-specific nature of the socio-technical issues is to be understood. In countries where WMSII has worked over a period of time, effective interdisciplinary teams can now be comprised of host country professionals.

With the WMSII approach in mind, the project was designed to assist host country and mission professionals to improve irrigated agriculture. This design was based on the need for farmer participation, joint interdisciplinary teams and inter-organizational cooperation. In keeping with this approach, WMSII personnel have tried to strengthen the institutions in developing countries that plan, design, operate, maintain and evaluate irrigation systems. The WMSII program of technical assistance, training, technology transfer, and special studies has synthesized irrigation experiences and applied them in specific settings to make a major impact on irrigated agriculture throughout the developing world.

In Pursuit of Professional Development

WMSII was established in recognition of the need for developing a solid core of well-trained, in-country technicians and professionals to handle various interdisciplinary aspects of irrigated agriculture. These professionals are needed to rehabilitate older systems, to construct new systems without repeating past errors, and to manage all systems efficiently and fairly. To do this required involving the client-farmer, understanding the agricultural system through an interdisciplinary team, and formulating organizational arrangements that enhance irrigation development.

Farmer Involvement

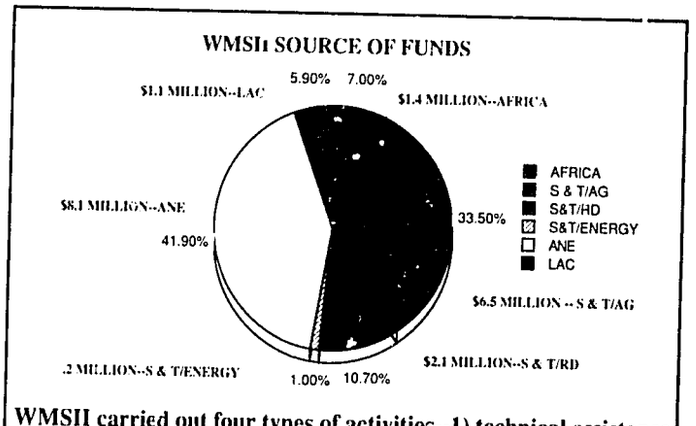
Irrigation projects in developing countries often have provided the farmer with the physical structures of an irrigation system without developing an accompanying information network or other social and organizational tools. The lack of communication and organization has contributed significantly to the poor management of many irrigation systems. Farmers, not irrigation agencies, are the producers of agricultural products. Therefore, farmers must be viewed as an integral part of successful irrigation systems.

Joint Interdisciplinary Teams

WMSII personnel view an irrigation system as comprising many parts -- each person may only see part of the whole according to his discipline; yet, working together the team members can construct a more complete understanding of the irrigation system, and its problems and solutions. By having a team composed of WMSII and host country professionals, the team can have good access to site-specific information and a working set of general concepts for analyzing irrigation systems. Both are required if the constraints and potential of a particular irrigation system are to be understood. Using their combined knowledge, the team can create a program that successfully serves the needs of government and the farmers.

Interagency Cooperation

In most countries several agencies are involved with irrigated agriculture -- an irrigation department, an agriculture department, and a planning and development department, for example. Improved management of irrigated agriculture will involve new approaches to organizational coordination.



WMSII carried out four types of activities--1) technical assistance in irrigation for mission and host country professionals; 2) training and technology transfer for various levels of host country personnel involved with irrigation from senior officials to farmers; 3) special studies, especially action research, for improvement of water management; and 4) administration and support provided the facilities, equipment, and personnel to carry out the variety of WMSII activities.

Synthesis: A Process and a Product

The goal of providing the means to increase agricultural production and rural equity through improved water management has posed an exciting challenge for the Water Management Synthesis Project. This goal was accomplished by emphasizing a "synthesis" effort. Synthesis can be viewed as both a process and a product which results from the synthesis process.

Synthesis as a Process

A great deal of the synthesis effort in the Project was aimed at developing effective ways of analyzing irrigation systems in terms of the socio-technical issues involved. The synthesis process requires us to understand the elements and how they can be combined for the most effective contribution to agricultural production and rural equity. The emphasis on the synthesis process is necessary because each irrigation system has unique social and technical characteristics. Therefore, the identifcation of operational solutions to problems must be site specific. This can be done most effectively if there is a well understood method for identifying problems and solutions. In order to explain such a method, some of the selected examples of WMSII work in the remainder of this Report deal with the synthesis process.

Synthesis as a Product

As the result of WMSII work involving the synthesis process, we've been able to develop synthesis products in the form of sets of interrelated concepts. These concepts can be used to help frame an effective analysis of a system by providing a means of organizing relevant facts, understanding what is taking place and predicting what will happen if changes are made in the system. The sets of concepts needed by a particular decision maker will depend on the needs of that decision maker. The situation is further complicated by the fact that as we continue to learn more about irrigated agriculture, we will need to update and modify the concepts. An effective working set of concepts must therefore be viewed as evolving over time. It is within this framework that project activities have provided the basic ingredients for another type of product that helped bring about changes in host countries' irrigation policies and their irrigation programs for training, research and development. The growing cadre of capable water management professionals is particularly noticeable in the Asian countries where WMSII personnel have been most heavily involved -- India, Sri Lanka, Pakistan, Nepal, Thailand, Bangladesh, and Indonesia. Building institutions in these countries has also been a major focus of WMSII activity.

With its programs in technical assistance, training, special studies and technology transfer, WMSII offers developing country governments an approach to involving farmers in management decision making and to better communicate and work with farmers.

The Project has provided technical assistance to USAID missions, developing countries, and regional institutions to help design water management projects, monitor and evaluate those projects, develop training programs, and consult on problems identified by the missions. Training and other technology transfer activities have been used extensively to build host country capability in water management. Special studies have given priority to research for particular topics in irrigated agriculture that will have practical benefits to a country or region's efforts to improve water management.

This WMSII team in Thailand is measuring conveyance losses in the channel by using a current meter. These losses will be examined not only technically, but also from the socio-economic aspects to see what the larger problems are and how they may best be solved. This will require synthesis as a process.

Synthesis: A Conceptual Framework

Accomplishments of WMSII might best be stated here as a set of working conclusions which are based on the numerous studies conducted by WMSII personnel.

Farmer Participation

WMSII work demonstrates the importance of meaningful farmer participation in the operation and management of irrigation schemes if those schemes are to be sustainable over the long term. Effective farmer participation depends upon the nature of the scheme and the characteristics of the society Farmer participation can often contribute to better design. On large irrigation schemes farmed by small holders, some formal mechanism for farmer participation is imperative for sustained, effective irrigation. Few, if any, irrigation agencies can sustain central control over a large number of farm turnouts delivering water to a large number of farmers.

Small-Scale Irrigation

WMSII has helped demonstrate the importance of small-scale, locally-managed, irrigation works to the overall irrigation sector of many countries. The project also has identified some of the major constraints to achieving better public policies and agency programs for small-scale irrigation development. These constraints show the need for investment policies that induce mobilization of local resources, better technical design procedures and agency arrangements to improve farmer-agency interactions. Many of the findings regarding small-scale irrigation also apply to the small hydraulic sub-units of large-scale systems.

Organizational and Hydraulic Interfaces

If irrigation schemes are small, there may be only a single level of organizational and hydraulic structure. However, even relatively small irrigation schemes may have organizational and hydraulic hierarchies. In such cases, the interfaces within these hierarchies need to be dealt with effectively. On many schemes there is a point where control of water shifts from an irrigation agency to a farmer organization. It is important to develop explicit rules for points where the authority for water control is transferred and the organizational and hydraulic spans of control need to coincide.

Main System Management

WMSII work has found that most main systems work in a way different from the way they were designed; a manager's expectations may also differ from reality. The first step in dealing with these kinds of problems is to design and operate a monitoring system that will give reliable information on the behavior of the main system. The second step is to develop a model, calibrate it to the particular system, and use it to forecast the hydraulic results of alternative ways of managing the system. The managers can then begin to use the main system more effectively in ways which make a productive and sustained irrigated agriculture feasible. WMSII has developed the first generation of such main system management models. These efforts permit us to see the potential for the continued improvement such models make possible.

Identifying Constraints and Opportunities

Identifying constraints and opportunities for irrigated agriculture is best accomplished by an interdisciplinary team working at the field level. A well-defined set of concepts specifying a synthesis process for analyzing irrigation systems has been formalized in a WMSII program called diagnostic analysis (DA). DA is an interdisciplinary field study of irrigation systems to understand the performance of irrigated agriculture and identify the constraints and opportunities for improved performance. DA workshops have been used extensively under WMSII to identify constraints and opportunities of existing irrigation systems. The results of these workshops have been demonstrated repeatedly: experience has been used as a basis for developing operational plans for the improved performance of the systems. An integral part of the DA Worskhops has also been the use of a host country counterpart team.

Farmers need to be involved in all phases of the development process in irrigated agriculture.

Ramchand Oad, a CSU professor, works with a Bangladesh irrigation professional to check field channel flow during a DA Workshop.

While less structured than DA, the same general principles have been applied in developing USAID project identification documents and project papers, in the joint field studies in Africa and in rapid appraisals. The basic approach involves the use of an interdisciplinary team working at the field level to understand the problems constraining improved performance. In most cases, the team was a joint team comprised of both WMSII and host country professionals. Training has been an integral part of such efforts. While the effectiveness of this approach has been demonstrated repeatedly, experience has also demonstrated the importance of adapting each effort to the particular system being investigated and the characteristics of the host country personnel involved in the effort.

Education, Training for Effective Irrigated Agriculture

An education and training program designed to promote a more effective irrigated agriculture should involve at least three groups of clients: a) *irrigation professionals* from both technical and socio-economic disciplines, b) *farmers* from irrigation schemes, and c) *senior officials* who either make or react to policies which influence irrigated agriculture.

Senior officials need appropriate training and education related to irrigated agriculture so that they can understand and advocate changes that may not be fully accepted with middle-level managers in irrigation or related agencies. For example, a meaningful farmer participation program often needs support from high officials if the grassroots efforts by farmers are to be effective. Farmers need to gain a better understanding of on-farm water use, how irrigation schemes work, and how the actions of an individual farmer can influence the well being of all farmers on the irrigation scheme. Irrigation professionals also need to be well-trained within their discipline. Irrigation professionals need to understand the range of socio-technical issues that are relevant for irrigated agriculture. Therefore, irrigation professionals also need the experience of working within an interdisciplinary setting at the field level if they are to help their country develop and maintain an effective irrigated agriculture.

Management and Coordination

Irrigation schemes need to be managed separately, but they also need to be managed as part of a country's program for agricultural development. The success of a program for irrigated agriculture in a country depends on establishing good working relationships among different organizations and officials. A good deal of coordination among organizations and officials is required if such a program is to be effective. For this coordination to occur, the organizations and officials must reach at least a working compromise on the specific objectives for an irrigation system. Once this agreement is accomplished, the effectiveness of individual activities must be evaluated in terms of their contribution toward accomplishing this agreed-upon objective.

While many early WMSII activities incorporated an implicit recognition of the importance of management and coordination, only later were WMSII activities in Pakistan and India specifically designed to deal with management and coordination. These activities integrated the use of general management principles by involving management professionals as members of WMSII interdisciplinary teams. While the WMSII experience is limited, the potential for improvement in management and coordination to contribute to increased agricultural productivity and rural equity seems to be considerable.

Note: Ideas and criticisms provided by host country professionals and officials have been particularly valuable. The advice and counsel of USAID officials in identifying problems and feasible solutions have also been helpful. In addition, many development professionals who have had no direct association with WMSII have made significant contributions in their published and unpublished writings.

Designing Development Projects for Irrigation

Project design by development agencies has become increasingly complex and bureaucratic. While the motivations for comprehensive design are laudable, the resulting processes can be cumbersome and the outcomes of limited value. Concern with the form of the design process and its final product has led to sufficient discussion among host country colleagues, the AID Mission staff, and external consultants.

For the past several years the Water Management Synthesis II Project has assisted a number of AID missions in developing project ideas and materials, background papers, project identification documents, and project papers, as well as examining project strategies and specific projects in process. To capture the experience with this design process that WMSII personnel gained, a conference was held at Cornell during the spring of 1986. The major lessons learned are presented here.

Ray Norman of Cornell checks flow measurement in Niger. Project design can be improved when long-term studies such as this are done.

The Planning Process

Most AID missions do not have a large enough staff of experienced professionals to design irrigation projects without the assistance of outside consultants. Consequently, outside consultants play a key role in nearly all AID irrigation development design activities. Less frequently, they also are involved in pre-project background and identification activities.

AID's design process includes three key parties: the host country, the USAID Mission, and AID/Washington. Each of these three parties brings to the process particular views and concerns that it wishes to see reflected in the project design. Producing an approved project design requires agreement on a broad conceptual level and on a more detailed level of project objectives, procedures, and outputs.

The consulting team is expected to formulate a design that will be acceptable to these three parties. To do this, it must draw on technical expertise and experience in a range of irrigation projects and combine this with the country-specific knowledge held by host country colleagues and USAID staff (and perhaps by some team members). Creating a setting that facilitates this flow of information and joining of knowledge and experiences is an essential requirement for effective use of the external team. In the following paragraphs we suggest how this can be achieved by considering several issues: team composition, developing the scope of work, preparing for the team, team activities, the policy context, combining institutional and technical components, and using the team in post-design activities.

Team Composition: Who Should be Included?

In the irrigation field, there has been growing recognition that irrigation development is a socio-technical process that requires the contributions of several disciplines. The result is widespread agreement that sound irrigation project design requires planning by a team able to deal not only with the technical issues of engineering, environment, and crop production, but also with economic, administrative, and organizational issues and policies.

The hallmark of WMSII project design teams has been their interdisciplinary composition. The team, which usually had expertise in engineering, agronomy, economics, and social science, also had a majority of team members with prior experience in applying the concepts of their profession to irrigation problems. In addition, the team leaders were professionals with established records of viewing irrigation as a multi-faceted enterprise, and thus were able to help team members to more effectively integrate their separate contributions. A majority of WMSII team members have been U.S. professionals, but a number of teams have successfully included national professionals. National experts have been most effective when they had specific irrigation and interdisciplinary experience.

Interdisciplinary teams can be expensive to field, and in some instances, missions have suggested including their staff (expatriate or nationals) to fill one or more team positions. This has advantages since it can provide to the team a direct source of information on mission experiences and plans. However, assigning a mission specialist to a team when that person lacks irrigation experience in applying his or her discipline is not satisfactory.

This observation is distinct from the desirability of including the USAID staff member likely to be responsible for subsequent project management as an active team member. Having the USAID officer participate in project design process will increase his or her understanding of team conclusions and suggestions and may serve to enhance his or her commitment to the final project proposal. It will also allow direct input of mission concerns.

Preparing for the Team's Arrival

The key to preparing for the team's arrival is achieving the right balance between too few and too many prior arrangements. Preparation involves assembling resources that they are most likely to need, while leaving the detailed use of these resources to the team itself. Three sets of resources are essential: documents (including information from AID, the host country government agencies, other donors, and local and international researchers), official briefings with senior USAID staff and key host country officials, and logistical preparation (including prior clearance for internal travel, scheduling of transportation facilities, arrangements for interpreters, and local officials to accompany field visits).

If possible, the mission may wish to assign to a staff member the responsibility for these arrangements. An alternative is to have the consulting team provide a team member who arrives in advance of the main team to make arrangements.

Team Activities

WMSII experience suggests that external teams need to strike a suitable balance among the following activities:

1. Obtaining adequate background information.

2. Visiting project areas to become familiar with the physical environment, the conditions within the rural communities and households, and the capacities of the implementing agency's field staff.

3. Meeting with host country colleagues, policy-makers, senior government staff, project implementors, knowledgeable academics, and other observers to obtain an understanding of experiences, current situations, and intended future directions for irrigation development.

4. Discussing with USAID staff broad policy objectives, Mission strategies, and current and past project design and implementation experiences; and, as the work progresses, frequently discussing with mission staff the emerging project dimensions.

The team needs time to assimilate and organize this new information, and to formulate project implications. In several WMSII projects, the design process occurred in two phases with several months lapsing in between.

Considering the Policy Context

Project design often neglects to consider the affect of broad government policies on project success. Often, little opportunity exists to modify state policies for a particular irrigation project. Where policies are either absent or non-supportive of project means and goals, project designers will have to accept these conditions as constraints to plan around or will need to incorporate policy modifications into the project plan. Good irrigation project design requires attention to policies affecting economic and fiscal issues, to policies that affect institutional matters, and to policies that affect the rights and responsibilities of local organizations. USAID can assist the consulting team with these matters by including policy concerns in scope-of-work statements, insuring that the team includes staff able to do this review, and helping the team gain access to relevant background information.

Combining Institutional and Technical Components

Sophisticated technology for distributing water will have little positive impact unless accompanied by appropriate institutional rules and organizational arrangements. However, a number of features in the design process often act to separate this essential connection. The external team may include a technical expert and an institutional specialist, each with distinct responsibilities. The host country agency may have many competent technical specialists, but few who are knowledgeable about institutional matters. Usually, there is a tendency to give precedence to technical decisions and to see institutional matters as merely supportive of the former.

To surmount this problem, the members of the external team should be carefully selected. A second corrective is to require that the design process identify technical alternatives for each problem. These alternatives can then be examined in terms of the institutional arrangements required to successfully operate and sustain them. In this way, choices can be made that incorporate both technical and institutional considerations. In addition, the design process can make implicit assumptions explicit and unambiguous. Thus, there should be discussion of the institutional assumptions implied in each recommended irrigation technique and technology and in each institutional arrangement proposed. This explicitness will facilitate making sound socio-technical choices and avoiding projects that install institutionally inappropriate technology or that create institutions not supported by effective technology.

Best Approximations

There is growing awareness that development planning is ineffective if viewed as drafting a blueprint. While the capacity to collect and process a wide range of design data has increased, the limits of planning and the negative consequences of overplanning also have become evident. What is needed in designing irrigation projects is a start based on a few sound propositions and providing a set of procedures whereby learning and needed corrective action can occur.

Thus, external consulting teams should have the responsibility to develop designs that formulate a sound action -- identifying critical objectives and broad strategies for achieving them. These designs should also set procedures and staff arrangements for developing means to implement strategies, for examing the outcome of implementation, and for enacting corrections as required. The irrigation project design should contain within it modes for identifying and resolving emerging problems.

Diagnostic Analysis

Diagnostic analysis is an interdisciplinary field study of an irrigation system to understand how the system operates and to identify the priority constraints to improved management of the system. Agronomists, agricultural engineers, agricultural economists, civil engineers, and sociologists or extension personnel combine into an interdisciplinary team to develop the understanding of the system. Irrigation system analysis in most countries has involved an interorganizational study of irrigation.

Diagnostic analysis has evolved into the concept of developing an information base for a management intervention. The interorganizational involvement results in a common understanding of the management objectives of an irrigation system and the priority of needs for improvement to achieve the objectives of the system. Managment intervention is a collaborative planning process involving multiple levels of interorganizational management to develop a plan for improving the structures, facilities, and management of irrigated agriculture.

Diagnostic Analysis -- Its Use and Impact

The first workshops were held in India and Sri Lanka. Since then, India has used diagnostic analysis in several states and projects to improve irrigation management. In addition, 11 Water and Land Management Institutes use diagnostic analysis training for professional development and action research to continue improving the management of irrigated agriculture.

In Sri Lanka, diagnostic analysis workshops have been held by the Mahaweli Development Authority and the Irrigation Department to initiate improvement in irrigated agriculture. Recent studies on four tanks have been the basis for designing a major irrigation systems management project and for initiating the management intervention in those projects.

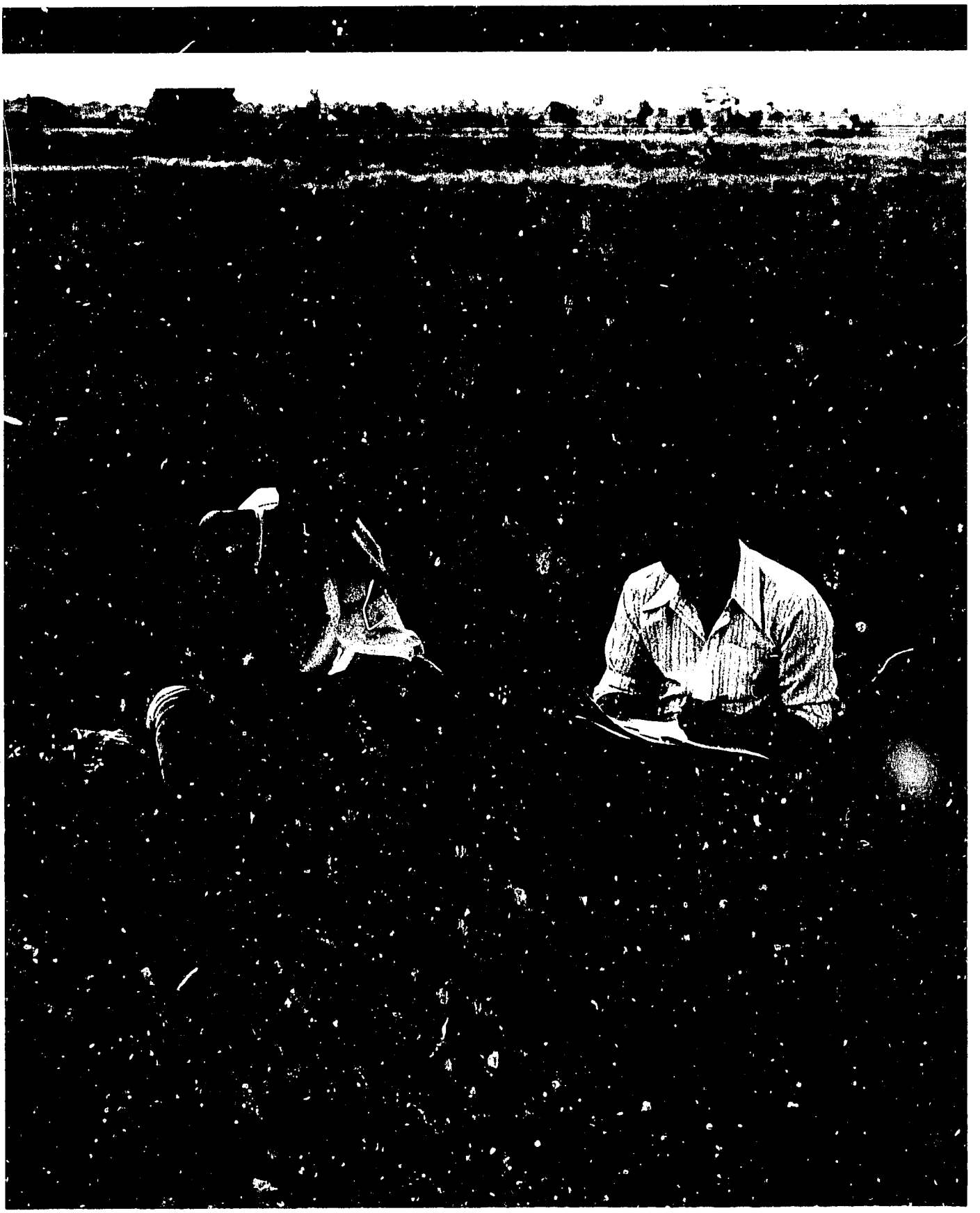
Bangladesh and Nepal have also used diagnostic analysis workshops to initiate improvement in irrigated agriculture. Though no follow-up activities were conducted by WMSII in Bangladesh, training and improvement programs are reported to continue. Nepal used diagnostic analysis results to design an irrigation improvement project and then used rapid appraisals (rapid diagnostic analyses) to identify appropriate projects to include in the improvement program. These improvement efforts are continuing in Nepal.

Diagnostic analysis concepts provided the basis for recent field studies in Africa for Zimbabwe, Rwanda, and Niger. These field studies were conducted jointly by host country and WMSII teams. Knowledge of the needs of irrigated agriculture in this part of Africa has been expanded, and a basis has been established for further management interventions.

The most recent efforts in diagnostic analysis have occurred in Pakistan where the concepts for field-based studies of irrigation projects were initially developed in the 1970s. Recent efforts in Pakistan focused on an initial training workshop for personnel from all four provinces to learn the concepts, principles, and practices of diagnostic analysis. Then diagnostic analyses were conducted in each province to identify the needs in irrigated agriculture in selected projects. Management interventions used the resulting information for a multi-organizational and multi-level, collaborative planning process to develop an inter-organizational management plan. Experience at implementing these plans has shown that significant improvements in irrigated agriculture, organizational coordination, and farmer involvement can be achieved as a part of the management improvement process.

The primary lessons from diagnostic analysis in many countries is that knowledge of the needs in irrigated agriculture can come only from careful study of the operating system. Using the diagnostic analysis methodology on a continuing basis is an important strategy for improving the performance of management in irrigated agriculture.

An agronomist interviews a Sri Lankan farmer as part of the Women in Development component of a Diagnostic Analysis Workshop in Sri Lanka.



Identifying problems in irrigated agriculture necessitates active farmer participation. Here a Sri Lankan social scientist interviews a farmer to find out about his irrigation practices. Working together with the farmers to solve complicated problems makes irrigation officials work more productive, as well as easier.

Improving Management in Irrigated Agriculture

Improving the management of irrigated agriculture has become one of the themes of WMSII through the emphasis on irrigation systems management and small-scale irrigation systems. The interest in improving management focused on Pakistan when it requested start-up training assistance for the Command Water Management Project in 1984.

Initially, diagnostic analysis training and development of computer-assisted management plans for the subproject areas in each of four provinces was proposed. After the first diagnostic analysis training workshop, AID/Washington facilitated the cooperative effort of WMSII and the University of Maryland to combine irrigation and management expertise in their assistance to Command Water Management (CWM) in Pakistan.

Management improvement focused on facilitating a multi-level, multi-organizational problem-solving and planning process to develop a management plan. The management plan addressed the needs of each irrigated area to achieve the objectives of irrigated agriculture.

The Procedures Followed

Diagnostic analysis studies were conducted in subproject areas in each of Pakistan's four provinces (Baluchistan, Northwest Frontier Province, Punjab, and Sind). These studies developed an understanding of the current performance of irrigated agriculture and the constraints to improved performance. These interdisciplinary and inter-organizational (Command Water Management, Irrigation Department, On-farm Water Management, Extension, and other organizations) field studies included the distribution of canal and tubewell water (main system); the watercourse, field and drainage systems (on-farm system); crop production; farmer knowledge, and decision-making (farmer involvement); and returns on investment. The problems were considered from the perspective of the farmers through extensive farmer interviews and were confirmed or elaborated through physical and biological measurements. The results of these studies were the basis for generating organizational interest, involvement, and commitment. The information base was effective in initiating the multi-organizational and multi-level process.

An organizational development process (called the Management Training and Planning Program) was used to follow the diagnostic analysis studies. This program lasted one month in each province. The MTP Program brought the operational field managers from the involved organizations together for a series of workshops in which the following goals were accomplished.

1. A common understanding of the problems of the project area and their organizational roles and responsibilities was reached.

2. The information from the diagnostic analysis and the knowledge and experience of the participants were used to plan solutions to the problems identified and to define roles and responsibilities.

3. The management plan was completed using a multi-level and multi-organizational review and input process to develop long-range goals and one-year objectives, activity plans, and coordination and monitoring mechanisms.

A common understanding of the problems requires coordination among irrigation-related agencies. To get that understanding, it is helpful to have data-based information.

Results of the Diagnostic Analysis and MTP Program

The results of the diagnostic analysis and MTP Program suggest that an effective process has been developed and applied for improving the management of irrigated agriculture. As the results of the diagnostic analysis studies became available, organizations at various subprojects began to change their statements about what problems were important for Command Water Management to address. For example, initially, reliability and equity of water delivery to the tails of the canals were not considered top priority needs. When large variabilities in flow began to be observed, and average flows observed were less than 50 percent of design, then equity and reliability began to be discussed.

During the entry phase, results of the diagnostic analysis were used repeatedly to illustrate and explain what the workshops would address in the problem solving and planning phase. Input and involvement for solutions in subsequent discussions were also obtained. Inter-organizational needs were able to be specifically illustrated and alternatives were discussed. High level input and commitment and permissions for lower level personnel involvement was the result.

The project achievements included:

1. Problems specific to the subproject area were understood, agreed upon, carefully defined, and addressed.

2. Solutions are being adapted as the implementation progresses.

3. Organizational coordination, including the involvement of farmers individually and as organizations, has been significantly improved and continues to improve.

4. The process continues to improve as plans are implemented and adapted.

Several different approaches were used to involve farmers more effectively in watercourse construction when initial plans did not produce satisfactory results. In addition, extension and an input supplier were able to agree on a revised plan for supplying inpats more effectively, and the private sector was involved in providing additional needed services.

The working relationships among organizations have not always been smooth, and not all the differences have been resolved. However, individuals have repeatedly considered the new working relationships as a positive improvement and have cited many different benefits in doing their job.

Data were gathered on these two minors in Pakistan as part of the MTP program.

Plan MERIS

Plan MERIS (Mejoramiento de Riego en la Sierra) was financed by USAID beginning in 1976. It was designed to improve the use of the land and water resources in the Peruvian highlands in general and specifically in two zones of the Sierra. The original project objectives included constructing small irrigation subprojects, reforestation and soil conservation, technical assistance to the project beneficiaries in on-farm water distribution and application, and the appropriate use of irrigation water together with other agronomic practices to increase agricultural production in the Sierra.

The AID-funded component of Plan MERIS lasted nine years, including two extensions, and was completed in December 1985. In spite of its goals, the project was largely construction-oriented, with emphasis on the engineering design and installing irrigation infrastructure in several subprojects.

The design and construction of the main delivery system and related structures was generally adequate at the primary level and to some extent at the secondary level. However, water control structures were largely lacking at the secondary level and totally absent at the tertiary level. Insufficient consideration was given to farm level distribution and water application in the fields, and to user participation in the planning, construction, and operation of the subprojects. No technical assistance was available to the farmers to help them best utilize their new irrigation facilities.

Clearing land of rocks became a major improvement under Plan Piloto.

For these reasons, the subprojects were under-utilized and were not increasing production and improving the incomes of the beneficiaries. In 1985, WMSII was asked to design and implement an activity that would help to improve the performance of the subprojects. USU was selected to coordinate this buy-in activity.

Plan Piloto

A five-member interdisciplinary team went to Peru in October 1984 to write the plan of work. The objectives of the plan of work were to develop an interdisciplinary approach to irrigated agriculture which included four major components: research, extension, agricultural economics, and rural sociology. The effort came to be known as "Plan Piloto" and was carried out in one of the Plan MERIS subprojects near San Marcos, in the department of Cajamarca. This subproject was to be the site of a concentrated, intensive, research, demonstration and training effort. Less intensive work was to be done at several "satellite" sites in other subprojects.

Plan Piloto was implemented by a technical team of Peruvians from the four disciplines with an engineer as field team leader. Plan MERIS counterparts were assigned for each technical team member. The WMSII short-term team members from Utah State and Cornell provided interim monitoring, supervision, and evaluation through December 31, 1985. The project could not have succeeded without the efforts of the Peruvian field team helping to overcome a series of logistical problems.

The San Marcos field site conditions -- small fields divided by rock fences and interspersed with shrubs and small trees--made laying out a distribution and application system extremely difficult. Plan Piloto undertook some land clearing, rehabilitation, and smoothing to facilitate the irrigation application system and increase the irrigatable area. The farmers in the area provided labor for clearing brush and rocks from the area and their own fields. Heavy equipment borrowed from the Ministry of Public Works was used to remove the rocks and trees that were too large to be moved by hand. These were placed in a small gully that ran through the area, thus eliminating an obstacle to farming operations, improving access to the area, and increasing the area that could be effectively irrigated.

Conservative estimates indicated that at this site the arable area was increased by more than 50 percent. This was made possible by the cooperation of the farmers with the field team and the government agencies. In addition to the significant physical improvements that were made to the land, the effort seemed to unite the farmers, technicians, and team members into an effective group,which carried through the growing season.

Agronomic research activities of Plan Piloto were of two kinds: examination of irrigated crop production and a drainage study. A study of the interaction of nitrogen and irrigation intensity on two varieties of potatoes resulted in a response to irrigation and nitrogen fertility. The maximum average yields (40 t/ha) in the experimental plots with the most intensive management (in terms of irrigation and fertility) were several times that of the average potato yields (10 t/ha) in the area.

The drainage study on 45 ha in Lower Huayobamba indicated that the principal source of the groundwater that is being forced to the surface in the affected area is the unlined irrigation canal.

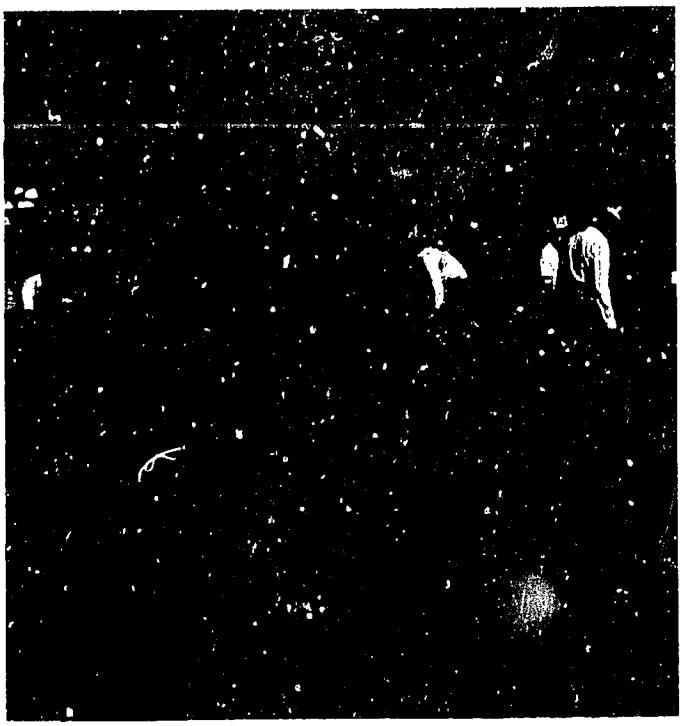
One of the principal activities of the extension component was training in irrigation water management. This training included using the Ecuavir video modules developed at Utah State University, as well as practical, hands-on training in such principles as water measurement, infiltration, use of siphon tubes, determining soil moisture content, and scheduling irrigation. The training was followed by season-long experience in producing a crop under irrigation, incorporating many improved agronomic practices in addition to water application. Twenty-nine Plan MERIS technicians received this training. As a result, a core of people exists in Cajamarca trained in irrigation water management.

In addition, 91 farmers received training in irrigated crop production. Estimates of irrigation water applied to the demonstration fields compared with crop evapotranspiration indicated that, in general, the farmers underirrigated the demonstration site. This demonstrated that one season does not make an irrigation farmer and emphasizes the need for continuing this type of effort.

Crop production and cost data were collected from 17 fields during the rainy season and from 16 of the same fields in the dry season. Based on a single year's field trial data, it appears that net profits can be significantly increased with improved cultural and water management practices in the production of potatoes in the Sierra. The payoff seems to be sufficient for a small farmer to seriously consider investing in an irrigation infrastructure and adopting improved practices.

Plan Piloto and Plan MERIS revealed several lessons:

1. Water is used not only for agriculture, but for domestic, hydroelectric, livestock, and other purposes.
2. Where community members request a project and are fully involved in the planning process, contributions of labor and cash are more likely to be forthcoming. Full local participation is more likely to occur if farmers are included in promotion and planning.
3. Projects should only be undertaken with ample farmer participation in planning, construction, operation, and maintenance through water users organizations.



Demonstration of irrigation techniques helps in farmer training as part of Plan Piloto.

The major objective of Plan Piloto was to develop a model for improving land and water use in the Sierra. The model is visualized as an evolutionary process involving irrigation research, demonstration, training, and economic and sociological research. Plan Piloto was both the prototype and the advanced testing ground for the model. The six stages of irrigation project development (initiation, planning and design, construction, operation, maintenance and modification, and evaluation) are considered to replicate themselves within the model. The model should be phased into irrigation project development so that by the time the irrigation project is completed and ready to deliver water to the users, a trained cadre of technicians is in place to assist and train the farmers in irrigated crop production. Thus, ideally the model should be initiated at least as early as the planning and design stage of project development.

Plan Piloto was the first time an intensive, interdisciplinary approach had been taken to irrigation water management research and demonstration in Peru. Despite various problems, it was a successful initial effort to improve land and water use in the Peruvian highlands through research, demonstration, and training in an interdisciplinary mode. Field days provided an opportunity for local and department leaders, government officials, and farmers to see the program in action. A video program prepared by the Ministry of Agriculture was shown on national TV. Plan Piloto demonstrated that Peruvian technicians are eager to learn and use the required skills, and teach them to farmers who are also willing to use them, once they realize the benefits.

Thailand

The Royal Irrigation Department (RID) of Thailand has recently changed its emphasis from "construction" to "operation and maintenance" of irrigation systems. This policy change has prompted RID to seek assistance in developing a national training capability for operation and maintenance. Funding has been provided by RID, USAID grant funds to the Northeast Small-Scale Irrigation (NESSI) Project, and WMS II. Utah State University has been assisting in the implementation of the "Operation and Maintenance Training and Applied Study Program" and "Computer-Assisted Irrigation System Management," while Colorado State University has initiated "Farmer Participation in Design, Operation, and Maintenance of Irrigation Systems" at one of the seven NESSI Project sites. The CSU effort is not presented here.

One of the lessons learned under the WMSII activity, "Operation and Maintenance Training and Applied Study Program" in Thailand is the value of conducting training on an existing irrigation project as part of the implementation for improving the system. Besides training, actual work is accomplished.

The appropriate field personnel at the irrigation project were included as trainees. In addition, field personnel from other project sites were carefully selected so that the program could be implemented at their projects.

The training of trainers is an important emphasis. The in-country training courses have been done at the NESSI sites and two large-scale irrigation projects. The entire program has been carefully designed to facilitate implementation of improved irrigation management practices.

WMSII funding has allowed development of state-of-the-art technology for computer operation of irrigation systems. This technology is being implemented first at NESSI and the Lam Nam Oon Large-Scale Irrigation Project in Thailand. This computer operation includes the watershed, storage facilities, the canal network, and the unit command area (group of farms served by a single outlet). Calibration of these models required extensive field data collection, which provided considerable insight to field personnel. The computer models allow daily changes in operation and more equitable distribution of the water supplies. Presently, it is anticipated that this computer-assisted irrigation system management supplemented with operation and maintenance training will be implemented in the Dominican Republic, Pakistan, Egypt, and Sri Lanka.

In Thailand, the Cabinet provided funding in October 1986 to duplicate the visible success story of improved operation, maintenance, crop production, and marketing at Lam Nam Oon on three other large-scale irrigation projects. RID has now involved the Department of Agricultural Extension (DOAE) in the tertiary system managment. The first training course was conducted jointly by RID, the DOAE, and Utah State University in March 1987. Planning is under way to involve the Department of Agriculture in applied irrigation and agronomic research at RID experiment stations, which would then be tested on farmers' fields by DOAE and RID.

Participants in Thailand workshop discuss details for calibrating the division gate structure.

Rehabilitation Conference

With growing interest and investment in irrigation system rehabilitation and the need for improving the process of rehabilitation projects, the International Conference on Irrigation System Rehabilitation and Betterment was organized. The conference was held October 27-31, 1986, in Leesburg, Virginia. The objectives of this conference were to synthesize the knowledge acquired from previous rehabilitation projects, provide an opportunity for sharing views on irrigation system rehabilitation, identify problems, and develop guidelines for better planning, implementing, and monitoring of rehabilitation projects.

The conference program included simulated field trips through videotape, working group discussions, panel presentations, and papers and case studies. Participants from 20 countries attended the conference. They included policy makers, project implementors, and researchers from developing countries. International development and donor organizations were represented by the United States Agency for International Development, Asian Development Bank, World Bank, the Food and Agriculture Organization of the United Nations, and the Ford Foundation. The Inter-national Irrigation Management Institute, the Consortium for International Development, and several consulting firms played an active role in this conference.

Rehabilitation and betterment were characterized as a joint process that combines the elements of deferred maintenance and the notion of change for upgrading system performance in light of current needs and opportunities. Underlying economic, social and political factors for inadequate system maintenance were highlighted, as well as the need for upgrading structures and operational procedures over time.

The common problems with rehabilitation and betterment projects identified by the conference participants can be categorized as follow:

- Inadequate focus on system operation and management.
- Inflexible design and a rigid implementation schedule.
- Use of an inadequate database and out-of-date information for project planning.
- Poor coordination among the agencies involved.
- Inadequate farmer involvement.
- Lack of an effective monitoring and evaluation program.
- Inadequate consideration of the sustainability of improvements made.

The desirability of enhancing the performance of existing irrigation systems was generally agreed upon at the conference. However, there was considerable debate on the degree of success in R&B projects and on the approaches to better planning and implementing them.

Most R&B projects have experienced the problems encountered in new irrigation projects and have also posed new constraints and challenges to project designers and implementors. Overall, rehabilitation projects have been unable to achieve their expected outcomes. In some cases, the irrigation system is in need of rehabilitation before the project is completed.

The following guidelines and recommendations were proposed to obtain more effective rehabilitation and betterment projects:

1. Due to the dynamic nature of the irrigation system and its environment, the irrigation system generally should not be restored to its original design specifications.
2. The current construction orientation of most agencies should be replaced by an approach that improves management as well as structures.
3. R&B projects should be flexible, allowing adjustments during project implementation to correct errors in planning and to respond to new information.
4. The institutional capacity for actively involving farmers should be developed.
5. Farmer involvement should be encouraged from the design stage, and farmers should be given some decision-making authority.
6. Greater emphasis should be placed on project design. Planning for design should involve consultation with relevant national, regional and local officials, and with operation and maintenance personnel and farmers.
7. In large projects, 1-2 years should be set aside for project start-up, and project implementation should be longer than the typical five-year period.
8. Diagnostic analysis of the irrigation system should be conducted to provide input into the planning process.
9. Realistic goals and objectives for the rehabilitation project should be set.
10. Donor and lending organizations should further pursue combining grants and loans in R&B projects to fund technical assistance.
11. Greater emphasis should be given to the economics of R&B to determine when to undertake an R&B project, the amount of investment in the project, and the improvements that have high benefits. Cost recovery for system operation and maintenance, and capital investments, need to be further examined.
12. The agency selected to function as lead organization for a R&B project must expand its functional and interdisciplinary capability.
13. Roles, responsibilities, sharing of funds, and training opportunities should be clearly defined for all participating agencies before a project begins. The role that each agency plays should be complemented by specific incentives.
14. New policies should be formulated and communicated to water users and others involved in the process prior to project implementation and not during and after.
15. Farmers should be involved in collecting and using irrigation fees to improve the collection and use of these fees.
16. The monitoring and evaluation unit should be linked with the project management office to effectively make revisions during project implementation.
17. A coordinating and feedback mechanism should be developed among and within agencies for continuous learning from the rehabilitation and betterment effort.

Microcomputers: An Irrigation Management Tool

In the past four years, microcomputer utilization in developing countries has become a reality. With the WMSII Project, an excellent opportunity presented itself to transfer a significantly higher level of expertise from the United States to developing countries with the microcomputer technology now available.

To improve the capabilities of the irrigation department and various related institutions in developing countries, microcomputer technology is essential in irrigation system design and operation, as well as in project management. In the past few years, there have been major developments in specialized software and in commercially available software that can be used to improve water management.

Workshop on Computer-Assisted Design & Management

To introduce various potential applications of microcomputers in water management, a "Microcomputer-Assisted Design and Management of Irrigation Systems Workshop" was developed at CSU and was conducted jointly by CSU and USU staff in Bombay, India, February 1987, for the Maharashtra Minor Irrigation Project. This workshop was designed to demonstrate the capabilities of microcomputer software for use in irrigation system design and management, to assess the applicability of microcomputers for a specific project, to identify groups for training, and to recommend microcomputer-related training courses to meet particular needs in irrigation system development.

The India demonstration workshop included an overview of computer technology in irrigation water management, microcomputer software and hardware, database management, project scheduling and resource management, computer-aided drafting, image processing, map information systems, geographic information systems, and irrigation system simulation and modeling. Example applications from Sri Lanka, Pakistan, and Egypt were presented.

Both formal and informal exchanges among the participants contributed to an increased understanding of microcomputer technology. Specifically, the workshop participants suggested the following factors to consider when introducing microcomputer-assisted improvements in irrigation water management:

- As the first step, there is a need to develop the basic microcomputer skills of the staff members for use in irrigation data processing and analysis, and project management using commercially available software.
- The staff should not start with "canned" specialized irrigation software that is more sophisticated than is warranted. Most participants feel very skeptical of the "black box" approach. They were concerned that the end results could be misinterpreted if the specialized software was not fully understood.
- Institutions need to select specialized irrigation software that offer the most promising returns for the project and which lie within the projects financial and technical capabilities. Most of these specialized software require modification and calibration in order to use them locally, and calibration often involves input data collection over several seasons.

Workshop on Irrigation Data and Project Management

Workshops on irrigation data and project management were conducted in India, Pakistan, Sri Lanka and the USA. These workshops were designed to develop the microcomputer skills of water management professionals for use in irrigation data processing and analysis, and project management. In addition, the professionals learned many potential uses of electronic data loggers for computer-assisted monitoring and evaluation. Most of the workshop participants had minimum experience in microcomputer operation or programming.

The training workshops covered electronic worksheets, database management, project management, statistical analysis, and example applications in irrigation data and project management. In addition, microcomputer fundamentals, a disk operating system, computerized technology for data acquisition, and case studies in irrigation management using microcomputers were presented and discussed. The workshops focused on using commercially available software that are powerful, flexible, and user friendly. Based on these workshops, the following are some of the key lessons learned from this experience.

- A personal development training strategy is the best for this type of training. The emphasis should be on improved individual competence in microcomputer skills for use in irrigation water management. Methods should include a good balance of presentations, demonstrations, discussions, hands-on instructions, electronic tutorials, exercises, and example applications.
- Three weeks for this type of workshop seems to be the ideal length to give participants ample hands-on practice.
- For hands-on microcomputer workshops, the following ratios of participants and trainers provide a good interactive learning environment for participants: 6 participants to 1 trainer, 2 participants per microcomputer, and 18 to 20 participants per workshop.
- Workshops should utilize computer equipment having service support from local vendors, unless the training facility has the appropriate computer set-up, so that any needed repairs can be made quickly.

WMSII's microcomputer application effort demonstrated the worldwide potential for microcomputer-assisted improvements in irrigation water management. Our effort in applying microcomputer software in irrigation design and management was only the beginning. We need to continue this effort in search of appropriate microcomputer technology for improving irrigation water management in this fast changing electronic age.

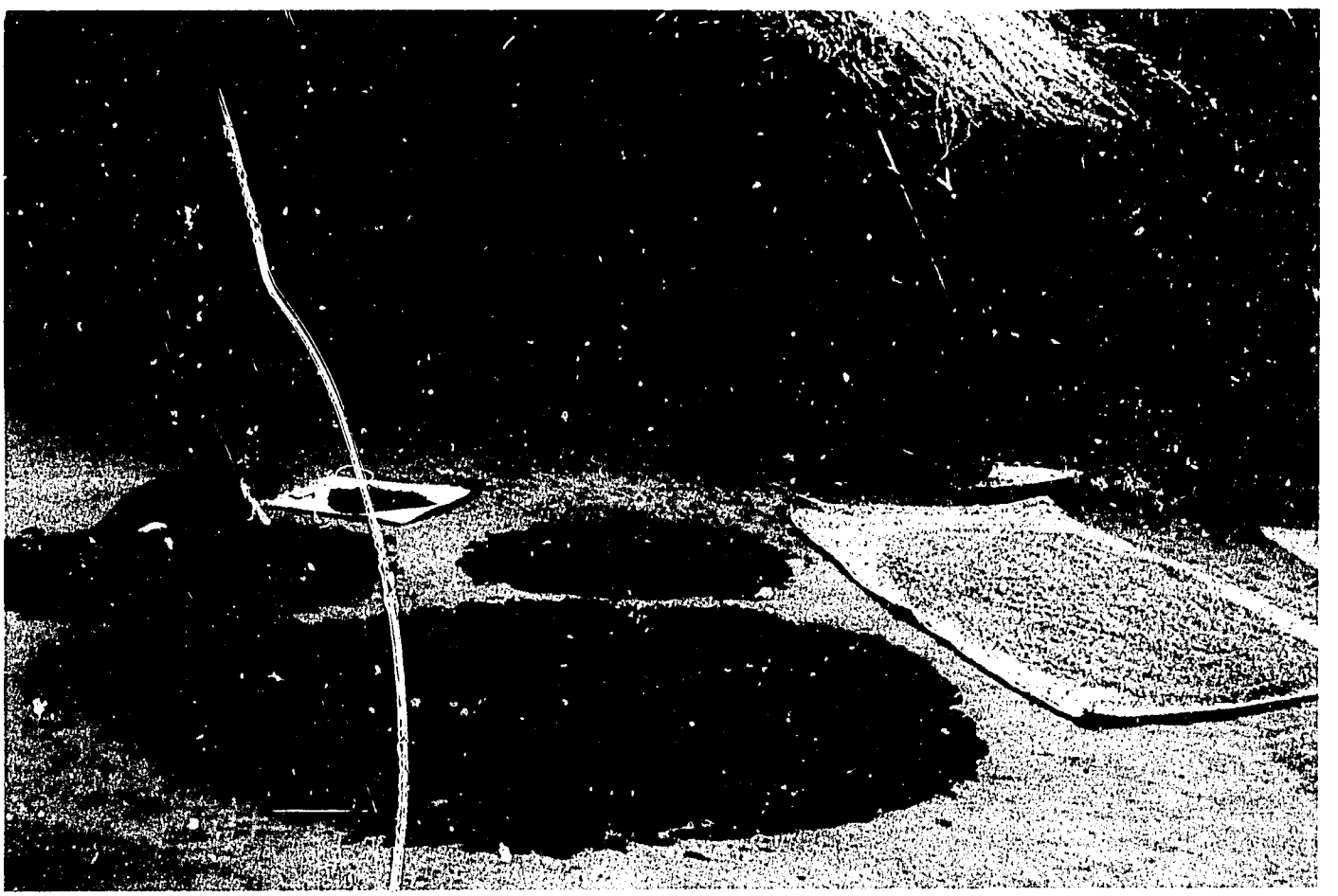
The Bureaucracies Workshop

An essential lesson drawn from the WMSII experience with farmer participation, small-scale irrigation development, and main system management is that improvement in implementation of new water management policies will almost always require some shift from a technical to a socio-technical orientation in irrigation bureaucracies. Yet, there is little empirical information for government agencies and donors to draw upon to guide this reorientation. However, the general concept of "management and coordination" may be able to provide considerable help at the operations level.

As a first step toward improvement of irrigation bureaucracy performance, Cornell irrigation specialists analyzed and assessed the performance of irrigation bureaucracies. The team developed a framework for analyzing bureaucratic structure and suggested several strategies for improving performance:

- Management approaches. Management by objectives; participatory management; decentralization of management; internal reorganization, including legal, financial, personnel, facilities, and monitoring and evaluation changes.
- Agency reorientation. Organizational changes; changes creating interdependence between bureaucrats and farmers; normative or attitudinal changes brought about through changes in organization culture, peer dynamics, and career paths; material and non-material incentives to change bureaucrats' behavior.
- Institution building. Developing linkages between the bureaucracy and its environment in order to promote leadership, provide resources, and develop programs and internal structures.

In May 1987, a group of leading analysts of irrigation and bureaucratic performance met with implementors of irrigation policies in developing countries, AID, and WMSII staff to review the analytical framework in the context of experiences from Asia, Africa, and Latin America. Afterward, several conference participants added a regional dimension to the analysis, as well as perspectives from comparative development administration and engineering management. The resulting guidelines for improving the performance of irrigation bureaucracy in their capacity to manage water were published as a WMS report.



The goal of getting bureaucracies to work together with farmers is for increased food production. Here a farmer sorts his chili pepper.

Farmer Participation in Irrigation Management

Examples of successful management of indigenous, small-scale irrigation systems by farmer groups occur in Asia, Africa, and Latin Ameria. Studies of these systems in the past two decades have helped to reorient the thinking of irrigation development experts. Farmer participation is increasingly seen as useful, perhaps essential for effective management of large, as well as small-scale systems. Also, as resources for irrigation development diminish, governments and donor agencies are turning toward water users to provide cash and labor for system improvement, operation, and maintenance. Mobilization of local resources requires participation and organization at the local level.

Two outstanding early efforts to incorporate farmer participation into the irrigation development were Cornell University's work in collaboration with ARTI on the Gal Oya scheme in Sri Lanka and the efforts of the NIA in the Philippines. Early results of these efforts suggested that incorporation of farmer participation into all phases of project development would be a promising strategy for improving water management on small and large schemes alike.

From its inception, WMSII has incorporated into its program a number of activities designed to strengthen local irrigation organizations and to promote farmer participation in water management. Notable among these are

1. A state-of-the-art review of farmer participation in irrigation management throughout the world.
2. Continued collaboration between Cornell and Sri Lanka's ARTI (Agrarian Resource and Training Institute) at Gal Oya in the institutional organizer program and farmer participation in rehabilitation.
3. An analysis of farmer participation and local organizatien for small-scale irrigation development undertaken as part of a small-scale irrigation special study.

Improving International Irrigation Management with Farmer Participation

As a first step toward a methodology for improving farmer participation in water management, a group of faculty and students at Cornell undertook the first comparative study of farmer participation experiences. They analyzed reports and data from 50 irrigation systems in Asia, Latin America, and Africa with command areas ranging from 60 to 4,000,000 acres. These systems -- indigenous and government built -- are managed by agencies, water users, or some combination of these two.

In May 1985, a group of scholars and professionals from AID, Colorado State, Utah State, and other universities gathered to present propositions drawn from their observations of farmer participation in irrigation projects in Egypt, Sri Lanka, the Philippines, Indonesia, and Pakistan. The central question addressed at the workshop was "What from these experiences is relevant to other irrigation contexts?" A concluding panel addressed the applicability of the workshops findings to India, Africa, and Latin America. Building on the results of these three activities, a policy report titled *Improving Policies and Programs for Farmer Organization and Participation in Irrigation Water Management*, WMS Professional Paper No. 1, was prepared.

Sri Lankan farmers in Gal Oya meet to make plans for the last month of irrigation during dry season.

Improving Small-Scale Irrigation Systems

In the past 10 or 15 years, development agencies, both private and governmental, for various reasons, have placed considerable emphasis on small-scale irrigation. Where locations for large systems have been exhausted, small-scale systems are the only option for expanding irrigated areas. When the costs for large-scale systems are prohibitive, or where public funding for irrigation development, operation, or maintenance is restricted, small-scale systems provide a potentially cost-effective approach to the expansion of the irrigated area. They also reduce the time lag between initial investments and the start of local use. Theoretically, their size means they can be tailored to the needs of targeted farmers.

Agency involvement in small-scale systems poses a number of questions. For example, no consensus exists on the optimal mix of state and local responsibilities for small-scale irrigation. What investment strategies are appropriate for small-scale development? What factors promote or inhibit local resource mobilization? In response to this need, a group of faculty and students at Cornell began delving into these and related issues. Their objectives included:

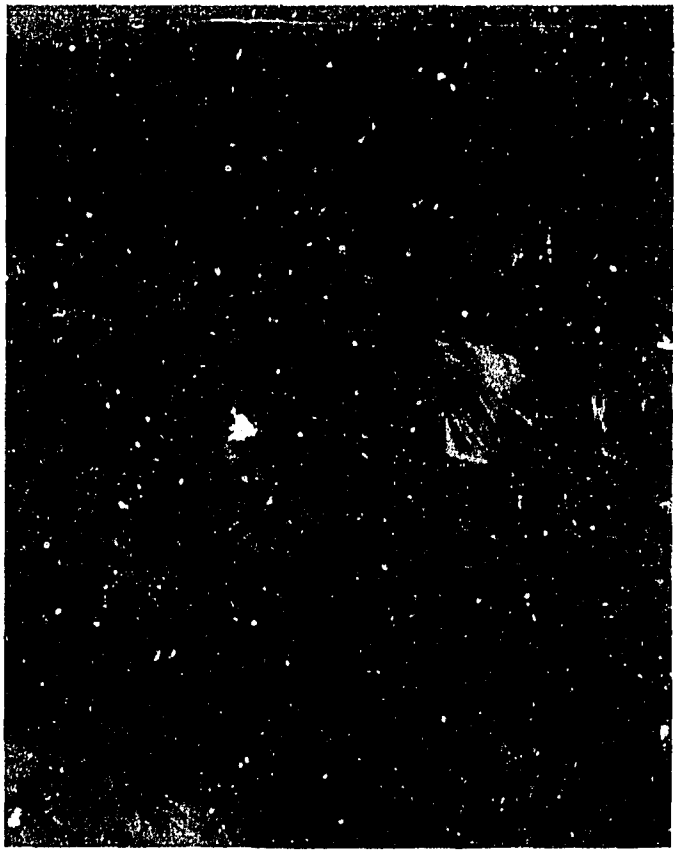
1. Understand small-scale irrigation development.
2. Identify key constraints to successful development of small-scale irrigation.
3. Develop a set of guidelines for program planners instituting small-scale irrigation projects.

In the initial phase of the project, investigators surveyed the available literature, drew from the experiences represented by various team members, and made field trips to Mali, Niger, Peru, Bolivia, Mexico, India, and Sri Lanka to identify key issues and potential sites for action research. Attention focused on four elements of a small-scale irrigation development strategy:

- The investment process
- The engineering design methodology
- Local organization and farmer participation
- The role of technical agencies

In November 1983, a Cornell workshop brought together U.S. and international participants representing irrigation agencies, donor agencies, and the research community. Based on input generated by this conference and previous work, the small-scale working group prepared four reports.

Investment decisions answer the question of what resources will be provided by whom and through what processes. Past experience indicates that indirect investment approaches foster user responsibility for system operation, encourage local investments in system development, and ameliorate problems of goal incompatibility between agencies and users.



Water lifting is a common problem for many farmers who irrigate small plots of land. Here two young farmers lift water to the field channel from the ditch below.

Engineering design methodology for small-scale systems has proven particularly thorny. Agency design experience lies with massive systems. As a result, small-scale system designs are often reduced versions of large-scale blueprints. This, combined with inadequate local data, results in systems that cannot match local conditions. Experience with indigenous systems argues for an evolutionary approach that allows systems to fit the local environment.

Community participation in agency-built, small-scale systems often begins only after construction ends. From the users' viewpoint, an agency's conception of local organization may be strictly negative -- an agency appendage that maintains canals, collects fees, enforces agency rules, etc. Effective community participation is engendered through local organizations that were developed before construction began and were based on a detailed understanding of the local social structure. Such local organizations must be independent of the irrigation agency. They must be flexible and able to adjust to the changing needs of the users and the system.

Interfacing On-farm with Main System Management

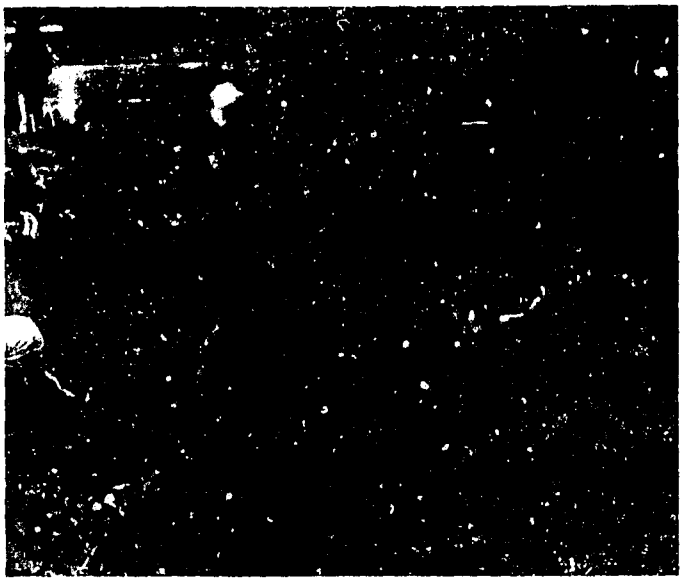
Purpose and Need

The CSU special studies effort focused on a comparative cross-cultural interdisciplinary investigation of ways to more productively link farm water management with main system management in Sri Lanka (Polonnaruwa District), India (Dahod tank), Pakistan (Niazbeg), and Thailand (Lam Chamauk). It is suggested that the failure of farmers to secure adequate control over irrigation water and to achieve potential yields is often directly associated with the absence of an effective local organization that can reconcile the varying requirements of main system management and farmer water demand. Research centered on farmer irrigation water control problems, investigation of main system factors affecting farmer water control, farmer participation in local water management activities, examination of problems and potentials of current local farmer organizations, and identification of culturally appropriate and replicable local organizational forms.

The special studies interdisciplinary effort was rooted in the premises that

- Design of local farmer organizations as interfaces between farmers and main system management is a strategic determinant of farmer water control and, thereby, water productivity.
- Water control and productivity are key determinants of willingness of farmers to pay maintenance fees and to deliver sustained support of local organizational rules and tools.

Farmers separating the rice from the chaff. Increased productivity is the goal.



Farmers need to work together to maintain the field channels.

- The design of local farmer water user organizations is strategic to improvement of main system management and local farmer water management.

Farmers cannot be expected to enthusiastically support organizations, by fee payment or other means, which do not provide them appropriate forms of water control necessary to make water deliveries reliable and productive.

The general objective was to contribute data, information, and options to policy discussion regarding means to advance farmer participation in local water user associations designed to enhance water control and productivity, while adapting forms of farmer organization and participation to main system management requirements.

Knowledge Developed

At each research site, data were collected which:

1. Described and documented current procedures for water allocation, system maintenance, and conflict management at study sites.
2. Permitted analysis of farmer water control and distribution problems in the context of main system management constraints.
3. Revealed farmer and local main system employee attitudes and expectations regarding possible irrigation improvements.

The results of these studies appear in *Linking Main and Farm Irrigation Systems in Order to Control Water*, Volumes 1-5.

Interfacing On-Farm with Main Systems

All the studies supported the contention that farmers play a crucial role in the management of irrigated agriculture. Farmers make important management decisions that affect productivity, and they decide how water will be distributed among themsleves and on their farms. Because farmers are primarily concerned with the uniques characteristics of their particular farms, farmers interests often conflict with those of main system managers. As a result, farmers who maximize their personal benefits from the system may lower productivity in the system overall.

Some causes of poor management have become more clearly understood as a result of the special studies. The studies strongly indicated that physical rehabilitation of the four systems without accompanying organizational improvement would be a temporary solution at best. Organized farmers are willing to follow rules they help to develop and that they understand and believe will be fairly applied. Also, they are better able and more willing to mobilize theri resources for maintenance, which would help to sustain the life of improvements made in the system.

To create an organization that will successfully fulfill the role of intermediary between farmers and main system managers, Volume 1 stresses that the main system managers must recognize the importance of farmer participation and establish organizational mechanisms for making joint decisions, that farmer rights to water need to be legally recognized and supported, and that more responsibility for system operation and maintenance needs to be developed from the main system to the farmers.

Conditions necessary for successful organization building include:

***Authorities must legally establish local farmer organization;**

***Farmers must be able to raise and disburse their own revenues as needed through their local organization;**

***Farmers need to be able to hire and release organizational staff so that the organization will be responsive to farmers' needs; and**

***Authorities need to support organizations in their efforts to control "free riders."**

Highlights of the Special Studies Cases

Niazbeg, Pakistan. In Niazbeg, farmers have informally organized themselves into small groups to develop tubewells to use in conjunction with canal water supplied by the Irrigation Department. Where the canal system fails to deliver water, farmers rely almost entirely on tubewell water. Where canal water is plentiful, farmers use tubewell water to supplement canal water. Formal and informal rotation schedules exist. Where water control is better, farmers support the formal rotation schedule sanctioned by the Irrigation Department. Where water control is poor, farmers have agreed upon informal schedules for rotating tubewell and/or canal water delivery. The study recommended that the importance of tubewells be recognized and incorporated into planning for the rotation scheduling. In addition, farmers should pay fees based on the water they receive and not for water they are scheduled to receive (the current practice). Improved water delivery would require improving the physical structures in some areas.

Dahod Tank, India. The study focused on how the degree of water control that farmers held affected their choices in regard to cropping intensity and crop choice. The study demonstrated that farmers with greater water control (which often meant having a turnout directly on the distributary or field channel) were more likely to grow crops which were higher yielding and more sensitive to water. Farmers with less water control tended to grow more drought-resistent crops. Many of these farmers received their water through other farmers' fields. The report noted that this system needs appropriate rules to govern operation and the appropriate physical structures to support such rules. Since performance was poor throughout the system, location was not significantly related to cropping choice or intensity.

Lam Chamuak, Thailand. Farmers have been organized into turnout groups and a water users association (WUA) by the Royal Irrigation Department. Turnout groups with strong leaders were reported to organize regular maintenance on their distributary, and most of the turnout groups have formulated sanctions to govern farmer irrigation behavior. Farmers and officials reported that they prefer a decentralized WUA; thus, farmers have attempted to modify the structure and operation of the WUA to be more responsive to farmers' needs.

Giriatale and Parakrama Samudra schemes, Sri Lanka. The study reported that no adequate procedures exist for specifying the rights and obligations of government personnel and farmers. Also, no adequate means exists for mobilizing resources for maintenance. In the absence of a water users association to clarify such matters, farmers have developed informal arrangements to manage water. The capacity of each distributary group of farmers to manage water was thought to depend on the authority held by the local vel vidane (a government official with Agrarian Services), the degree of concensus among farmers on allocation rules, and the presence of influential people who successfully helped the vel vidane resolve conflicts over water. Distributary communities which had higher management capacity proved to have greater water availability and control and higher yields. They also indicated that they would support the development of a WUA. The report recommended that the role of the vel vidane should be supported by incorporating it into a water users association.

AID's Assistance Program in Irrigation and Water Management

Although significant progress is being made in bringing about better water management and improved irrigation system performance throughout the developing world, the goal of fully and more effectively utilizing available irrigation resources remains far from being achieved. And, while WMSII has contributed greatly to this progress, particularly by helping strengthen capabilities of national institutions responsible for irrigation development and improvement, demand for the type of assistance that has been provided remains as great as ever.

However, while the demand remains strong, its composition in terms of problem mix and diversity, geographic distribution, and priorities has changed somewhat, becoming both greater and more complex, since WMSII was initiated five years ago. These changes have necessitated corresponding adjustments in the assistance required, as well as in the organizational structure through which it can be provided. These needed adjustments have been recognized within AID and are reflected in its planned program of continued field support and broader sector-support assistance in the irrigation/water management area, after the completion of WMSII.

How the Scope and Focus Have Changed

Geographically, Asia not only contains most of the world's irrigation, but it also remains the dominant area for irrigation expansion and improvement. It also is the leading recipient of foreign assistance in irrigation. Given this and the importance of irrigated agriculture to the region, the strong commitment demonstrated by national governments, and the central role increased irrigation efficiency and better water management play in promoting broader agricultural development will make water management a priority focus of AID's assistance efforts in that region. Asia will also continue receiving the majority of the AID's overall support for irrigation and water resource development and improvement. Continued field support such as WMSII has provided will take place over the next several years..

However, despite this continued dominance by Asia, the need for greater attention to irrigation development and improvement in the other regions has also grown significantly over recent years. This is especially true for sub-Saharan Africa where the high rate of population growth continues to more than offset any improvements in agricultural productivity that have been achieved, and where irrigation's role and potential, while not as great or as critical as in Asia, is neither as well identified nor as strategically integrated into national development plans in Africa.

And, although AID's bilateral program of assistance in Africa is not expected to expand greatly in this sector, due mainly to budgetary constraints, that of other donors and lending agencies is. However, in the early stages of irrigation development, efforts are likely be focused primarily on the physical aspects of irrigation system development, with little attention to the underlying policy, planning, and institutional weaknesses that exist. Thus, there is an urgent and important role that a centrally-supported project can play in helping address these constraints. There is also a critical need to broaden this focus to include attention to other types of agricultural water resource management and to the growing concern about the overall deterioration of the natural resource base and the substainability of its use over time.

While much of the present project has focused on Asia, one of the follow-on projects will have considerable effort in Africa.

With respect to the Near East (Middle East and North Africa), water scarcity and need for the careful management and utilization of water resources has been a historic fact of life. This emphasis on water will continue with efficiency in its capture, distribution, and utilization remaining the priority concern, with respect to improving agricultural productivity, as well as in trying to conserve and protect the fragile natural resouces. In Latin America, where the focus is also on better water management, the driving force behind this concern is in exploiting the opportunity for diversifying into non-traditional and other high-return crops that well-managed irrigation affords.

Although the level of AID's bilateral assistance in irrigation is not expected to increase over the next few years, the impact that a central-support project can have in making this effort more effective and in favorably influencing the programs of other donors is considerable and warrants its

continuation. Thus, from AID's perspective, the progressive widening of WMSII's geographic scope and the expansion of its activities clearly needs to be perpetuated.

AID's Follow-on Program of Assistance

Not only is this situation recognized within AID but efforts to effectively address it are being taken. These will culminate in two new projects which will jointly expand the type and range of assistance available under WMSII. One of these projects has been initiated by the Asia and Near East Bureau (Irrigation Support Project for Asia and the Near East -- ISPAN) and focuses exclusively on those two geographic regions; the other, the Irrigation Management Support and Research Project (IMSAR), will be jointly funded by the Science and Technology, Africa, and Latin America Bureaus and will concentrate on these latter two regions. Thus collectively, they will extend and expand WMSII's scope in terms of problem domain and range of assistance provided.

Service to Missions the Main Focus of ISPAN

AID Missions and host countries in Asia and the Near East have consistently been heavy users of WMSII's services, largely for project design (WMSII has assisted with 12 such efforts in seven countries), but also for broader sector studies/surveys, strategy reviews/assessments and project evaluations. Thus, with the ANE Bureau's irrigation portfolio now consisting of 16 projects totaling over $700 million in life-of-project funding, and future investments in irrigation expected to proceed at a similar, though slower, pace, the need for assistance of this type remains strong. And, while design assistance will continue to be needed, the emphasis is expected to shift more to project implementation, requiring the need for greater project monitoring and redesign/redirection assistance and evaluation.

The need also will continue for assistance in the development of training curricula, materials, and trainers, as well as help in assessing and sharing information about lessons learned and experiences throughout the ANE region. Applied studies and research to support general irrigation sector growth and development will also be sponsored. This includes the assessment of strategic issues and trends affecting irrigation management and the development of responses that are relevant to the physical and institutional circumstances of the region. However, in selecting research topics and areas for study, major emphasis will be placed on those directly affecting AID's bilateral assistance program in Asia and the Near East regions. In addition, besides helping develop and improve an information support network for their country missions and irrigation specialists throughout the region, the project will also work with regional support institutions to strengthen their capabilities to better serve the irrigation development and improvement needs within their spheres of influence.

Consequently, with most Asian/Near Eastern countries depending heavily upon irrigated agriculture to feed their growing populations, raise rural incomes, and generate expanded employment opportunities, there remains an urgent need to improve the efficiency and productivity of existing and newly developed irrigation systems. However, as the WMSII experience has clearly demonstrated, achieving this requires not only an interdisciplinary approach, but also attention to a broader set of constraints that extend well beyond the physical system. ISPAN, like WMSII, is designed to deal effectively with this broader set of interrelated needs. However, somewhat less like WMSII, its applied studies, training/technology transfer activities, and technical assistance components will be more closely related to Mission requests and the Bureau's overall bilateral irrigation program.

IMSAR Will Deal with a Broader Problem Domain

As compared to its current counterpart (ISPAN) and its predecessor (WMSII) projects, the Irrigation Management Support and Research Project will have a broader problem focus, as well as a somewhat different emphasis in terms of the assistance/support mix it will provide. This results mainly from the latter's strong geographic orientation on sub-Saharan Africa; the general state of agricultural development in that region relative to the demands placed upon it; the range of problems African countries face relative to better management and utilization of their water resources, including irrigation development and improvement; and the nature of AID's bilateral program in sub-Saharan Africa with respect to agriculture and irrigation/water management.

Specifically, ISMAR will expand its domain to deal with the more comprehensive concerns of "irrigated agriculture" as compared to "irrigation." It also will broaden its attention to include all types of agricultural production systems involving the management and utilization of water resources. This includes flood recession farming, swamp cultivation, wetlands agriculture, and water harvesting/spreading. While placing strong emphasis on strengthening the capabilities of national institutions responsible for irrigation and water resources utilization development and improvement, the project will especially try to better identify irrigation's strategic role in agricultural development and how it can be more effectively integrated into a country's overall development effort.

In terms of overall project activities, while continuing to be responsive to Mission assistance requests, this component is expected to be significantly less than under either WMSII or ISPAN, with a shift from design help to more direct assistance to host countries. The emphasis will be more on applied studies and technology transfer, with training also increasing in importance, at least with respect to Africa.

Environmental issues and attention to broader natural resource management questions will also become a more explicit part of the program as the importance of water and the need to better develop, manage and utilize the vital resource becomes increasingly critical for countries in these regions.

Synthesis of Lessons from Diagnosing Irrigation Systems

The Water Management Synthesis II Project has been involved in extensive activities related to the diagnosis of irrigation systems. Diagnostic analysis workshops and diagnostic analysis studies have been conducted in India, Pakistan, Sri Lanka, Nepal, Bangladesh, Zimbabwe, Niger, Rwanda, and Thailand. Additional system diagnosis has been a part of sector reviews and project designs. Most technical assistance efforts have included some form of system diagnosis. This rich experience has been systematically reviewed to reveal lessons learned about diagnostic methodologies and about system problems that need immediate attention.

For example, preliminary synthesis of lessons learned indicates that a structured process for a diagnosis needs to be clearly agreed upon by the interdisciplinary team. Most study results suggested some areas were dealt with by individuals on the team, which were not clearly a part of the team effort. A team needs to adopt a logical structure for diagnosis, such as looking at the system, identifying the areas of low performance, identifying the factors causing the low performance, and then developing recommendations (or a project design) that deal with the important needs for improvement. Otherwise, important problems are omitted, recommendations are made for poorly defined problems, and actions that need to be taken are poorly or incorrectly defined.

Important lessons learned are that most of the teams involved in system diagnosis did not explicitly address the issue of sustaining irrigated agriculture or of conserving resources. In many instances the factors constraining the productivity of irrigated agriculture were not explicitly identified or were ignored. Poor organizational coordination was often inferred to be a reason for poor performance, but usually such a conclusion did not include both irrigation and agricultural considerations. The on-farm system for water control was not explicitly evaluated in more than half of the diagnostic studies. Farmer involvement was the most deficient area in terms of effective system performance. Low main system performance also was consistently identified by the teams.

Irrigation professionals work together to analyze and then synthesize lessons learned from diagnosing an irrigation system.

Joint Field Studies

Three field-based studies to understand the performance issues facing small-scale irrigation systems in Africa were completed in 1987. The studies were joint efforts between host country irrigation professionals and WMSII personnel to gather field data to evaluate irrigation performance in Africa. Studies were completed in Niger. Rwanda, and Zimbabwe. These interdisciplinary examinations of the constraints facing small-scale irrigation projects provided a major thrust for an Africa-wide conference in Nairobi, Kenya during January 1988.

Zimbabwe

Four Zimbabwe irrigation systems were evaluated during a joint field workshop in January and February of 1987. The 5-person U.S. team worked closely with the 6-person Zimbabwe team to develop an understanding of interdisciplinary methods for evaluating irrigation systems. Two energy specialists were added to the team for a short time to examine pumping and other energy-related issues.

The level of irrigation development on communal lands in Zimbabwe is impressive. While some of the communal schemes appear to have serious problems, many have supported high levels of production, contributed to increased incomes for rural families, and decreased the impact of drought. A few of the existing communal schemes have been expanded but no new schemes have been established in recent times.

The Government of Zimbabwe wants to establish new irrigation schemes on communal lands for rural employment, social welfare, and food security. What is the potential for small-scale irrigation in Zimbabwe? What did we learn from the Joint Field Workshop? The opportunities exist, the official support exists, but new communal schemes have not been developed. Unless changes occur, the future is unlikely to differ from the past. The Joint Field Workshop was designed to make a significant contribution towards the solution of this problem.

For any rehabilitation or development program, technical and financial analyses of alternatives need to be determined; all viable alternatives should be vigorously pursued. Education and training of key individuals, from farmers to irrigation professionals, are necessary for successful, effective irrigation management. Information "gaps " in agronomy, engineering, and institutional structures should be filled through research and administrative studies. Farmer involvement and organizational structures can be strengthened through educational programs and innovative organizational approaches. Reliable water supplies and equitable distribution are fundamental to productive irrigation schemes and should be ensured by wise water use policies.

Niger

This Joint Field Study/Workshop was multidisciplinary with a set of expatriate professionals with broad international irrigation development experience, and a set of Nigerien colleagues who brought in the local perspective. The study component was designed to use a rapid appraisal approach for developing a more in-depth understanding of the successes in, and constraints to, irrigated agricultural development at four representative sites. The workshop component was designed as a means of learning together how successes might be extended locally as well as regionally, and developing strategies for reducing or eliminating the constraints.

The team studied four major separate and uniquely different irrigation schemes. Each rapid appraisal involved three to four days of field work and associated discussions plus time to write a draft report. The four cases studied were:

* A community-managed river lift scheme (3 ha.)

* A multiple (50) deep-well irrigation scheme supplied from a common electric grid (500 ha.)

*A surface reservoir gravity-fed irrigation scheme (245 ha.)

*Private irrigation development from dug wells (300 to 500 ha.)

In general, the irrigation schemes visited were functioning reasonably well. Farming practices were adequate to good by West African standards, though there is room for improvement. Farmers seemed to know how to prepare and irrigate their parcels effectively and efficiently. This was especially true for onion production with world class yields of 35 to 40 tons per hectare, but less so for general field crops, but it does indicate a high level of indigenous farmer capability. We were also impressed by the ability of farmers to organize and manage their irrigation systems at the tertiary level where this was required. Farmers generally planted improved varieties and applied close to recommended levels of fertilizers. However, yields of most crops were still relatively low even with the improved varieties because of weed, disease, insect and soil problems. To solve these problems will require considerable research to develop better irrigated cropping packages.

Most of the irrigation potential in Niger (and for that matter, in West Africa) does and will continue to require water lifting. Three of the four sites the team visited required water lifting. Therefore, minimizing the capital plus operating costs of lifting water is extremely important for the economic development of the region's irrigation potential.

Rwanda

WMSII responding to a request from the USAID mission in Rwanda for technical advice on water management of the small marais, fielded a joint field study team in 1987. The increasing population pressure and the failure of donor sponsored projects to improve agricultural production in the marais made a national policy for development of the marais necessary.

Small marais, making up four percent of the total land area, are the lands between the hills that are continuously wet throughout the year and subject to periodic flooding during the monsoon season. The valley lands are statutorily defined as Government-owned lands, but in actual practice the mayor and common council allocate land. Farmers have to relinquiesh the land to the government without compensation if asked to do so. The water management in the marais is extremely complex, although very little information is available. In general, there is an excess of water during the long rainy season from March through May, requiring drainage and a severe water shortage during the summer.

The project began in January 1987 with the arrival of the project coordinator. His main task was to make contact with Rwandan officials and experts, coordinate the activities within Rwanda, collect baseline data and lay the ground work for the joint field team. The joint field team met in the months of August and September and was comprised of two faculty members of the National University of Butare (Agronomy and Agricultural Economics), the Director of the Soil Science Department of the National Agricultural experiment station, the Head of the Agrohydrologic Division of the Rwandan Department of Agriculture, the Director of Rural Development at the President's Office, two students from the University of Butare, and six American experts.

In farmer-developed marais, fields consist of raised beds 50-80 cm high and generally 3-8 m wide and 10-25 m long. These dimensions which were arrived at by farmers' experience are also the most optimal. Drainage discharge and irrigation is by means of open ditches throughout the marais among the beds. The considerable expertise that is required for the dual use of ditches for subirrigation and drainage, is available traditionally among the farmers.

Donor-sponsored projects were successful only when they followed the traditional practices followed by the farmers. One such project was rice irrigation scheme of Rwamanaga where the irrigation water was obtained from the central drain. Other schemes importing irrigation and drainage technology from other geographic regions were not helpful in increasing yield. In fact, farmers soon transformed the infrastructure back to the traditional way.

Agricultural production of the marais is limited by four factors. The first is the extreme low fertility level of the soils. Also, farmers are not willing to make the necessary improvement because they do not have an enforceable right to cultivate the marais fields. Another limiting factor is the lack of a market to sell the products. Finally, the water management needs to be improved when production is intensified.

Solutions to the above limitations were discussed by 80 Rwandan scientists during the National Marais Development Conference in February 1988. The ultimate objective of the conference was to finalize a plan for a National Strategy of the Marais.

Participants at the Forum on the Performance of Irrigated Agriculture in Sub-Saharan Africa discuss possibilities of building a network of African irrigation professionals.

Africa Conference

An Africa-wide conference for irrigation professionals focused on performance issues of irrigation at the January 1988 meeting in Nairobi, Kenya. Prior WMSII experience and recent activities in sub-Saharan African irrigation provided the basis for the conference. To develop a data-based understanding of African small-scale irrigation systems, WMSII initiated Joint Field Studies in Zimbabwe, Niger and Rwanda. The field studies were done collaboratively with African irrigation professionals. The joint interdisciplinary teams conducted field-based investigations to gather information on the opportunities and constraints facing irrigated agriculture. These joint field studies, along with prior WMSII experience in irrigation development, provided the background for WMSII professionals to interact with African irrigation professionals at the conference. Also, effort was made to include other irrigation professionals outside WMSII, including those from the European community who have had extensive African experience.

The Forum on the Performance of Irrigated Agriculture in Africa was held in Nairobi, Kenya, Jan. 18-22, 1988, at the UNEP conference center. The conference center provided facilities for simultaneous translation in French and English.

The keynote address by Shem Migot-Adholla, an African professional who works for the World Bank, laid the foundation for examining issues that affect performance of irrigated agriculture. The five-day forum examined such issues related to performance as economic and financial, technical and energy, organizational and institutional, health impacts, and sustainability of the natural resource base. Invited papers and joint field study presentations set the agenda for intensive small group discussions. From these small group discussions the Africans and other irrigation professionals made specific recommendations regarding regional, national, and system-wide implementation efforts to take advantage of the opportunities that irrigation provides, as well as to reduce the constraints it faces.

The 50 participants included more than 30 African professionals from both East and West Africa. Five small groups were formed to discuss each presentation and to develop specific recommendations for improved performance of irrigated agriculture. The final session of the forum dealt with suggestions about how to continue working together as irrigation professionals even though they are spread out over an entire continent. Networking suggestions ranged from working with existing professional networks to meeting again in a followup forum within 12 to 18 months.

The final day of the forum included a field trip to see irrigation agencies, commercial outlets, and irrigated farms. The field trip was arranged through the Kenya Ministry of Agriculture.

The African small group discussion leaders, who had been selected for their knowledge and participation in earlier irrigation activities, met with the conference organizing committee after the forum had concluded to refine their recommendations for use by the Water Management Synthesis Project. Key recommendations are highlighted below. However, for a more complete look at the recommendations see either **WMSII Report 86.Forum on the Performance of Irrigated Agriculture in Africa: Papers and Proceedings**, 1988, or **Summary: Forum on the Performance of Irrigated Agriculture in Africa, WMSII Special Report**, 1988.

Toward A Strategy For Africa

Key recommendations from the Forum include the following:

1) Because of the general lack of resource data, project development should be carried out in incremental steps.

2) Greater stress should be placed on maintenance of irrigation systems.

3) Economic and financial evaluations of irrigation projects need to clearly identify those components whose costs are directly attributed to irrigation development.

4) Irrigation development programs in Africa need to include an explict program for cost containment which is based on the analysis of alternatives for the physical and organizational design of proposed developments.

5) Professional development activities should be planned to acquaint African social scientists with the study of irrigation.

6)Considerable farmer training is needed in support of new roles and responsibilities with irrigation.

7) Studies of indigenous, or local, irrigation institutions and organizations in Africa are needed.

8) An aggressive health education program should be undertaken in irrigated areas, focusing on water-related diseases and stressing steps people can take to reduce both the incidence of disease and exposure to it by those at risk.

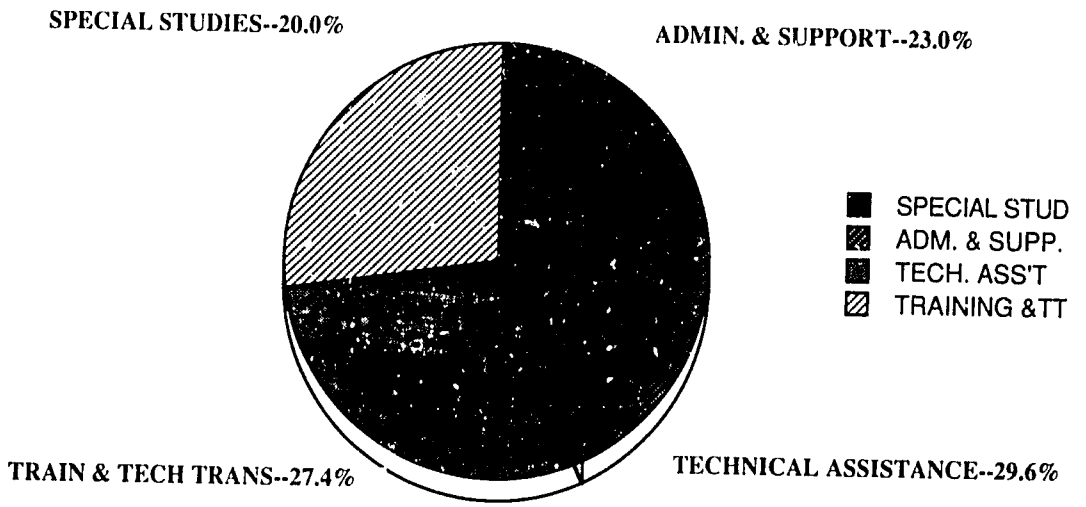
9)Planning of irrigation projects must explicitly consider the organizational, economic and financial, and technological sustainablity of each project as policy guidelines for planning and implementation.

10) Two irrigation development networks, one each for irrigation professionals in West Africa and East and Southern Africa should be established and assisted.

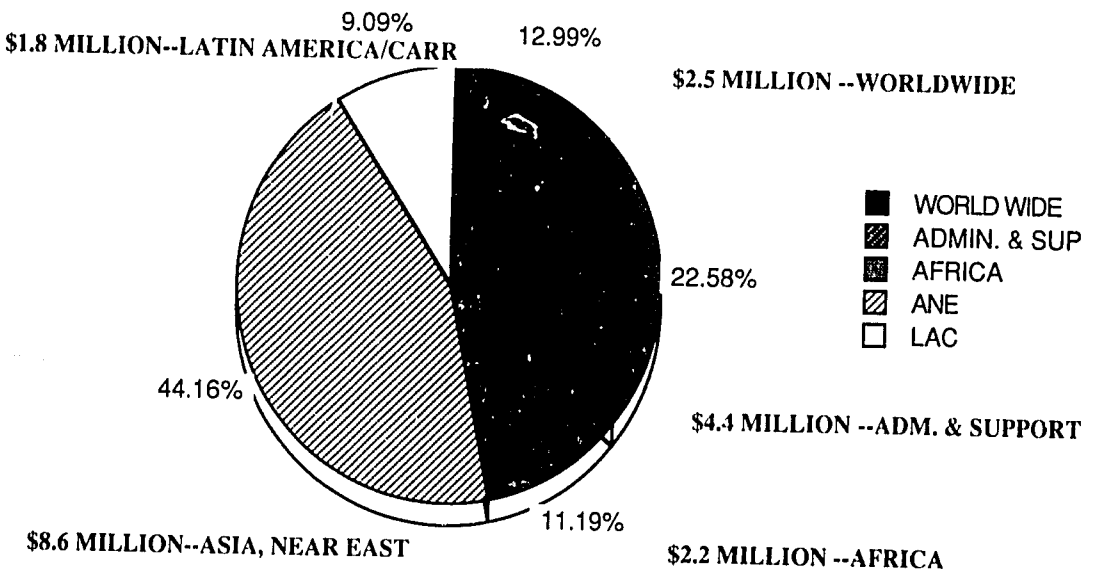
Documenting Project Achievements

There are many ways to look at WMSII achievements, but here we show how the money was spent and where it came from and then provide a list of project materials that have been produced during the last decade. Some of the document will be available from the universities for a few months ; however, the AID document center is the best place to obtain the material in the long term.

WMSII AUTHORIZATION BY TYPE ACTIVITY



WMSII EXPENDITURE AUTHORIZATION



Location of WMSII Activities

Number of Activities by Bureau and Country

Africa Bureau:	# of Activities	Asia/Near East	# Activities	Latin America	# Activities
Botswana	1	Bangladesh	6	Bolivia	3
Chad	1	Burma	1	Dominican Rep.	4
Kenya	1	China	1	Ecuador	2
Mali	1	Egypt	4	El Salvador	3
Mauritani	1	India	33	Guatemala	1
Niger	5	Indonesia	7	Haiti	4
Rwanda	2	Jordon	4	Honduras	1
Tanzania	1	Morocco	4	Paraquay	1
Zimbabwe	3	Nepal	5	Peru	5
Africa-wide	11	Pakistan	17	LAC-wide	2
		Sri Lanka	19		
		Thailand	1		
		Tunisia	1		
		ANE-Wide	11		

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Appendix A: The Indian Subcontinent
Appendix B: East Asia
Appendix C: Near East and Africa
Appendix D: Central and South America
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Slide Shows

(available only on videotape)

Farmer Organization in Minipe, Sri Lanka. Nine-minute slide show indicating the success of one irrigation scheme's farmer organization.

Diagnostic Analysis Workshop. Eleven-minute slide show about the five-week workshop that the Project has presented in several countries.

Water Management on Small Farms: Training for Farmers in Hill Areas. A series of five slide-tapes: a companion to *Water Management on Small Farms: A Training Manual for Farmers in Hill Areas.*

Plant-Nutrient Deficiencies. Discusses major nutrient deficiencies.

Sprinkle Irrigation --An Overview. A 25-minute slide-tape program introducing the different methods of sprinkle irrigation.

Irrigation in Somalia: Fragmatic Rehabilitation Along the Shelbelle River. A 26-minute slide show documentation. 1987.

Niger Irrigation Schemes Case Study. A slide/videotape program documentation. 1988.

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Measuring Conveyance Losses in Watercourses. T. Trout. Series of tapes discuss how to measure and evaluate water losses. (See *Videotape Guides*)

Farmer Involvement. Investigates the need and benefits of involving farmers in all phases of the development process.

Diagnostic Analysis Workshop. Illustrates the five-week project workshop.

Research-Development Process. Discussion of the development model used by Water Management Synthesis II Project.

Diagnostic Analysis Process. Outlines the first phase of the development model. This phase is divided into reconnaissance and detailed studies. Flow charts describe the sequence of activities.

Diagnostic Analysis in Sri Lanka. An overview of the diagnostic analysis workshop conducted in Sri Lanka in July 1983.

The Minipe Project. Looks at how a group of religious leaders organized farmer groups in Minipe, Sri Lanka.

The Agronomy Series. Three tapes that examine soil moisture measurements, salt-affected soils, and plant/soil/water relationships.

The Role of Economics in Diagnostic Analysis. Discusses the major economic considerations in the diagnostic analysis of a system.

Farmer Organization. Describes the necessity of organizing farmers into groups for more efficient water management.

The Social Organization of Irrigation. Social processes in irrigation.

The Role of Women in Development. Examines the WID component in understanding the role of women in an irrigation system.

Exercises in Vision. Examines the India Training Program and the diagnostic analysis of an irrigation site near Fort Collins, Colorado.

Irrigation Training Modules. A series of 40 video programs in English and Spanish designed to introduce irrigation concepts to agricultural technicians.

Computerized Irrigation System Management. A series of six programs documenting USU's computer models that assist in operation and management of irrigation systems.

Forum on Improved Performance of Irrigated Agriculture in Sub-Saharan Africa. A 30-minute videotape summarizing the various presentations at the 1988 forum in Nairobi, Kenya.

Zimbabwe Joint Field Study. Video of field study done by joint WMSII and Zimbabwe interdisciplinary team.

Joint Project Management Team

The WMSII Project was managed by a Joint Project Management Team composed of the following members:

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