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Cover photograph shows farmers in India using traditional water lift device on an irrigation canal.

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International Irrigation Management Institute

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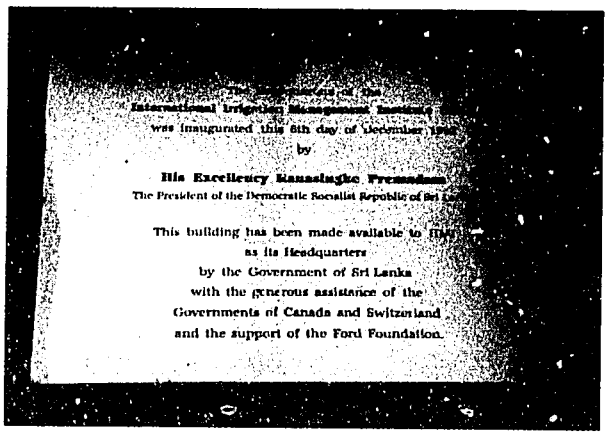
FOREWORD

In more ways than one, 1992 marked the "coming of age" of IIMI.

The most compelling evidence of the Institute's maturity is the scientific quality of the research results presented in this year's Annual Report. Progress is particularly evident in IIMI's work to compare and analyze experience across different countries and locations, which has begun to yield valuable insights for managers and policymakers. The research section of the report reflects our efforts to develop a program that is both more integrated and more output-oriented than that of previous years. Although there are still challenges to overcome, IIMI's program has made considerable progress towards achieving the standard of excellence expected of a full-fledged member of the international agricultural research community.

Operationally, the year was marked by several important milestones. Findings with important implications for the sustainability of irrigated agriculture worldwide emerged from our collaborative research with national agencies in Pakistan. IIMI gave significant attention to developing relationships with China, Egypt and Mexico, where the irrigated sector is large enough for improvements in performance to have a global impact. IIMI also placed renewed emphasis on environmental and public health issues, taking steps to shape its future program in accordance with the priorities emerging from the UNCED meeting. Following the recommendations of a 1991 report, the Institute launched a global program to investigate gender issues. Lastly, the Institute obtained TAC and CGIAR endorsement in principle of its strategy and medium-term plan. Both documents reflect IIMI's intention to capitalize on the opportunity, derived through membership in the CGIAR system, to develop a coherent core-funded program.

In the process of formulating its strategy, IIMI made a small but significant change to the wording of its mission statement: improving the performance of irrigated agriculture, rather than the irrigation system alone, is now the focus of the Institute's work. Slight to the casual observer, this change is part of an important evolution occurring throughout the international research and development community. As the Brundland Commission noted in 1986, "Sectoral organizations tend to pursue sectoral objectives and to treat their impacts on other sectors as side-effects, taken into account only if compelled to do so....Sustainable development requires that this fragmentation be overcome." By broadening its focus to irrigated agriculture, IIMI has played its part in breaking down these sectoral barriers. In so doing it hopes to encourage similar moves at national level, where irrigation



and agriculture frequently remain the responsibility of different ministries and institutions.

This shift in emphasis cannot but be reinforced by IIMI's new membership in the CGIAR system, which will enable it to form closer working relationships with international crop research institutes. Over the past year IIMI has acted to strengthen its links with IRRI, WARDA, CIMMYT and ICARDA, as well as IFPRI and ISNAR. In the longer term, the broadened scope of research at system level — now encompassing forestry and fisheries alongside agriculture — will allow IIMI to forge new relationships in all three sectors.

A tangible symbol of IIMI's coming of age in 1992 is the inauguration plaque that now stands outside the main entrance to IIMI's new headquarters building. The plaque was unveiled on 6 December 1992 by the late President of Sri Lanka, His Excellency, Ranasinghe Premadasa, in a colorful ceremony attended by IIMI's Board of Governors, representatives of donor agencies and the Government of Sri Lanka, and IIMI staff. In its pleasant surroundings close to the country's new Parliament on the eastern outskirts of Colombo, the building is a handsome gift to the Institute from its host country, with the generous assistance of the Governments of Cananda and Switzerland and the Ford Foundation. From its new permanent home, and with its several field programs around the world, IIMI will be able to tackle the challenge of its important mandate with renewed vigor.

Roberto L. Lenton

Roberto Lenton
Director General

IIMI's Research Results 1992

Details of IIMI's achievements during 1992 are presented in this report. The first section focuses on five themes of research carried out by the Institute during the year. The five themes are Performance of Irrigation Systems, Management of Water for Irrigation, Institutional Change and Policies, Farmers and the Farming Community, and Environment and Public Health.

These themes follow the structure of the program of the Institute during 1992. From January 1993, the program has been reorganized into different themes and this will be reflected in future Annual Reports and other IIMI publications, dating from this time.

The Country Programs section describes IIMI's in-country collaborative research with national programs conducted in several developing countries. There are separate sections on Capacity Building, Information, and Finance and Administration. A concluding Annexes section provides additional information on projects, publications, awards and other matters of interest.

THEME 1: PERFORMANCE OF IRRIGATION SYSTEMS

INTRODUCTION

IIMI was established because there is a serious gap between the potential and actual performance of irrigated agriculture. This gap is attributed to the poor management of the technology available for irrigation, and of the institutions and individuals responsible for its productive, sustainable and equitable use. All IIMI's activities therefore contribute in one way or another to the performance theme, which lies at the heart of the Institute's mandate. In recent years, however, the Institute has realized that the topic is so important that it merits a separate and sizeable program of its own.

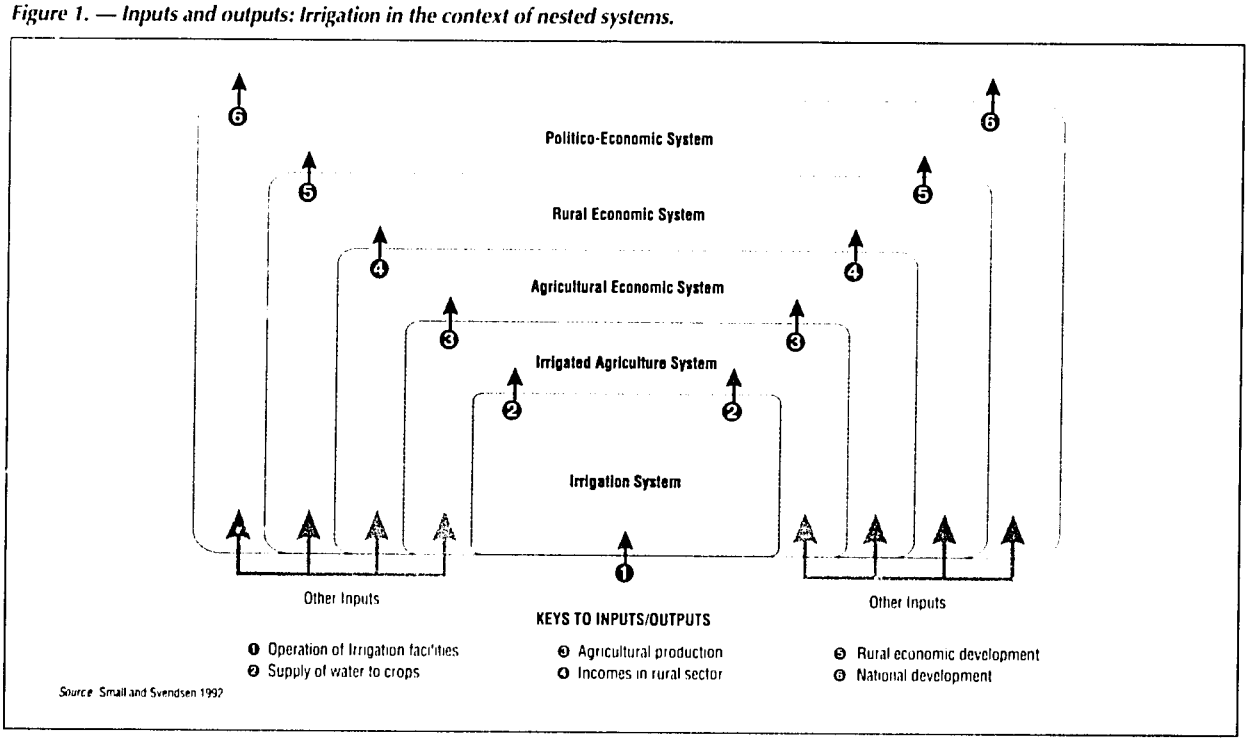
This it now has. Late in 1991, IIMI established a task force to implement an ambitious program of research on the subject of performance and the methods required to assess it. This year's Annual Report reports the program's first year of operations.

DEVELOPING A CONCEPTUAL FRAMEWORK

Approaches to assessing the performance of irrigation systems have varied widely in the past, leading to difficulties in comparing data across countries and systems. One of the first tasks of the new program, therefore, was to develop a conceptual framework and methods that can be shared and used by IIMI scientists, their partners in national research systems and other interested parties.

To accomplish the task, a joint project with the International Food Policy Research Institute (IFPRI) had previously been launched, funded by the Ford Foundation. Input to the development of the framework was provided at several jointly sponsored workshops, the third of which, on performance indicators, had been held at IFPRI in 1991. In 1992, the project completed its work, and the final version of the framework was published (Small and Svendsen 1992).

Figure 1. — Inputs and outputs: Irrigation in the context of nested systems.



A salient feature of the framework is that it distinguishes the hierarchy of nested systems within which irrigation takes its place, and hence the different levels at which interventions affecting the efficiency of irrigation can be made (see Figure 1). The Performance Program has so far focused its attention mainly on the two primary elements of this hierarchy, the irrigation (or water delivery) system and the irrigated-agriculture system. In the future, it will pay somewhat more attention to the links between these systems and the broader economic and social systems.

The Table at right summarizes the conceptual framework developed. It illustrates the many choices to be made in undertaking a performance evaluation and the importance of specifying these choices explicitly if results are to be comparable across systems and over time. It also highlights (in bold) a class of assessment parameters neglected in the past. These concern the recurrent processes of irrigation systems rather than the episodic design and construction processes; a focus on the irrigation system proper; and an interest in the collectively or bureaucratically managed portion of the system. This class of assessments is felt to be important for four major reasons:

- With investment in new irrigation systems declining, donors and policymakers are anxious to increase the efficiency of existing systems.
- The point at which water is delivered to farmers' fields usually marks the transfer of responsibility for irrigation from a group to an individual. Assessment at this point makes it possible for the group to evaluate its own performance.
- The assessment of irrigation performance in terms of water deliveries minimizes the confounding influence of other, nonirrigation variables.
- The point of water delivery to farm fields is the most appropriate one for linking two analytic methods — the hydrologic model and the agro-

Outline of the conceptual framework for evaluating irrigation performance.

I. Delineating Boundaries on What Is To Be Evaluated

A. System
   1. **Irrigation system only**
   2. Irrigated-agriculture system (including irrigation system)
   3. Other systems (including irrigated-agriculture system)

B. Irrigation subsystems (system functions)
   1. **Acquisition** 2. **Distribution** 3. Application

C. Life-cycle processes
   1. Planning 3. Construction 5. **Maintenance**
   2. Design 4. **Operation** 6. **Support**

D. Geographic extent
   1. **Physical basis**
      a) Design area
      b) **Service area**
      c) **Net Irrigated area**
   2. Social basis

II. Delineating Types of Evaluation: Concepts of Performance Assessment

A. Models of performance
   1. **Goal-oriented**
      a) Goals of society
      b) Goals of external constituents
      c) Goals of internal constituents
   2. Natural system

B. Rationale for assessment
   1. Operational performance monitoring
   2. **Accountability**
   3. **Intervention**

C. Types of performance measures
   1. Level
      a) Process
      b) **Output**
      c) Impact
   2. Scope
      a) Achievement
      b) Efficiency
   3. Relationship to conceptual indicator
      a) Direct
      b) Indirect

D. Source of performance standards
   1. Internal 2. **External** 3. **Relative**

E. Time dimension of assessment
   1. Single point in time
   2. Multiple points in time

Source: Small and Svendsen 1992.

economic model. Specifying water flows at this point can lead to significant improvements in the ability to predict the agronomic and economic consequences of alternative irrigation scenarios.

This framework provides a useful conceptual basis for designing research to evaluate irrigation performance, and will be adapted further by IIMI to facilitate future comparative studies.

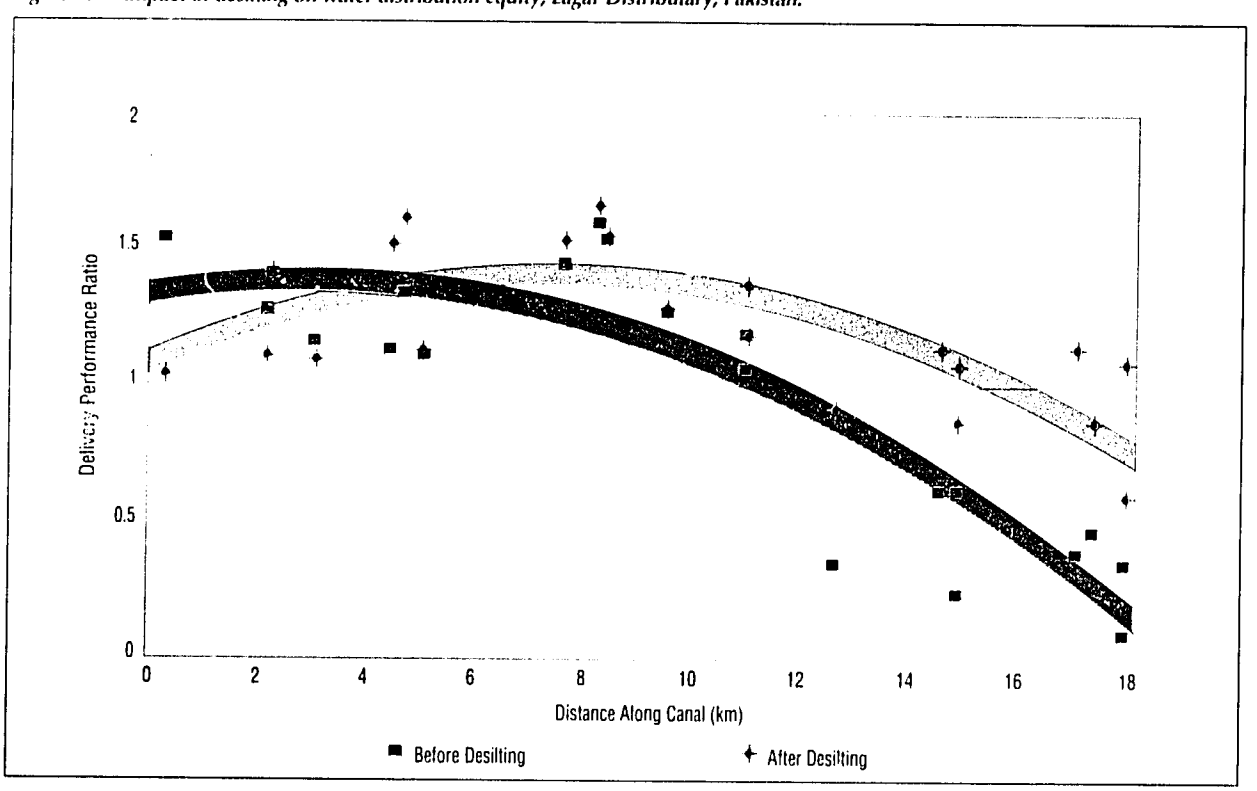
ACHIEVING MORE EQUITABLE WATER DELIVERIES

The unreliability of water deliveries to farmers at the tail end of the distribution network is one of the commonest problems affecting irrigation schemes worldwide. Often, the problem reflects not just the scarcity of the water resource itself, but also its profligate use by farmers in the head and middle reaches of the scheme. These farmers habitually take more than their fair share of water, frequently acting illegally to do so.

The findings of an IIMI project conducted in collaboration with the Punjab Irrigation Department (PID) in Pakistan have important implications for improving the efficiency of water delivery to tail enders. Long familiar with the problem, the department had been considering various ways of dealing with it. The project compared three possible interventions: lining the canals with brick and mortar to minimize seepage, desilting to improve the flow of water, and improving the efficiency of canal management and supervision.

Lining proved the most expensive of the three, costing some US$30 per hectare. IIMI's research showed it to be also the least effective. When brick and mortar lining was introduced, water delivery became less reliable than it had been before, and even declined in some canals. The major reason for this

Figure 2. — Impact of desilting on water distribution equity, Lagar Distributary, Pakistan.



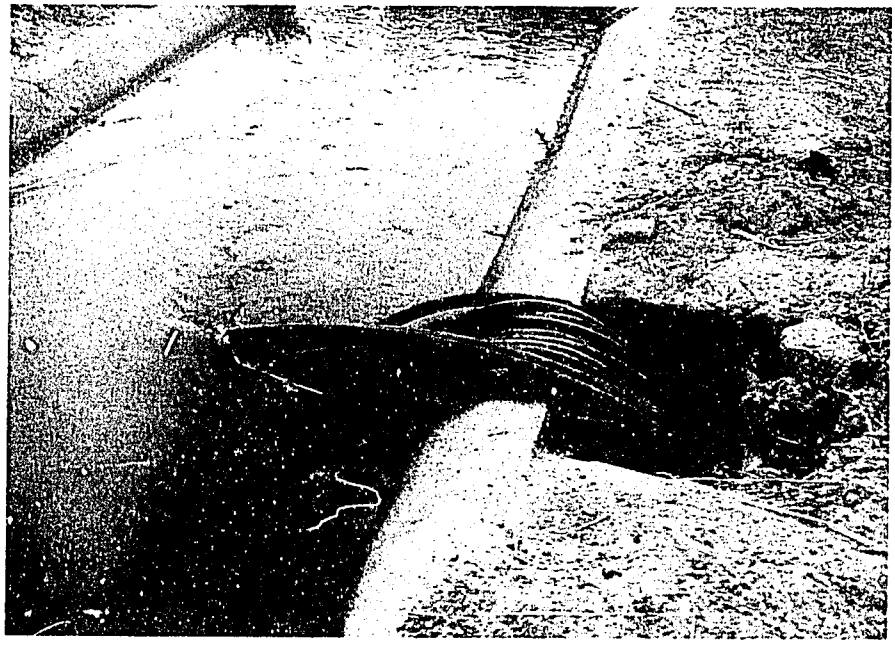
was that farmers tampered with the dimensions of their outlets during the lining process so as to increase the amount of water they would receive. In addition, the poor quality of the construction meant that the lining would be unlikely to last for more than a few years.

Desilting proved much cheaper. Two different approaches were adopted both of which led to significant improvements in performance. The first followed the standard practice of desilting the entire length of the canal, at a cost of about US$2.20 per hectare. This led to a significant gain in the equity of water supplies between head and tail users. The second approach, proposed by IIMI, was based on a computer simulation of water flow that predicted what would happen when only limited sections of the canal were desilted. The optimum theoretical trade-off between cost and performance gain was calculated, and was then tested in the field. The calculation was found to be correct, validating the model and confirming its usefulness as a management tool. The cost of selective desilting, carried out by the PID, amounted to only US$0.22 per hectare, and still led to the virtual elimination of differences in water deliveries between head and tail users. Although total desilting may last longer than selective desilting, increasing the interval between interventions, analyses suggest that regular, focused desilting on the most seriously affected sections will prove the most cost-effective solution (see Figure 2).

Improvements achieved through desilting remain highly sensitive to the management of irrigation operations. Desilting restores the potential for operating the system at the level of discharge for which it was designed, but whether or not this actually happens again depends on farmers at the head and middle reaches. These farmers may continue to help themselves to the increased supplies of water at the expense of their neighbors downstream (see box below). If this happens, tail enders will be just as badly off as before.

WATER THEFT: THE REASONS WHY

Farmers who steal water in the Punjab do so at a specific time of the year and for entirely rational reasons. IIMI's research showed that theft occurs as soon as farmers start to prepare land for rice cultivation, normally in June. Farmers are anxious to ensure early planting, over as large an area as possible, of their most valuable crop, the long-grained, scented basmati rice. This traditional variety, with its good flavor and cooking qualities, is in high demand by restaurants and other urban consumers in Pakistan. It also fetches a high price as an export commodity. Attempts by plant breeders to transfer



Water theft occurs when farmers start to prepare land for rice cultivation.

Depriving tail-end farmers of surface water forces them to use more groundwater.

its quality characteristics to modern high-yielding varieties have not so far met with success. Hence, yields are lower than for other rice varieties, while farm-gate prices remain high. Water theft tails off once the crop nears maturity, and stops altogether after harvest.

By stealing water, farmers in the upper and middle reaches are able to maximize both yields and total production of this valuable crop. Water theft is what makes them wealthier than their neighbors downstream.

At present, not much can be done about this problem, although better policing of the system by agency officials would doubtless help. A new tool developed by IIMI enables the total volume of water stolen to be calculated by comparing actual discharges into watercourses with those predicted under water conditions when theft does not occur.

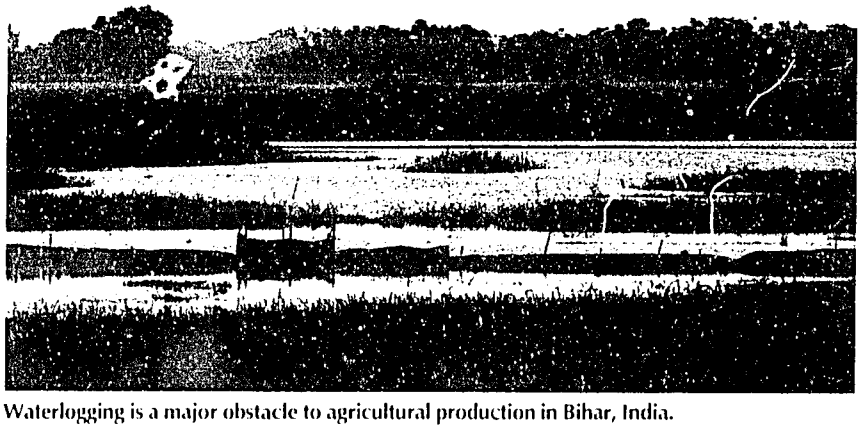
The equitable delivery of surface water is important not only for the short-term productivity of irrigation systems but also for their long-term sustainability. Depriving tail-end farmers of surface water forces them to use more groundwater. As this declines in quality, higher levels of salinization occur. In collaboration with national research groups in Pakistan, the Performance Program completed detailed studies on this problem during 1992. The results are reported under Theme 5, Environment and Public Health.

CUMULATIVE RELATIVE WATER SUPPLY: A CONCEPTUAL STEP FORWARD

The concept of relative water supply (RWS) has been used by scientists for more than a decade to assess the performance of irrigation systems. It is the ratio of the water supplied to the water demand associated with specific crops and cultural practices, in a given command. The concept can be applied to both rice and upland crops. Both groundwater and surface water can be taken into account. The values are based on field observations and measurements at a particular point in time. RWS is easy to calculate, and is a good indicator of operational performance. But if it rains or if extra groundwater is applied the day after the measurements are taken, neither this water nor its effect on subsequent canal operations is accounted for.

IIMI scientists have, therefore, developed a complementary concept called cumulative relative water supply (CRWS), which takes ijto account the total supply of water to the crop over time. Whereas RWS is useful for evaluating the ratio of supply to demand at a given point in time, CRWS can be used to evaluate it over an entire season. It can, therefore, be used by system managers to monitor water delivery performance on a continuous basis and to make any necessary adjustments as the season progresses.

THEME 2: MANAGEMENT OF WATER FOR IRRIGATION



Waterlogging is a major obstacle to agricultural production in Bihar, India.

INTRODUCTION

IIMI's objective under this theme is to develop better management systems for water conveyance, allocation and distribution. This requires the study of technical issues affecting the matching of water supplies to the water requirements of crops. It also requires an understanding of the managerial capacity of agencies to implement water delivery plans, and of the staffing and other resource implications of different approaches to operations and maintenance.

The relationship between the physical design of an irrigation system and the management requirements associated with it is complex. When systems are designed without taking into account the management requirements in different agro-ecological or socioeconomic environments, performance may fall disappointingly short of expectations. Symptoms of this include unreliable water deliveries, inequitable deliveries at main, secondary and tertiary levels, waterlogging and low crop yields.

IIMI is developing various tools and approaches to overcome these problems by improving the information available to system managers. Research takes place at two levels: acquiring better baseline data through field surveys, and developing (or introducing) more efficient means of processing data, using state-of-the-art computer technology.

BASELINE DATA

Conjunctive Use in Bihar: Support for Management Decisions

Farmers often depend on both groundwater and surface water to irrigate their crops. This so-called conjunctive use complicates the delivery of surface water. If deliveries are planned and implemented without regard for the availability of groundwater, the results may be both inequitable and damaging to the environment, depriving some irrigators of adequate supplies while leading to growing problems of waterlogging and/or salinization (see Themes 1 and 5).

Bihar State, in northern India, is a relatively water-rich area. There are few salinization problems as yet, but considerable waterlogging is apparent in areas where surface water is supplied. Crop yields are far below their potential, and Bihar is one of the country's poorest states.

In 1992, IIMI began a new study in the Gandak System of Bihar State to determine the extent of conjunctive use — asking farmers exactly how they irrigate each field at different times of the year. The aim is to develop methods for detecting and assessing conjunctive use so as to support management decisions on the allocation of surface water. The study

builds on previous work undertaken as part of a comparative study across four states, carried out mainly by Indian professionals (see page 44).

Initial indications are that the area in which the use of groundwater and surface water overlaps is smaller than was originally expected. Farmers do not invest in pumping up groundwater unless they have to; in other words, unless the supply of surface water becomes so unreliable that their livelihoods are threatened. In most parts of the system under study, this situation has not yet arisen.

SMALL TANK IRRIGATION IN SRI LANKA: FACT AND FICTION

Like that of other traditional practices and systems in agriculture, the study of small-scale tank irrigation is currently receiving renewed interest (see box below). With the sustainability of modern approaches being increasingly subject to question, scientists and planners are turning their attention to those of the past. By nature retrospective, in the study of traditional systems they run the risk of being romanticized.

TANK IRRIGATION: NEW LOOK AT AN OLD TECHNOLOGY

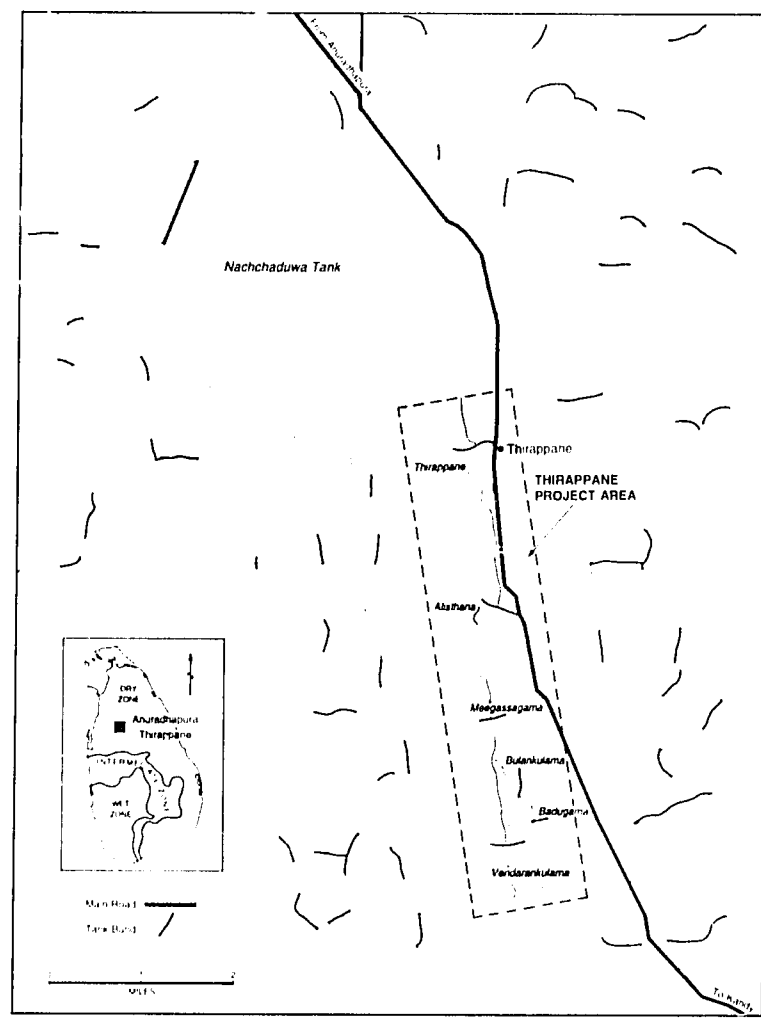
IIMI's host country, Sri Lanka, is also home to some of the world's most ancient systems of irrigation — the so-called tank cascade systems of the island's dry northern central areas.

These systems consist of chains of interconnected small reservoirs sited at strategic points in a watershed, often at the confluence of two watercourses (see Figure 3). The reservoirs are primarily used to irrigate rice fields, but they also provide local water supplies for domestic use as well as for watering livestock, raising fish and growing vegetables.

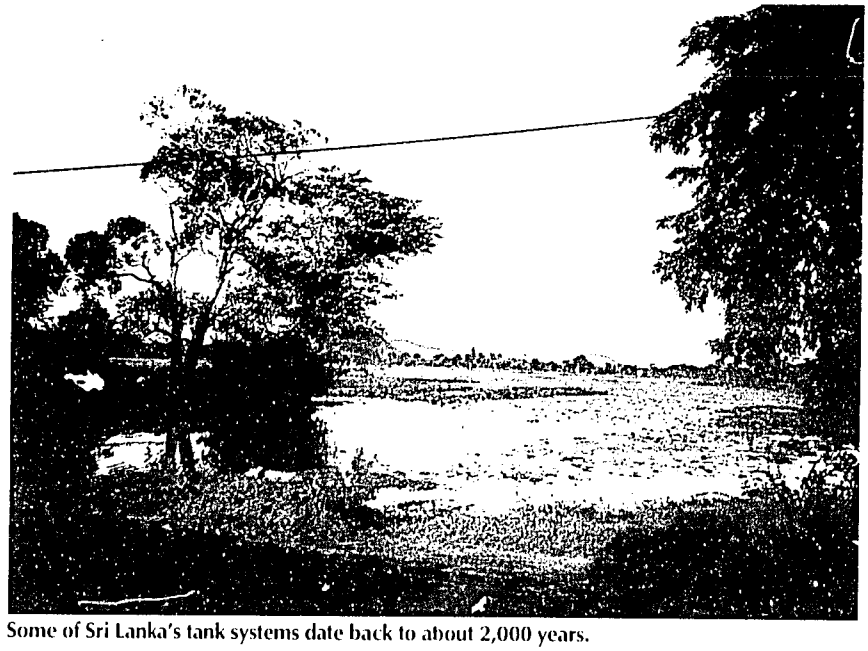
Some of Sri Lanka's tank systems date back to about 2,000 years. Following the collapse of the country's dry-zone civilization in the twelfth and thirteenth centuries A.D. and the mass migration of its people southwards to the humid zone, the larger systems fell into disrepair. Many smaller village tanks still survived, however, and continue even today to meet rural people's everyday needs for water.

Sporadic attempts to rehabilitate tank systems began during the colonial era. Following

Figure 3. — Nachchaduwa Tank surrounded by small tank cascade systems.



independence in the postwar years, these attempts continued on a modest scale, but were largely overlooked as the government turned its attention to the construction and management of large-scale agency-controlled flow irrigation schemes. However, the 1980s saw renewed interest in small-scale tank irrigation as the supply of new irrigable land began to run out and the poor performance of large-scale schemes came under increasing criticism.



Some of Sri Lanka's tank systems date back to about 2,000 years.

Tank irrigation has not escaped this fate, having been widely hailed as a sustainable system that could, if properly managed, improve the livelihoods of some of Sri Lanka's poorest people. The romanticism lies in the assumption that a system that worked well in the past, when human population pressures were so much lower, can meet today's greatly increased demands. What is needed is a good hard look at tank irrigation systems to determine whether they can, in fact, be improved through mere physical rehabilitation — a common approach for improving the performance of these systems, or whether the real causes of system decline lie in the social and economic pressures that have long surrounded such systems and that continue to increase today.

The basis for claiming a potential for system improvement rests largely on the rehabilitation of individual tanks. This approach may improve local water supplies, but it ignores the hydrological relationships within the watershed as a whole. In one important respect tank systems may turn out to be no different to canal systems: more water for one group of users means less for another.

In 1992, IIMI launched a collaborative project with the Tropical Agriculture Research Center (TARC) of Japan to investigate these issues in more detail. The project had two components: a technical one, designed to quantify water balance in tank irrigation systems on a whole watershed basis, and a socioeconomic one, intended to investigate whether small tank systems could be sustainably and equitably managed to meet the demands now placed on them.

During that year, the project's scientists selected research sites and began data collection in the Thirappane area, part of the catchment area for the Nachchaduwa Reservoir, in the Anuradhapura District of north central Sri Lanka.

Initial findings confirm the existence of hydrological relationships at system level. However, several features of tank systems make them more flexible than canal systems. These include the relatively short distances over which water is conveyed, the greater potential for returning excess water in farmers' fields to a lower-lying part of the system, and the option for utilizing the water from upstream tanks that are full, allowing more water for use further downstream. These features may allow some room for the overall improvement of system efficiency.

LARGE-SCALE SCHEMES IN SUDAN: THE DRIVE FOR GREATER EFFICIENCY

Located at the junction of the Blue and White Nile rivers, the Gezira is Sudan's largest and best-known irrigation scheme. Given the importance of the irrigated sector in national food production (see page 53), the government affords high priority to increasing the productivity of schemes such as the Gezira. A project to assist the Gezira Board in its efforts to improve the efficiency of water deliveries ended in October 1992. It made over 20 recommendations, identifying several key areas in which efficiency could be improved (see box below).

WATER DELIVERIES IN THE GEZIRA: KEY INTERVENTIONS

Among the project's most important findings was the fact that decisions on crop area are made not according to the water available, but on an ad hoc basis. Switching to the use of long-term data on stream flow as a basis for making these decisions would improve efficiency considerably.

Water allocation is another area in which insufficient use is made of available data. A fixed volume is allocated regardless of the different crops grown in different seasons. Allocations should be based instead on the actual water requirements for specific crops. This should be tried out at a pilot level, starting with wheat, before being more widely promoted.

Water deliveries were found to vary greatly between different areas of the scheme. Inequity was attributed mainly to the breakdown of the flow monitoring and measuring system, to siltation and weed growth, and to inadequate maintenance. The original project design had not provided for flow measuring devices at the distributary canal level. These devices should be installed.

A great deal of water — up to 40 percent of the requirement for wheat, for example — is lost from farm-level watercourses due to "dead" storage. Better use could be made of this water by installing small pumps to irrigate higher-lying areas.

The night storage system introduced over half a century ago has lost its relevance, as farmers in most areas have started to irrigate during the night. Night storage encourages silting and weed growth. These problems could be avoided by reverting to the continuous irrigation practiced in the project's early days.

Water use efficiency was low for all major crops. Even though yields in the 1991–92 crop season were double those of the previous year, the range was 0.02 to 0.45, compared with 0.14 to 0.39 obtained in 1990–91. Low plant density was identified as a major factor contributing to low yields.

To institutionalize the interventions recommended by the project, a Water Management Advisory Unit was set up within the Gezira Board. The project's final report made several recommendations for strengthening this unit. To wind up the project, a workshop was organized to present and discuss its findings and recommendations.

VILLAGE IRRIGATION IN BURKINA FASO: ORGANIZED CHAOS

Burkina Faso's village irrigation schemes have evolved around small dams originally used for watering livestock and meeting human domestic needs. They are managed by farmers' organizations, with technical support provided by parastatal agencies. Under a project begun in 1991, IIMI is investigating ways of improving water storage, conveyance and distribution at five village locations. At two of these, Mogtédo and Itenga, diagnostic research was completed during 1992, and reports were written up and submitted to the government.

The research revealed the socioeconomic pressures that so often underlie technical shortcomings in the delivery of water supplies. In both systems, the reservoir represents the nucleus of local economic development. Besides irrigated agriculture within the official command area, it permits a host of other activities, including fishing, livestock production and opportunistic cash cropping. The latter leads to the proliferation of unauthorized plots on canal reservations, around the reservoir and, during the dry season, even within the reservoir itself.

The simultaneous use of canal flows by too many farmers leads to low discharges and longer periods required for irrigation. It also leads to water shortages during the dry season, contributing to low cropping intensities.

Farmers' organizations and government agencies appear powerless to change matters. The land tenure system, whereby the state expropriates and redistributes land within the irrigation system, discourages farmers from investing in their land and developing it. State-imposed tenure also conflicts with traditional land rights. The size of allocated plots is too small, and competition for labor from rain-fed agriculture delays important tasks such as planting and weeding.

During the rainy season, government support services tend to concentrate primarily on the supply of seeds and fertilizers, paying little attention to system management and water use. Support services are considerably reduced during the dry season, leading to difficulties in obtaining credit, seed and other inputs. There are also problems of storing and marketing surpluses. Under these conditions, farmers seek to minimize risk, favoring subsistence crops over potentially more profitable cash crops which entail a higher initial investment.

At the start of the project, almost no management information was available for either scheme. IIMI has, therefore, gathered baseline data, starting with accurate lists of the farmers using the schemes. This information has been shared with the agencies and farmers' organizations concerned.

COMPUTER APPLICATIONS

Speedy access to up-to-date information is crucial to the improved management of water deliveries. Computer technology offers new opportunities to improve the storage and processing of data, and so to support the routine tasks of irrigation managers. In many instances, standard commercial software can be used, such as database management systems, spreadsheets and geographic information systems. Alternatively, specific applications, such as simulation models, can be tailored to meet specific needs.

IIMI is currently testing computer-based methods and tools mainly at its field sites in Sri Lanka and Pakistan.

Diagnosing Decision-Making Problems

During 1992, the first draft of an analytical framework for diagnosing weaknesses in the decision-making process of canal managers was completed (see Figure 4).

The framework illustrates the interactions between the physical infrastructure of a main canal, and the people who operate it. The latter can be divided into two categories — those who take management decisions, and those who implement the decisions. In addition, each system has three basic management functions — a "command" function, in which decisions are made and implemented; an "observation" function, in which information is gathered on such topics as infrastructure and hydraulic behavior; and an "evaluation" function, in which performance indicators are added to the overall analysis. The combined outcome of the observation and evaluation functions modifies the decisions made at the command level.

The framework serves as the basis for defining the terms of reference of computerized management information systems. Having decided what kinds of information need to be collected at what points in the system, managers can then identify the methods that

can be applied to analyze the information and, where appropriate, the tools required for system simulation. They can also assess the operational implications of introducing the system — the number and type of measurements to be taken, the communication facilities needed, and the hardware requirements.

In 1992, the framework was successfully applied for the first time, using the Kirindi Oya Scheme in southern Sri Lanka as a testing ground. To encourage use of the framework elsewhere, IIMI made a video to document the application process.

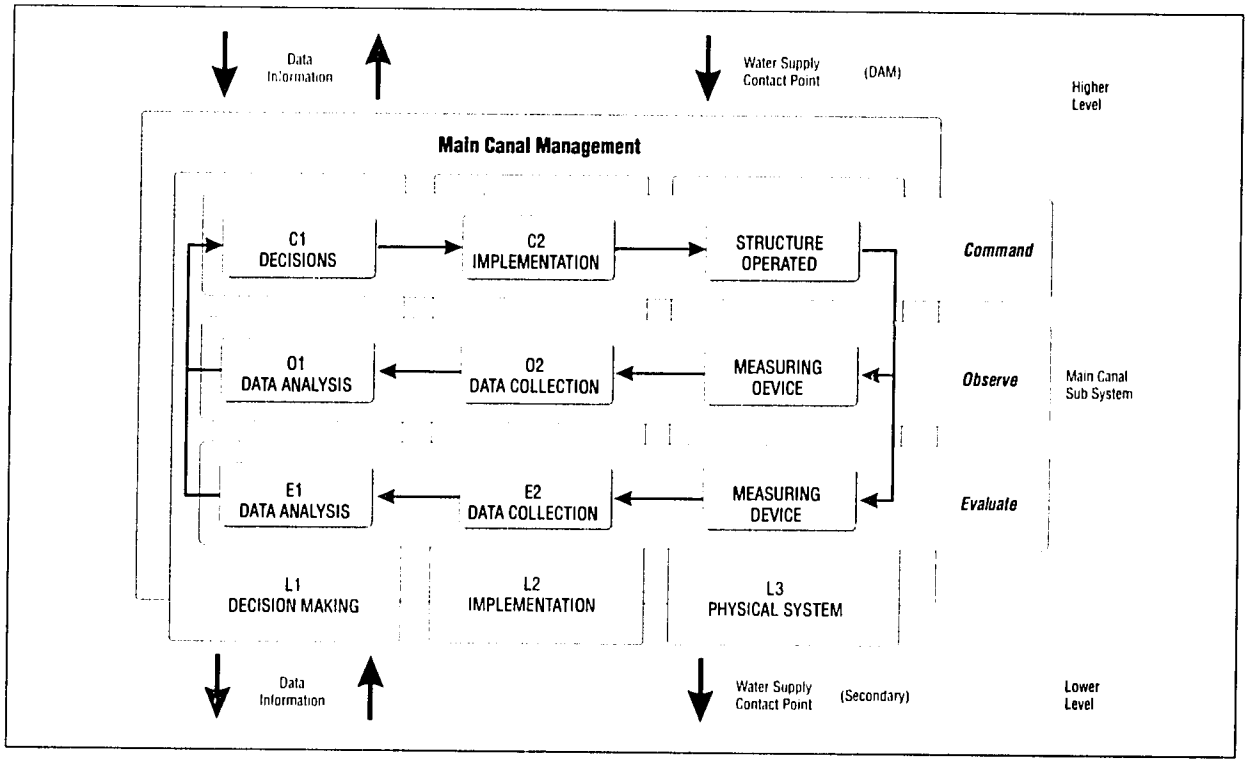
Following the diagnostic phase, a data collection and communications network was set up, using messengers and a display board in the engineer's office. This brought immediate savings in water, estimated at approximately 10 percent over previous years during the 1991/92 season.

To address the problem of data acquisition and storage at field level, a study has been launched to design and test a low-cost water-level data logger. The first prototype of the logger, made by Sri Lankan researchers at the University of Peradeniya, has now received laboratory testing. It will be field-tested at Kirindi Oya during the 1993 season.

Flexibility: Counting the Cost and Assessing the Feasibility

Designing irrigation schedules involves a trade-off between the flexibility required by farmers, on the one hand, and the labor costs and managerial capacities of agencies, on the other. Again, computer technologies can assist in identifying an appropriate balance. A new model for this purpose, the Canal Operations Management Assessment (COMA) model, was completed in 1992. It enables managers to calculate the labor inputs and other resources required to operate a given schedule, with a given irrigation infrastructure. The generalized version of the software program, together with a users' manual, will be available from IIMI headquarters in 1993.

Figure 4. — Main canal management.



THEME 3: INSTITUTIONAL CHANGE AND POLICIES

IIMI and its national partners have launched a project to study experiences in irrigation management transfer to farmers.

INSTITUTIONAL CHANGE

Introduction

In the rush over the past century to expand the area of irrigated land for agriculture, governments worldwide have constructed thousands of expensive irrigation systems, spending roughly US$15 billion each year on irrigation development since the 1940s. By 1989 there were about 233 million hectares of irrigated land in the world, 73 percent of them in developing countries.

At the start of the 1980s the tide of expenditure on new irrigation development began to wane. Partly, this reflected a general decline in public-sector investment, which fell out of fashion as belief in market forces gained ground. But the main reason was the acute shortage of funds experienced by developing countries as their debts mounted and the terms of trade turned against them. With the prices of many agricultural export commodities falling, further investment in infrastructure to grow those same commodities made little sense. In addition, almost everyone involved in irrigation — farmers themselves as well as system planners, engineers, crop scientists and government policymakers — felt disappointed with the performance of state-run irrigation systems, which showed rapid deterioration from both an infrastructural and an environmental point of view; they were also disappointed with the levels of productivity that fell well short of planners' targets.

The result has been the widespread adoption, during the late 1980s and early 1990s, of policies to transfer all or part of the management of irrigation systems from government agencies to farmers' associations.

Irrigation management transfer involves a host of complex issues. For a start, dramatic organizational changes may be required in irrigation agencies whose management and staff must accept and adapt to their new roles. Cutbacks in staff, and changes in responsibilities for those that remain, must be successfully managed. So also must the change from a direct, "hands on" management style to one in which the agency sees itself primarily as a supplier of services. New training in service functions may be needed. And as if dealing with these internal changes were not enough, government agencies may, in addition, be required to find ways of encouraging the development of local management institutions. This in turn may give rise to new problems, notably how to ensure adequate representation of the interests of less-privileged social groups.

In 1992, IIMI and its national research partners launched a project to study experiences in irrigation

management transfer. The intention is to examine six cases in depth, while widely disseminating more concise information on at least 15 others. The aims of the project are to analyze and compare the various approaches taken and the changes in irrigation performance that result, with a view to producing a synthesis and guidelines for policymakers and others engaged in planning and implementing management transfer programs.

What Is Management Transfer?

IIMI defines irrigation management transfer as "the transfer of responsibility and authority for irrigation management from the government to nongovernmental entities." This may or may not include the transfer of ownership of infrastructure and other assets.

Transfer may be partial or total, and may involve large- or small-scale systems. The management transfer programs of Indonesia, Nepal, Senegal and Bangladesh provide examples of the total transfer of small-scale systems. Those of India, Nepal, the Philippines, China and Sri Lanka illustrate the transfer of the distributary levels of large-scale systems, with responsibility for main canals being left in government hands. Countries such as Mexico, Colombia and Madagascar have launched programs to transfer management to water users' associations, with farmers gradually increasing their share of responsibility, starting at field level, then moving to the distributary and finally to the iain canal levels.

Transfer of management responsibility may cover one or more of three major areas: maintenance of system infrastructure, decisions on cropping plans and patterns, and the distribution of water. It may also imply increased farmer involvement in the mobilization of labor and financial resources, and in the resolution of conflicts.

Transfer may be accompanied by the privatization of other parts of the agriculture sector, such as the supply of agricultural inputs and marketing services. This is the case in Senegal, Sudan and Nigeria.

What Are the Benefits?

Managed properly, irrigation management transfer can bring rapid gains in the efficiency, productivity, equity and sustainability of irrigated agriculture. An example from Nigeria demonstrates these benefits (see box below). Management transfer can, of course, also bring important savings in public-sector expenditures.

MANAGEMENT TRANSFER: NIGERIAN FARMERS REAP THE BENEFITS

IIMI's field research in Nigeria started only in early 1992. Already, however, there are encouraging signs that the introduction of joint management in the project area is gathering pace and will benefit system performance.

Working closely with the Hadejia-Jama'ara River Basin Development Authority (HJRBDA) and the Kano River Irrigation Project (KRIP), IIMI has assisted in the formation of users' associations at three pilot research sites. The associations have begun to mobilize labor for cleaning and maintaining the distributary channels.

This brought considerable cost savings and more reliable water deliveries in 1992. For example, 108 farmers in the Agolas IV system of KRIP organized themselves to desilt and cut the Baham grass along 2.3 km of the distributary channel at a total cost of N 3,780, as against N 10, 120 if the work had been done under a contract organized by KRIP — cutting costs by well over 50 percent. The system's tail enders, who had previously suffered acute water shortages, received improved supplies as a result of cleaning. They were able to irrigate their fields in a shorter time, no longer having to irrigate at night.

The HJRBDA management has a positive attitude to the proposed changes. It has established a new unit responsible for farmers' cooperatives and water users' associations.

In Nigeria, IIMI has assisted in the formation of water users' associations.

What Needs To Be Studied?

In its study of management transfer, IIMI is addressing four broad questions:

- What are the impacts of transfer on water deliveries and on the performance of irrigated agriculture?
- What key legal, policy, infrastructural and institutional issues must be addressed to ensure success?
- What changes in the roles of agencies and farmers are needed to support successful transfer?
- What kinds of transfer processes and self-management models work best in different environments?

Information Exchange

So rapidly is the process of irrigation management transfer occurring that it is vital to exchange research results quickly if effective use of them is to ba made by others.

For this reason, in 1992, an entire issue of the *IIMI Review* was devoted to a preliminary analysis and synthesis of experiences in the field. It includes a lead article that sets out the issues, initial findings from the IIMI case studies, and further information drawn from the literature. Experiences in such countries as India, Indonesia, China, Sudan, Mexico, Colombia and Nepal are compared and contrasted.

Case Studies

The best-documented experience of management transfer currently available is that of the Columbia Basin in Washington State, USA (see box below). A monograph on this experience was completed in 1992, and is due for publication in 1993 (Svendsen and Vermillion 1993).

A GRADUALIST APPROACH: NEGOTIATED CHANGE IN THE COLUMBIA BASIN, USA

The Columbia Basin Project is a large one, covering over 225,000 hectares and extracting some 2.6 million acre-feet of water annually from a dam on the Columbia River. By 1986, US$1.687 billion had been spent on the construction of the dam and irrigation facilities, and of a 6.5 thousand-megawatt hydroelectric power plant. The US Bureau of Reclamation, responsible for developing the project, negotiated construction repayment contracts with the irrigators before water began flowing through the canals in the early 1950s. Irrigation fees were also paid for annual organization and management costs, and for a capital replacement fund.

Irrigation was managed initially by the Bureau, but, in accordance with a longstanding Bureau policy, negotiations were begun to transfer responsibility to three irrigation districts (users'

associations) during the early 1960s. Farmers were interested in management transfer chiefly because they wished to keep irrigation fees low. They felt they could achieve this if they gained control over the water resource and its management.

Negotiations were successfully completed by 1969. The chief obstacle to agreement was how to redeploy the Bureau staff made redundant by transfer, whose status as civil servants guaranteed them security of tenure. In the end, more than 80 percent of them were reemployed by the districts, which were able to absorb them largely because of their ability to raise revenues. The remaining 20 percent either retired or were transferred elsewhere in the Bureau.

Each district now has between 2,000 and 2,500 water users, who elect a Board of Directors to oversee policy and guide district managers. Water is distributed according to demand, subject to availability of supply, scheduling constraints and willingness to pay. Delivery is cut off if farmers do not pay their fees.

The Bureau displayed considerable adaptability, absorbing much of the shock through successful reorientation of its activities. During the late 1960s, it cut back heavily on construction and took on new functions, including the management of wetlands, the development of fisheries and the monitoring of wildlife and water quality. In other words, the Bureau was successful in identifying new roles suitable for long-term public-sector involvement, while divesting itself of other responsibilities best handled by the private sector.

IIMI's case study found no evidence of negative impacts on either productivity or the environment as a consequence of management transfer. Farmers' yields, already on an upward trend when transfer was implemented, continued to rise thereafter. The quality of services received by farmers did not deteriorate. Despite minor fluctuations, the equitable and timely distribution of water continued. Transfer appeared to have facilitated technical innovation, notably the introduction of sprinkler irrigation.

Sources: IIMI Review 6(2), November 1992; and Svendsen and Vermillion, 1993.

The social, political and economic environment in which irrigation management transfer takes place often differs radically between developed and developing countries. The study of the Columbia experience brought these differences into sharp relief, revealing some of the factors that may be critical for success.

Perhaps the most significant difference is the speed with which transfer is implemented. In the Columbia Basin, management transfer had always been a clearly articulated policy. It was familiar to all participants, and regarded by them as inevitable. In addition, it was negotiated and introduced only slowly. In contrast, driven by sheer financial necessity, many developing countries are pushing ahead rapidly with their transfer programs, sometimes with little appreciation of the difficulties involved and with little awareness of the experience gained in other settings. The situation in Sudan provides a classic example of this (see box on page 16).

Other important differences concern the support available from the country's legal system. In the Columbia Basin, lawyers were instrumental in the satisfactory conclusion of negotiations. Strongly developed professional services of this kind are often not available in developing-country settings, or are too expensive to be used by farmers' associations. In addition, laws regulating the use of water by different groups and sectors (such as industry and tourism versus agriculture) may either be poorly enforced or lacking altogether.

A third important difference concerns the ability and willingness of farmers to pay new charges for the provision of water and other services. Farmers in the Columbia Basin, wealthy compared to those of most developing countries, had always paid an irrigation fee. Resource-poor farmers in developing countries,

on the other hand, are often faced with a major additional financial burden when transfer is introduced. They may see no reason to pay for services and inputs previously provided free of charge, and whose delivery is, in any case, often highly unreliable. Why start to pay for water you are not likely to get?

THE "BIG BANG" APPROACH: ACCELERATED PRIVATIZATION IN SUDAN

Irrigation management transfer in Sudan is taking place against a background of far-reaching political change. The frontiers of state involvement are being rolled back in almost every sector, reversing the 1968 nationalization of the economy, now widely blamed for stagnation and inefficiency. Government agencies involved in irrigated agriculture are rapidly shrinking; some have been abolished altogether.

In large-scale schemes such as the Gezira and Rahad, the roles of the parastatal agencies in providing inputs and marketing facilities are being turned over to profit-making companies and farmers' cooperatives. Management of field channels is being shifted to farmers, that of other canals to the Ministry of Irrigation. Meanwhile, increasingly powerful farmer tenants' unions are demanding more control over cropping decisions.

Even more dramatic changes are occurring in the pump irrigation schemes along the White Nile and the Blue Nile. In April 1992, the White Nile Agricultural Corporation, a parastatal agency, had 2,196 staff. By the end of August, only 500 remained. All small-scale schemes were to be under private management by the November 1992 cropping season. Farmers had two options: self-management, or management by private holding companies. Larger-scale schemes are expected to be taken over by commercial companies, somewhat more gradually.

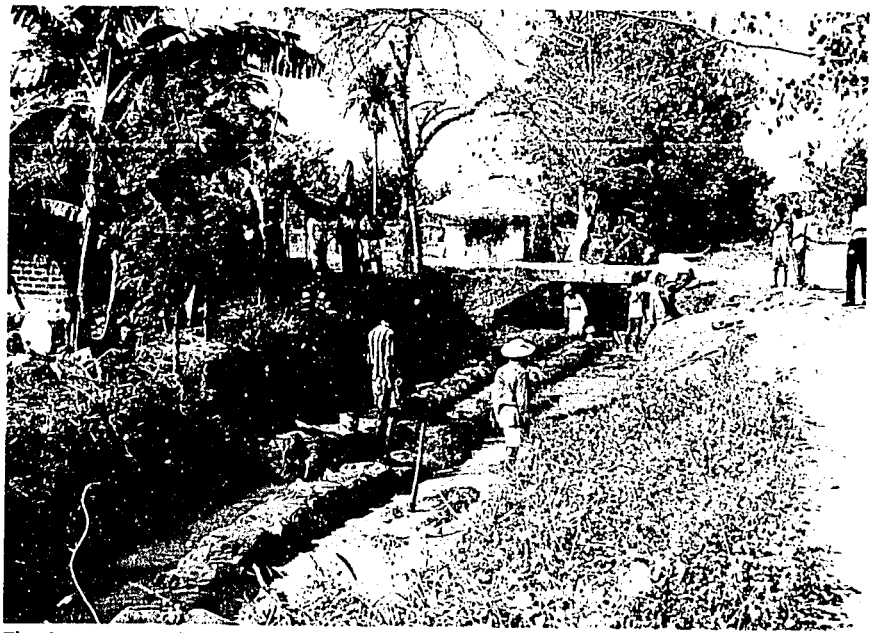
Farmers interviewed by IIMI were enthusiastic about self-management but unsure whether they could operate schemes efficiently without at least some support in the short term. They were anxious to avoid contracts with commercial companies where possible because of the large share of the harvest demanded in return for the services and inputs provided. Farmers had little experience in obtaining loans or marketing their produce. There have been virtually no efforts to organize them for management purposes.

Privatization is coming fast to the farmers of Sudan, without the benefit of phased institutional or infrastructural development and training. The outcome of these rapid changes is as yet unclear, particularly for social equity and local control over resources.

Source: IIMI Review 6(2), November 1992.

The experience in Sudan stands in fascinating contrast to that of the Mahaweli Authority of Sri Lanka. If the wholesale dismantling of government agencies in the former country is being pushed through without adequate planning, it at least has the virtue of ensuring that transfer takes place — whether or not farmers are ready to catch the ball and run with it. The Mahaweli experience presents the opposite case: a gradualist approach that has so far failed because the main agent of change — the agency itself — has not been subject to sufficient external pressure to ensure commitment to the process. The result has been a series of half-hearted attempts at power sharing, often thwarted by vested interests within the agency itself.

In 1992, IIMI completed a report on this experience (see box on page 17). The report examines attempts at devolution in three systems of the Mahaweli Authority: System H, a relatively new settlement scheme; Uda Walawe, an older scheme; and System B, another of the relatively new schemes. It compares these attempts with experiences in a group of older schemes that come under the auspices of a different government agency.



The Government of Sri Lanka is firmly committed to the policy of participatory management of irrigation.

DEVOLUTION IN SRI LANKA: CAN A POWERFUL GOVERNMENT AGENCY LEARN TO LET GO?

The Government of Sri Lanka is firmly committed to the policy of participatory management of irrigation. Several successful experiences with agencies other than the Mahaweli Authority demonstrate that devolution to farmers can work. Indeed, the country has become well-known over the past two decades for its success in creating effective farmers' organizations.

In contrast, the Mahaweli Authority's repeated attempts to create farmers' organizations have so far proved unsuccessful. In System H, efforts date back to 1979, when a formal program was launched to organize turnout groups for training purposes. In the mid-1980s, these were complemented by the establishment of distributary channel organizations. But in both cases these groups were seen by farmers as merely an extension of the Authority, with limited functions and no real autonomy. They felt they were being dominated by agency staff and larger farmers, whose interests they served. Research by IIMI in the mid-1980s came to the conclusion that no effective farmers' organizations existed.

Failure in System H was attributed by some observers to the inability of new settlers to form effective organizations. But the Authority also manages an older scheme, Uda Walawe, where its experience has been no better. Sporadic attempts were made to form organizations in 1986–87, but these soon disappeared, primarily because the Authority was unclear about the organizations' objectives and senior management was not supportive. A further attempt in 1988 also failed, again for want of clear objectives and a long-term plan. In this instance, farmers were limited to a "watchdog" role, monitoring the contractor's work on the rehabilitation of the system. Their involvement in planning, design and construction was not considered. In 1989–90, the task of establishing farmers' organizations was subcontracted to a nongovernmental organization, but this initiative was discontinued at the request of agency staff.

Experiences in System B again reflect the reluctance of some agency officials to allow the involvement of a nongovernmental organization. In addition, the appointment of special outside organizers to serve as catalysts in the formation of farmers' organizations was considered unnecessary. Despite the lack of success in other schemes, agency staff felt that their own unit managers would be equal to the task, albeit with some additional training. The outcome of devolution efforts in System B remains unclear, but it may be considered a test case on whether the current organizational structure of the Authority is compatible with the creation of self-reliant, responsible farmers' organizations.

IIMI's study concludes that the hierarchical structure of the Mahaweli Authority creates and maintains the relationship of dependency between settlers and agency staff. Attempts to launch participatory management approaches within the existing structure have so far been unsuccessful. A special unit was recently set up at its head office to promote farmers' organizations, but it has minimal resources, no clear mandate and few community organizers on its staff, and is not integrated with the rest of the Authority's management.

There is growing awareness that more profound changes are necessary. Consultations in 1991 resulted in proposals to consolidate the Authority, remove overlaps and redundancies, decentralize responsibilities, reduce the number of field-level officials and shift from control to service functions. Late in 1992, the new leadership of the Authority's operations launched an ambitious program to promote farmers' organizations, but it remains to be seen whether this initiative will meet with the success that has eluded previous efforts.

Source: Merrey, 1992.

One of the problems in the Mahaweli case is that the policy of reform has not so far been sufficiently radical. If the objective had been the complete transfer of managerial responsibilities, rather than mere participation, the pace of change might have been more rapid. Similarly, changes to the Authority's mandate, only now under consideration after all else has failed, might also have increased the chances of success at an earlier stage. The Authority's resistance to change forms an intriguing contrast with the adaptability shown by the US Bureau of Reclamation in the Columbia Basin case, in which a policy of management transfer was written into the agency's mandate from the outset.

Conclusion

The conditions governing the successful transfer of management functions in the irrigation sector are complex. When irrigation management transfer is introduced too rapidly, in settings where the legal framework and institutional arrangements are insufficiently developed, it carries the risk of reinforcing existing inequity and transferring more control over resources to those who are already relatively powerful and wealthy. On the other hand, bureaucratic inertia and existing power structures can all too easily thwart the transfer process when a more gradualist approach is adopted. Changes in the mandate and culture of the responsible agencies may need to be introduced at an early stage, preparing the way for a shift in attitudes and a subsequent reorientation of activities.

POLICIES

Introduction

Important though it is, management transfer is only one amongst an array of complex policy and planning issues affecting the performance of the irrigated sector. Examples of these other issues include the development of national land and water resources for irrigation, technology generation and dissemination for the irrigated sector, the profitability of irrigated agriculture, conservation issues, and strategies for rehabilitation and future investment — to name but a few.

Getting the policy environment right is crucial for the productivity, sustainability and equity of irrigated agriculture. And, in an increasingly complex world, it is important to adopt a holistic approach to policymaking — one that takes all the issues into account. No amount of institutional reform will increase the output of the irrigated sector if the market prices received by farmers for their surplus crops remain too low. Coherent planning for the irrigated sector depends critically on incorporating the viewpoints of the different disciplines and interest groups concerned. Perhaps the most important ingredient of a holistic approach is that it should be participatory — consulting with and listening to the

wide range of people who must make and implement policy as well as those whose livelihoods will be affected by it.

Supporting Policymaking in Sri Lanka

August 1992 saw the completion of a 2-year process of policy analysis, discussion and reformulation under the Irrigation Management Policy Support Activity (IMPSA) in Sri Lanka.

This project, which involved a complete policy overhaul of the country's irrigated sector, adopted a participatory approach throughout. Farmers, agency staff, policy analysts and specialists in research and development sat around the same table, discussing issues on which they often held widely divergent views. The aim was to reach a consensus that would make the subsequent implementation of policy easier.

The IMPSA initiative owed its origins to the conviction that farmer participation in management was the key to increasing the efficiency of the irrigated sector. Among the many experiences in strengthening farmer participation gained by government agencies in the past decade, some had undoubtedly been highly positive. A forum was needed to analyze the factors conducive to success and to plan future directions.

The complexity of the institutional landscape in Sri Lanka — the country has "more irrigation institutions per hectare" than almost any other — has been a serious impediment to consistent and coherent policymaking for the irrigated sector. An interministerial and interdisciplinary committee was needed to tackle this problem. Accordingly, the Irrigation Management Policy Advisory Committee (IMPAC) was established under the project in June 1990. Chaired by the Secretary of the Ministry of Lands, Irrigation and Mahaweli Development, this 20-person committee included the Secretary of the Ministry of Agricultural Development and Research, the heads of the departments and agencies under the two ministries, as well as representatives from the policy and finance ministries.

Whereas the task of IMPSA was to promote the involvement of a broad spectrum of public- and private-sector organizations in determining future irrigation management policy, that of IMPAC was to seek agreement among the concerned agencies and ministries on the policies and policy measures to be recommended to the Cabinet. This two-tiered process of consultation has worked well, ensuring both broad consensus building and adequate filtering before final proposals are put to senior politicians.

The output of IMPSA over the 2-year project period has been impressive. Ten project papers, 51 working papers and 8 special reports were prepared by a working group set up by the committee. For each paper, a series of workshops was convened to elicit the input of farmers, field-level officials, middle managers and representatives from the private sector. Each paper was reviewed by a smaller working group of IMPAC, then by the full committee, to reach agreement on its contents before being submitted to the government. The first policy paper provides an overall vision of the future of the irrigation sector, while subsequent papers flesh out the details. Recommendations and guidelines are provided on such topics as farmer management and the transfer process, operation and maintenance, and performance monitoring. One paper proposes far-reaching changes in the mandate, staffing and organization of the major implementing agencies. Another provides an overview of future water resources policy, a useful exercise in view of the national water resources planning process scheduled to begin shortly.

Several lessons that may be relevant to other countries emerged from the IMPSA experience. They are summarized in the box on page 20.

LESSONS FROM THE IMPSA EXPERIENCE

- The process can create consensus on major policy issues and a sense of ownership of the outcome.
- A broad overall vision of the irrigated sector created at the outset serves as a useful common ground during the subsequent more detailed (and difficult) negotiations on specific issues.
- Including policy implementors and water users in the planning process ensures realism in the setting of targets.
- Links with senior politicians should be sufficient to retain their commitment, yet not too demanding on their time.
- The process should take place in the context of a clear policy framework for the agriculture sector as a whole.
- Without institutionalization it is difficult to monitor the changes set in motion and to ensure a continuing commitment to change, once the project has ended.

Two disadvantages:

- The process is time-consuming.
- Some decisions reached may reflect the need to avoid conflict rather than being the best solutions to a given problem.

THEME 4: FARMERS AND THE FARMING COMMUNITY

INTRODUCTION

Farmers and the broader farming community are the users of irrigation systems. As users, they comprise many groups with differing interests and, particularly, with differing degrees of access both to the water provided through the system and to the land irrigated by it.

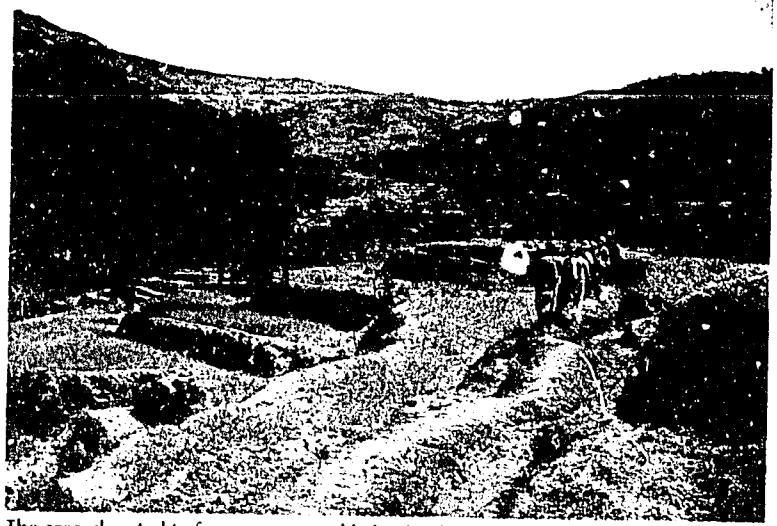
For many farmers, irrigated land is only part of their farm, with the result that interventions in the irrigated area must take into account the impact on the rain-fed area. Efforts to improve the planning, design and management of irrigation systems must also take into account the needs of such groups as women and landless laborers — frequently disadvantaged by current power structures in the local community. In villages where new irrigation schemes are planned, the interests of existing land users, such as migratory pastoral groups with traditional riverine grazing rights, have also to be considered. Finally, migration to urban areas affects the efficiency of many systems, reducing labor availability and, in some cases, disrupting water supply schedules.

Farmers are not only the users of an irrigation system. They are also, increasingly, its managers. The study of systems that have traditionally been managed by farmers is, therefore, a key topic under this theme. The performance of such systems takes on added significance in view of current moves to privatize state-run irrigation systems in many countries (see Theme 3).

Other socioeconomic topics studied under this theme during 1992 include gender issues and crop diversification. Initial diagnostic studies were completed in several countries, notably in Morocco and Niger.

FARMER-MANAGED IRRIGATION SYSTEMS

Farmer-managed irrigation systems cover large areas and a vast number of beneficiaries in many countries



The area devoted to farmer-managed irrigation is expanding rapidly in many countries.

throughout Africa, Asia and Latin America and the Caribbean. Improving their performance could bring substantial benefits in terms of the alleviation of hunger and poverty in the local farming community, with important secondary effects on overall economic growth.

IIMI's main research objective in this area is to find ways of strengthening government assistance to farmer-managed systems. Activities undertaken so far include the establishment of a network, the setting up of an advisory committee, the publication of a newsletter and the organization of various workshops, seminars and conferences. The most important conclusions reached during this initial phase are summarized in the box below.

GOVERNMENT ASSISTANCE TO FARMER-MANAGED SYSTEMS: SOME LESSONS LEARNED

The preliminary findings of IIMI's research on farmer-managed systems have important implications for future investments and efforts in this area. They are that:

- Assistance to farmer-managed irrigation is much more cost-effective than assistance to agency-managed systems.
- Policies and laws regulating farmer-managed irrigation are often underdeveloped or under-enforced. Greater clarity and stronger laws on rights to water and on the authority and responsibilities of water users' associations are particularly needed.
- Different types of water delivery systems — diversion, storage, groundwater and surface lift — require different approaches to the planning and delivery of support services.
- The area devoted to farmer-managed irrigation is expanding rapidly in many countries as a result of management transfer and development of groundwater irrigation.
- Investment by users is vital to sustain irrigation infrastructure and is more easily achieved through farmer-managed systems than through state-run systems.
- The rehabilitation of farmer-managed systems requires different design and construction criteria from those used in more technically perfect (but often less socially acceptable) agency systems.
- Government efforts to develop local water users' associations should be based not on a standard model but on a case-by-case diagnosis of locally needed management functions.
- Key constraints to the effective delivery of services to farmer-managed systems often lie within government agencies, which are frequently averse to participatory approaches, late in supplying inputs, evasive about budgets, and generally unresponsive to local needs. With their greater emphasis on farmer participation, nongovernmental organizations often have an advantage over government agencies in the development of farmer-managed systems.

Growth of a Network

Interest in IIMI's network on farmer-managed irrigation systems continues to flourish. The network grew steadily during 1992, and now links about 1,300 members in 75 countries. It continues to be an important medium for the exchange of ideas and experience, having published two further issues of its Newsletter in 1992, bringing the total to 11 issues since 1988. A Spanish edition of the Newsletter was launched during the year.

Two New International Data Bases

During 1992, preparations were made for developing a data base on irrigators' organizations based on field and household surveys. The aim is to make the data base relational — that is, to generate information enabling eventual comparative analysis at subsystem, system and river-course levels. This will allow the factors conducive to effective performance to be identified.

Data collection instruments were designed and reviewed by 15 experts outside IIMI. By the end of the year the instruments had been revised and were ready for field-testing. Data collection will start in Nepal and Sri Lanka in 1993.

The surveys will elicit detailed information on management performance, including sources of income for the organization, success rate in the collection of water fees, sanctions for nonpayment, causes of disputes over water deliveries, effectiveness in managing conflict, accounting practices, and so on. This information will be complemented by more general information on the performance of irrigated agriculture as a whole, including trends in family farm income, in crop yields, and in various environmental parameters such as level of water table, degree of soil salinity and prevalence of waterlogging.

Also during 1992, work began on the development of a data base compiled from secondary information available from the IIMI library and other sources. This data base, which will complement the field-based one, will include information on 67 variables related to the social and political context of farmer-managed systems. It will enable researchers to explore the relationships between such factors as system size, authority of management, technology used for water delivery, and performance. Data on over 400 irrigation systems worldwide are already included.

Once completed and made accessible to users, these two data bases will be an important asset to IIMI researchers and their national partners, enabling many different variables relating to the performance of farmer-managed systems to be compared and analyzed.

Case Studies

Hard evidence on the performance of farmer-managed irrigation systems is scarce. Much of the information currently available is anecdotal, and there has been a tendency to romanticize — depicting farmer-managed systems as invariably more efficient than state-run ones.

Farmers in Nepal have designed and operated their own irrigation systems for centuries.

Nepal is a good country in which to study the performance of farmer-managed systems. Its men and women have designed and operated their own irrigation systems for centuries. In addition, many systems built by the state have, in fact, been "transferred" to farmers by default, due to the inability of the government to provide inputs and services. It is estimated that around 70 percent of irrigation systems in Nepal are now managed by farmers.

Past research in Nepal has shown that performance does, in fact, vary considerably. Some farmer-managed systems are highly productive, enabling three irrigated crops to be grown each year, with a total output of more than 8 tonnes per hectare (Yoder 1986). Others are performing far below their potential, due to poor physical infrastructure and lack of a strong users' association.

In 1992, IIMI launched a study in Nepal, comparing the performance of a large number of farmer-managed irrigation systems in two districts in the west of the country. The aim was to generate a set of data that would serve as a basis for improving government support services to such systems, especially to those performing less well. This participatory study involved farmers as part of the study team. Farmers were also represented on a newly formed nongovernmental organization, involved in the study as a potential supplier of advisory services. Also in 1992, IIMI concluded a detailed study of the performance of the Chhattis Mauja Irrigation System, in the Terai plains of southern Nepal. The initial results of this study are already available (see box below).

THE CHHATTIS MAUJA SYSTEM: ADAPTATION TO ENSURE GREATER EQUITY

Flash floods during the monsoons make two maintenance activities vital to the efficient operation of the Chhattis Mauja System: annual desilting of the main canal, and the rapid mobilization of labor and materials for emergency repairs.

A well-defined four-tier users' organization has evolved, with a 12-person executive committee at the third level, responsible for operating and maintaining the main canal. The committee appoints a system-level leader *(meth mukhtiyar)* responsible for daily operations along the main canal and for the keeping of records. He is assisted by a messenger, to ensure the rapid exchange of information and the mobilization of labor when needed. The organization has a written constitution, setting out the rules governing both operations and maintenance.

The system provides an interesting example of how a users' organization can serve simultaneously both to apply the rules and to adapt them in the interests of greater equity.

Water allocations were originally set in proportion to the area of land irrigated. The same basis was used to establish the requirements for providing labor for the maintenance of the main canal. It was reported that, some 20 to 30 years ago, each branch canal was required to send one person for canal maintenance for each day that maintenance work continued for each 17 hectares irrigated. The term used for this person-day of labor was *kulara*. Since the share of water a branch canal was entitled to was in the same proportion as its labor requirement, the water allocation became known as "so many kulara of water." The word is now used interchangeably to refer to water entitlement and labor mobilization. If a branch canal does not send labor for main canal maintenance, it loses its entitlement to water.

In recent years, jungle has been cleared and new land brought into cultivation in the upper reaches of the system, increasing the demand for water. Percolation and seepage losses in such areas are high, adding still further to the increased burden on the system.

As a result, the linear relationship between area irrigated and water allocation no longer exists.

Measurement of the branch canal outlets showed that only seven were within 25 percent of the theoretical width required for water delivery according to area irrigated. Most were larger than proportional delivery would allow, suggesting that water requirements for farmers' crops were the de facto criteria used to decide allocations.

Villagers from each branch canal may decide that they need more water, but whether they get it or not depends on the executive committee. The committee's decision may be deferred to a general meeting at which each branch canal is represented. If a change in water allocation is approved, a corresponding change in the labor requirement is also made.

Changes are made by the meth mukhtiyar and the messenger, starting at the head and adjusting the flow into each branch canal as they move downstream. They are assisted at each branch by the branch canal leader and farmers from that branch. The branch leader may be asked to sign a statement to the effect that the adjustment is acceptable, and that they will not try to increase the flow.

Due to siltation, the discharge is continually changing. However, it is up to the farmers of each branch to check and inform the central committee if they feel maintenance action is needed. There is a fine of Rs 200 to 500 for stealing water from the main canal.

Thus, instead of implementing fixed rules, the organization tries to respond fairly to changing demand. The increased demand for water at the head end has meant less water for tail enders in recent years, a situation apparently condoned by the executive committee, since it allows larger branch outlets than those dictated by area irrigated. Yet on several occasions during the 1992 season, the chairman instructed the meth mukhtiyar to make adjustments in favor of lower branches, and even assisted him in making them.

Labor requirements have been adjusted to reflect the increased inequity between head and tail enders. It was calculated that the head branch is now required to provide 1 kulara per 10 hectares, while the tail-end branch supplies 1 kulara per 48 hectares.

The slow but steady change in water and labor allocations indicates that there is pressure for those receiving more water to pay for it with increased labor, and that this pressure is being effectively applied through the users' organization. Otherwise, the head branch would have been able to capture the extra water it required without formalizing access by adding more kulara. The tail-end branch has similarly adjusted to reduce its costs of belonging to the system, but nevertheless continues to provide its agreed share of the labor. The near total compliance by each branch canal with requests to mobilize resources for maintenance suggests widespread acceptance of the current rules for operating and maintaining the system.

Source: Tiwari and Yoder, 1992.

Chhattis Mauja provides an example of a farmer-managed system that performs relatively well. Mean yields estimated in the course of the IIMI study were 3.7 tonnes per hectare per season — well above the present national average of 2.5 tonnes for irrigated monsoon rice in Nepal and close to the target yield of 3.8 tonnes per hectare set in Nepal's irrigation master plan. The system shows what can be done under farmer management when strong local users' associations are in place and the strains and stresses on the system are not too great.

This picture forms a marked contrast with systems that continue to be run by the state. According to a recent economic survey, lack of timely repair and maintenance of canals, lack of proper management of water in farmers' fields and untimely and inadequate water supply during the planting season are major problems in such systems.

Aware of these defects, Nepal's Department of Irrigation has launched a program to strengthen farmers' participation in the management of state-run schemes. The program is an important preparatory phase of the country's management transfer policy. IIMI was requested to assist in implementing the pilot phase of the program, using the Banganga Irrigation System located in the hill country as a testing ground. Launched in May 1991, this collaborative project with the Department of Irrigation was completed in July 1992 and a final report submitted in August (see box below).

THE BANGANGA SYSTEM: LEARNING FROM OTHERS

Experience in the Banganga Pilot Project provides clear evidence of the positive value of farmer participation in irrigation management. It also shows the effectiveness of farmer-to-farmer training as a tool in spreading participatory approaches.

At the start of the project, water users' groups existed only in name. An initial survey identified lack of effective group leadership, conflicts between users, the absence of communication between agency staff and farmers, and the agency's style of management as the main problems. Closely associated with these were infrastructural defects and the untimely and unreliable supply of water. Some infrastructural improvements had been made under a previous development project, which had also drawn up a management plan. But the plan had not been implemented and, as a result, the tasks associated with operating and maintaining the system were either poorly performed or neglected altogether.

IIMI staff felt it important that the system's farmers and agency staff should see for themselves the benefits of self-management. So they took selected farmers and the system's manager to visit two large, well-managed irrigation systems in the Terai plains. These visits motivated the farmers from Banganga to reactivate their own water users' associations. They also convinced the system manager that such associations could play an effective part in management. During the following year, 13 associations were strengthened and reconstituted, covering an average area of 2,000 hectares each.

After defining their responsibilities, the new associations set about their main challenges: tackling the neglected task of maintenance and preventing the theft of water. In the first year, nearly 3,000 person-days were allocated to the cleaning of 40 kilometers of the main canal. Weed growth was identified as a major problem, and a weed expert was hired to provide advice. To prevent regrowth and improve the flow of water, two types of canal lining with gravel were tested. Each association introduced and imposed fines for the violation of rules. By the end of the first year, a reduced level of vandalism of control gates along the main canal had already been noted.

Farmers also began sharing responsibilities with agency staff for the preparation of water distribution schedules, the resolution of conflicts, and the implementation of rules and regulations. In addition, they now work collectively to acquire support services and inputs for crop production and diversification. Increased confidence in water supplies has led to earlier planting, more crop diversification, and the improved protection of crops from grazing cattle.

The achievements of the Banganga Pilot Project were shared and compared with experiences elsewhere in Nepal at a 2-day workshop organized by the Department of Irrigation. An important output of the workshop was a set of guidelines on the introduction of participatory management.

Perhaps the most important lesson to emerge from the Banganga experience is that, when farmers invest their time, energy, money and labor, they start to feel a sense of ownership of the irrigation system. And a sense of ownership, whether or not it is reflected in legal title, is the key to improved management.

Source: IIMI, 1992.

Comparative Analysis

A broader literature study, comparing experiences with farmer-managed systems in different countries, was completed in 1992. While the study confirmed that most experiences described in the literature were highly positive, it also noted that scientists had tended to select systems with above-average performance for their field studies. There are still plenty of farmer-managed systems that have not achieved these levels of performance. It is these less successful systems that need to be identified and targeted for government assistance.

The study highlighted the usefulness of construction and improvement activities as a means of building effective local institutions. In the process of meeting to discuss and plan such activities, irrigators learn to make decisions as a group, define roles, handle conflicts and establish a system for keeping records. The box below summarizes some of the factors identified as common across successful projects.

FARMER MANAGEMENT: INGREDIENTS OF SUCCESS

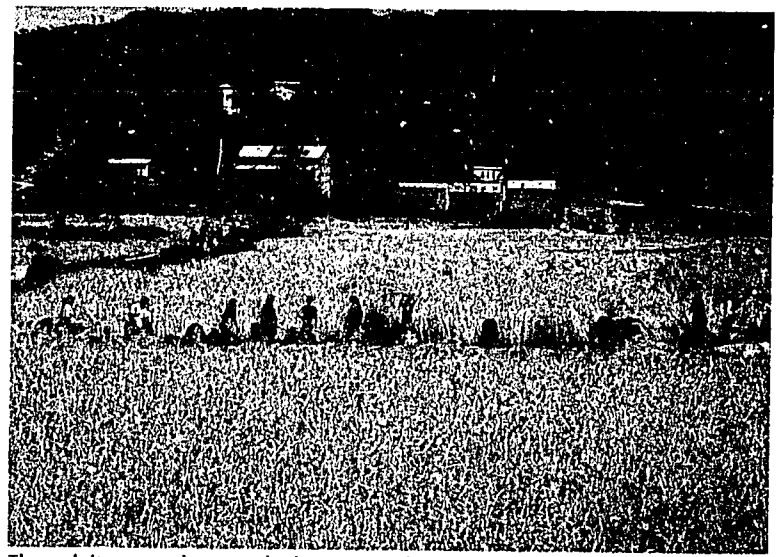
1. Farmer involvement in construction helps build local institutions.
2. Those who build and maintain a system develop a strong sense of ownership towards it.
3. Clearly defined membership status and secure water rights determine farmers' willingness to invest in the future of the system.
4. Having full authority vested in users' associations increases their managerial flexibility — that is, their ability to adapt rules and procedures to changing conditions.
5. Strong attendance rules for meetings (fines for absenteeism) ensure that all users have a voice in decision making.
6. Equitable decision making, in turn, reduces complaints and conflicts.
7. Farmers need to be able to monitor the compliance of water deliveries with their entitlement.
8. Systems for recording the cash and labor contributions of members should be clear and easily accessible to the public.
9. Successful locally managed systems are able to elicit greater cash and labor contributions from members than agency-operated systems.
10. Especially in areas where the terrain is difficult, the rapid sharing of information is important in ensuring operational efficiency and timely responses to emergencies.
11. Local control over the appointment of officials makes it easier to hold them accountable for their decisions and actions.
12. Strong and carefully graded sanctions must be applied, and be seen to be applied, against those who break the rules.

Perhaps the most important general principle is that the irrigators must become and remain the primary actors in the irrigation system, devising and implementing their own solutions to problems. Other actors, including voluntary, private-sector and international research and development organizations as well as government agencies, can propose, but in general they should not dispose.

Source: Adapted from Yoder (1992).

GENDER ISSUES

Among the many social and economic aspects of research on irrigated agriculture, IIMI has elected to give special emphasis to gender issues. The reason is simple: despite the increasing attention given to women's roles and needs in agricultural development, generally over the past 20 years, irrigation projects retain an unenviable reputation for ignoring them.



Through its research on gender issues IIMI aims to find out more about the role of women in irrigated agriculture.

While it is true that in some countries irrigation activities and management are exclusively the domain of men, in many others the contributions of women have simply gone unnoticed. Even where women are not directly involved in the application of water to crops or in the operation and maintenance of canals, they have clearly defined interests in the timely delivery of adequate and good quality water supplies. These interests may include overall responsibility for the cultivation and marketing of cash as well as subsistence crops, or for the performance of specific tasks within the cropping cycle, such as weeding and harvesting. They may also include such activities as watering cattle, washing clothes and utensils, and bathing themselves and their children.

Through its research on gender issues IIMI pursues several objectives. It aims to find out more about the roles of women in irrigated agriculture and irrigation management. It also seeks to determine the extent to which existing management practices and institutions prejudice the interests of women. Answers to these questions will, it is hoped, lead to better recognition and accommodation of the specific needs of female water users, easing the flow of information and resources in irrigation systems.

IIMI's research in these areas is still in its initial stages. Nevertheless, some progress was made in 1992 in several important areas, and extensive preparations were made for future efforts.

Conceptual Framework

Gender issues relevant to irrigation can be broadly categorized as (a) design issues, (b) operational issues, and (c) issues related to the provision of support services. IIMI's research is concerned with all three areas. Research begins and ends on farmers' fields and in their households, for it is here that the impact of water deliveries is experienced by different users' groups. Following identification of the different roles of female and male household members, their needs with respect to irrigation can be identified. For female water users, for example, it will be important that the timing of water deliveries is compatible with the performance of their domestic duties. The interests of male and female water users need not necessarily conflict, but women typically have less power and fewer opportunities to defend their interests. The next step is, therefore, to find out to what extent female stakeholders in the irrigation system participate in decision-making bodies and processes, and/or in what other ways they may influence decisions and their implementation. Once this is known, steps can be taken to improve the representation of their interests where necessary. Where system management remains in agency hands, this may necessitate the analysis of gender issues within the agency itself, perhaps leading to the identification of new opportunities to recruit, train or promote female staff members.

To be understood properly, gender issues in irrigation need to be seen in their broader social context. Gender biases in irrigation management processes and their outcomes are often a reflection of gender relations in society as a whole. Moreover, gender is not the only source of bias: factors such as caste, class or ethnicity also need to be taken into account.

Literature Review

The year 1992 saw the completion of an initial literature review. Some 70 publications dealing with gender issues in irrigation were collected and examined. A working paper was prepared, summarizing the most important findings. In addition, the December 1992 edition of the Newsletter of the Farmer-Managed Irrigation Systems Network presented highlights of the review.

As expected, the review revealed that government-induced changes such as the privatization of irrigation (both management and infrastructure) ajd the introduction of new land tenure arrangements have not always benefited men and women equally. Men continue to be thought of as being the head of the family — the main farmer as well as the main income- and food provider. As a result, the scale and significance of women's farming and income-generating activities have been largely ignored. In many systems, women are expected to provide unpaid labor to irrigated crops whose income is controlled by their husbands. Examples from Africa document their reluctance to do so, and how this has led to disappointing returns to irrigation investment. Examples from Asia show how the nutritional status of young children can deteriorate when irrigation is introduced, because women are deprived of the opportunity to grow traditional rain-fed crops that form an essential part of the diet for this age group.

An increasing number of irrigation agencies throughout the world now acknowledge the need to address women's interests when planning and implementing interventions. Nonetheless, experiences reflect a continuing failure to recognize that the role of women is not confined to the stereotype unpaid worker in the household and in subsistence production. Many projects have been designed to develop irrigation-based income-generating activities for women, but few have proved successful, often because they have not taken into account the fact that many women are already fully engaged in productive activities. Many projects have also lacked institutional support, with the result that they have had no lasting impact.

Evidence from several countries, including Nepal, Indonesia, Burkina Faso and Peru, documents the discrepancy between the considerable involvement of women in irrigation and agriculture and their limited participation in water users' groups. In a few cases, the inefficient use of water was found to be caused in part by poor communication between women, who were the actual irrigators, and male irrigation managers.

In the Philippines, female water users had protested against a regulation that households should be represented on the water users' association by just one member, normally the male head. As a result, the regulations have been changed to allow both husband and wife to participate.

In Nepal and Indonesia, women have become increasingly involved in irrigated agriculture during the past 10 years, often because their husbands and male relatives have migrated. Initially unsure of themselves as managers, they had formed separate female water users' groups alongside the formal water users' associations. These groups had helped them gain the confidence to express their concerns and insist on their rights.

Field Studies

A field study was conducted on the role of women in irrigation in the Punjab of Pakistan. The resulting report presents strong arguments for increasing

national research and development activities to support and enhance the role of women in irrigated agriculture.

The official ideology in Pakistan discourages women from working outside the four walls of the home. A woman who can afford to remain inside the house is a symbol of the prosperity and honor of the family. Because of this, women as well as men are reluctant to admit female involvement in agricultural activities.

Irrigated crop diversification has the potential to increase rice farmers' income.

The IIMI study revealed the true picture, which was very different. More than 80 percent of the women surveyed in the study area were involved in agricultural activities, especially in transplanting and harvesting. Women grew and harvested vegetables and other crops, raised livestock, and took full responsibility for the storage of food grains. Except in the case of livestock products, marketing remained largely a male affair, however.

Irrigating crops was also considered to be the responsibility of men. Nonetheless, a few women were reported to irrigate the crops by themselves. Women showed acute awareness of the salinity problems in the area. Many mentioned the decreasing quality of water due to salinity as being their main problem, leading to lower crop yields and to difficulties in performing domestic duties.

Preliminary surveys were carried out in Sri Lanka and Nepal. Especially in the Terai plains of Nepal, the low profitability of irrigated agriculture causes many young men to migrate in search of off-farm employment. As a result, irrigated agriculture is increasingly becoming a female activity geared towards meeting household food needs. In Sri Lanka, the degree and nature of women's involvement in irrigation and irrigated agriculture appear to vary with the availability of water and the types of crop grown. In both countries the level of involvement in irrigated agriculture was generally high, but participation in management was very low. Women often rely on male neighbors and relatives to represent their ideas and interests at meetings.

CROP DIVERSIFICATION

When IIMI was founded in 1984, several Asian countries had already achieved self-sufficiency in rice, while others stood on the threshold of doing so. Success in rice production has, in many cases, led to a decline in the farm-gate prices farmers receive for their crop.

Farmers in these surplus-producing countries need to diversify away from rice towards new enterprises such as vegetables, fruits, feedgrains and dairy produce. These higher-value commodities reflect the changing tastes of an increasingly urbanized human population whose incomes are rising rapidly. In theory at least, then, farmers should find a ready market for them.

In practice, developing alternatives to rice is not as easy as might at first be thought. With its good storage and transport characteristics, rice does not have to be grown close to its point of sale. The opposite is true for many vegetables and fruits, which bruise easily and do not keep for long. In areas remote

from urban centers, the introduction of vegetable or dairy production may therefore depend more on improving transport infrastructure and/or building local processing plants than on the introduction of new yield-increasing technology or more flexible irrigation management.

Whatever the marketing problems, diversifying away from rice makes sense in terms of resource use. Rice needs more water than most other commodities, which can therefore be grown more easily during the dry season, or in areas where competition for water from other sectors is causing water shortages. In areas such as the Punjab of Pakistan, where the situation is approaching crisis point (see Theme 5), a switch to pasture and livestock production for tail enders may be one of the few sensible land-use options available.

Network Activities

The idea of forming a network on crop diversification in rice-based systems emerged from a workshop hosted by IIMI in Sri Lanka in 1986. The network now comprises nine countries of South and Southeast Asia.

During 1992, the third issue of the network newsletter was published. It featured highlights from the 1991 workshop on crop diversification held in Yogyakarta, Indonesia, as well as many articles contributed by authors from member countries.

Articles from India and Sri Lanka demonstrated the profitability of switching to new crops. The net income to farmers growing a single crop of bananas in the Tamiravaruni System in Tamil Nadu, India was reported as Rs 40,000 per hectare, as opposed to only Rs 12,000 per hectare for two crops of rice (Kulandaivelu 1992). In Sri Lanka, the provision of credit and the construction of a cooling plant have encouraged farmers to grow high-value fruit and vegetable crops for export, while the cultivation of 1,000 tons of soybean under contract to the government has enabled imports to be cut back by this amount (Jayawardane 1992). An article from Bangladesh (see box below) demonstrated the positive secondary effects of diversification on the rest of the economy.

BANGLADESH: DIVERSIFICATION BENEFITS OVERALL RURAL DEVELOPMENT

The small, densely populated country of Bangladesh provides an example of how diversification can thrive when markets are close at hand. Vegetable production is reported to be highly profitable for farmers in the Chandina and Jhenaidah areas. Pulses and oilseeds also give high returns. Irrigation technologies for diversification have spread more rapidly in areas where institutional and infrastructural development have also occurred.

Diversification has brought secondary benefits to the rest of the rural economy. Because of its finer tillage requirements, vegetable production has increased the demand for power tillers. The extension of irrigation to nonrice crops has spurred the development of an irrigation water market, in which both sellers and buyers keep a watchful eye on the potential returns to different commodities. The expanded water market has, in turn, led to increased investment in tubewells. Water conveyance structures and the on-farm management of water have been adapted to meet the needs of different crops, especially vegetables.

Source: Adapted from Mandal, 1992.

Also during 1992, a study tour was arranged for eight professionals, two (one in engineering and the other in agriculture) from each of four member countries. The professionals visited Egypt and Morocco — two countries where irrigated agriculture is already highly diversified. The aim was to study the management implications of diversification, including the processes for water control and allocation among crops and farmers, the role of water users' associations, the interaction between agencies and

farmers, finance and cost recovery mechanisms, the factors influencing farmers' crop choices (including the availability of post-harvest facilities), seasonal water and crop planning methods, and the provision and management of drainage facilities. Following the tour, participants prepared a report on these subjects.

Diagnostic Research

The preliminary phase of a study on small-scale gravity systems in the Tadla Region of Morocco was completed in 1992. This study is being conducted in collaboration with the local Office Régional de Mise en Valeur Agricole (ORMVA) (see page 63).

The irrigation practices of a sample of ten farmers were surveyed and compared with a simulation of water requirements based on meteorological observations at a nearby experiment station. The majority of farmers were using traditional irrigation technology (small flooded basins), but two of them used furrow irrigation and were members of a cooperative. There were large variations in yield between farmers — from 2.7 tonnes per hectare to 5.3 tonnes per hectare, and from 0.63 kilograms per cubic meter of water to 1.54 kilograms per cubic meter in the case of wheat. The farmers who were members of the cooperative and used furrow irrigation had consistently higher yields than the others. However, irrigation practices only partly explain these differences. Crop rotation and land preparation also appear to be major determinants of yields. Farmers seemed relatively knowledgeable about good irrigation practices, but were often unable to apply them because of high labor requirements during peak periods. Tasks such as land leveling are still done manually, mechanized equipment being as yet unavailable.

Thus the major conclusion to be drawn from this preliminary phase is that the project must consider inputs other than those directly related to irrigation if it is to enable farmers to improve their irrigation management.

In Niger, field research began at three schemes along the Niger River — Saga, Kourani Baria and Tillakaina — selected for a collaborative project to improve the performance of farmer-managed irrigation systems (see page 59).

The Saga Scheme, 431 hectares in size, is a pump irrigation, diked basin rice scheme originally constructed by the Chinese in 1966. In the course of rehabilitation in 1988, improved water control, new electric pumping stations and the lining of primary canals were introduced. A single cooperative is in charge of system operations and maintenance, with a government agency providing advice and services under contract.

The rapid rural appraisal conducted at Saga highlighted major constraints of several different kinds — organizational, financial, marketing, technical and environmental. Among the organizational constraints were lack of participation in system maintenance, the monopolization of power by cooperative delegates, and the poor management of the financial and physical resources of the cooperative. Financial constraints included insufficient recovery of water charges, with adverse effects on operational efficiency. Records showed that the highest rate of recovery, 78 percent, had been achieved as long ago as 1977. Marketing problems concerned pricing, purchasing and payment arrangements with the national Rice Marketing Board (Riz du Niger), and insufficient and unstable returns from the private sector. Input supplies were also a source of problems, with farmers experiencing difficulty in obtaining even such normal inputs as fertilizer. Technical problems included lack of proper water management and drainage, irregular system maintenance, and rising levels of water theft. The major environmental problem was salinization, with some 35 hectares seriously affected.

Tillakaina is a pump irrigation, multi-crop scheme built in 1968, rehabilitated in 1982 and expanded in 1987. Relatively small in size (only 86 hectares), this scheme represents the river terrace cultivation system, which differs considerably from the basin system typified by Saga.

Again, the main constraints identified were of several different kinds. In terms of organization, control was split between two villages, with limited agreement on management issues and poor information exchange. There was competition for labor with rain-fed agriculture. Technical problems related mainly to system maintenance and operation. Marketing problems included the disadvantaged status of Niger in relation to export crops — only small quantities of string beans can be exported to Europe at present — and the lack of viable production alternatives for both export and local markets. Processing infrastructure and equipment are virtually nonexistent in the region. Among the physical constraints, severe soil nutrient depletion was suspected, since cassava was cultivated on over 75 percent of the scheme during the rainy season. Kourani Baria, studied only briefly in 1992, is a modern diked basin scheme for rice cultivation under conditions of total water control. Completed in 1987, the scheme occupies some 715 hectares. It is experiencing difficulties in cooperative organization and system operation (primarily drainage). The cooperative has limited irrigation experience, leading to serious management problems. There are also serious technical and physical difficulties, such as flooding. More detailed research on Kourani Baria will be started in 1993.

THEME 5: ENVIRONMENT AND PUBLIC HEALTH

ENVIRONMENT

Introduction

Not all the interactions between irrigation and the environment are negative. Indeed, if properly managed, irrigation can enhance the environment. Many of the wetlands listed by the World Conservation Union (IUCN) are associated with irrigation. New habitats for wildlife, especially birds and fish, are created when reservoirs are built.

That said, there are several problems which give cause for serious concern. Adverse downstream effects of irrigation include the contamination of groundwater or surface water, especially with nitrates and pesticides; the depletion of fisheries; the disturbance of wildlife habitats; and changes in river flow patterns, including both flooding during the wet season and the drying out of river beds during the dry season. The major upstream factors affecting the performance of irrigation systems are deforestation and vegetation loss in catchment areas, which may occur either independently of the system or in association with it, as new settlers inhabit the area. Deforestation entails not only the loss of biodiversity but also the acceleration of soil erosion, leading to the siltation of canals and reservoirs. Changes in stream flows into irrigation systems may also occur, again involving extreme fluctuations according to season. Finally, interactions occurring within the system itself include salinization and waterlogging, both of which may threaten the long-term sustainability of irrigated agriculture.

Irrigation managers are not usually trained to address environmental concerns. Nor is it normally in their interests to do so. In some circumstances, the primary objective of irrigation management — increased crop productivity — directly conflicts with environmental objectives, such as reduced levels of pollution by agrochemicals. For these reasons, new management approaches are needed to ensure that environmental issues related to irrigation are objectively investigated and effectively addressed.

To date, IIMI's most substantive project on environmental issues has concerned interactions within the system — specifically the study of salinization in Pakistan. However, additional

Salinization is now a serious and growing threat to the sustainability of irrigation in the Punjab of Pakistan.

resources made available in 1992 have enabled further studies to be launched, covering many of the broader range of issues mentioned above.

Sustainability of Irrigated Agriculture in Pakistan

The long-term performance of irrigation systems depends critically on several factors. Keeping salinization at bay is one of the most important.

Salinization is now a serious and growing threat to the sustainability of irrigation in the Punjab of Pakistan. The causes are various, but the use of poor quality groundwater to supplement surface water is a major one (see box at right). Because surface water is usually in short supply at the tail end of irrigation schemes, farmers at the tail tend to use a higher proportion of groundwater. So the problem of secondary salinization is worse there.

HOW DOES SALINIZATION OCCUR?

The salts in soils come mainly from rocks, as they slowly weather into soils. All soils thus contain some salts, which are normally washed downwards by water percolating through the soil (leaching). Some salts precipitate in the soil, but most continue to be transported in water and ultimately reach the sea. When precipitation occurs naturally, the process is known as primary salinization.

The commonest form of primary salinization in agricultural soils occurs when water in a shallow water table moves upwards in response to drier conditions nearer the soil surface. Once the water reaches the surface it evaporates or is transpired by plants, but the salts it carries remain behind, accumulating in the root zone.

Two special cases of primary salinization arise. The first is in dry areas, where low rainfall reduces the normal process of leaching. Such soils may remain highly saline for centuries. The second is in coastal soils, where the sea may be an additional source of salt. Salt intrusion occurs as a result of tidal movement, especially when river flow is reduced during the dry season. This is the case in many mangrove swamp areas where irrigated rice is grown.

Man-made or secondary salinization is caused by the excessive use of groundwater for irrigation. All groundwater contains salt because of the leaching process, and some of it is very saline, even more so than seawater. As pumped groundwater is used for irrigation, the salts remain in the soil as the water is taken up by plant roots and evaporates. Thus, where the groundwater used for irrigation is of marginal quality, additional surface water needs to be applied to ensure that these salts are washed downwards. If this cannot be done, the root zone becomes more and more saline until no crop will grow there any more and the land goes out of production.

IIMI's studies with the Punjab Irrigation Department (PID) raise serious questions about current policies towards the allocation, or reallocation, of canal water to reduce secondary salinization. In the past, the conventional wisdom has been that the major consumers of groundwater are tail enders, who use it to compensate for their unreliable supplies of surface water. However, IIMI's research showed that just as much groundwater is pumped in head-end areas as at the tail, suggesting that head-end farmers use groundwater as an additive to surface water rather than as a substitute for it. The more surface water is available, the more groundwater is used. Tail enders use less of both kinds of water. Secondary salinization starts to occur when the ratio of groundwater to surface water exceeds a certain threshold, probably 80 to 85 percent of total water used. Thus the problem could arise even in areas where groundwater is currently considered of suitable quality for sustained irrigation.

None of the options currently proposed in Pakistan for solving the secondary salinization problem is very attractive. Increasing the equitable delivery of water — so that tail enders get more and head enders less — would reduce the rate of salinization, but would not eliminate it altogether unless there were simultaneously a 50-percent increase in surface water supplies and a 20-percent decrease in the use of groundwater. Given design constraints in the canal system, increasing the use of surface water by this much is simply not feasible. Moreover, the IIMI study found that cropping intensity and patterns were closely correlated with access to good quality surface water. As this declined, so also did the number of crops grown in a year and the percentage of higher-value cash crops. Changing the allocation of surface water between head and tail sections would, therefore, have serious equity implications, leading to a redistribution of incomes that might result in considerable social unrest.

A second option would be to change the allocations of water to different commands, giving more surface water to those with poor quality

Figure 5. — Conjunctive use and water quality average decline along four distributaries, Lower Chenab Canal, Pakistan.

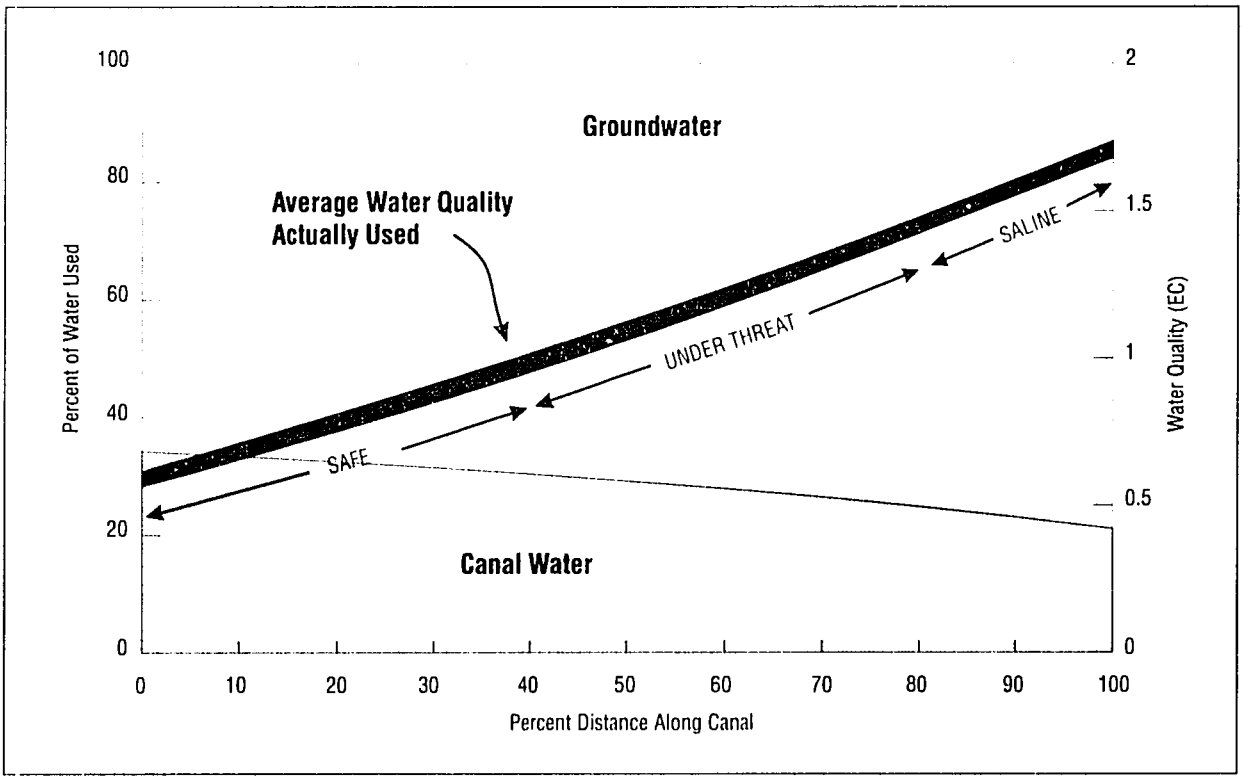
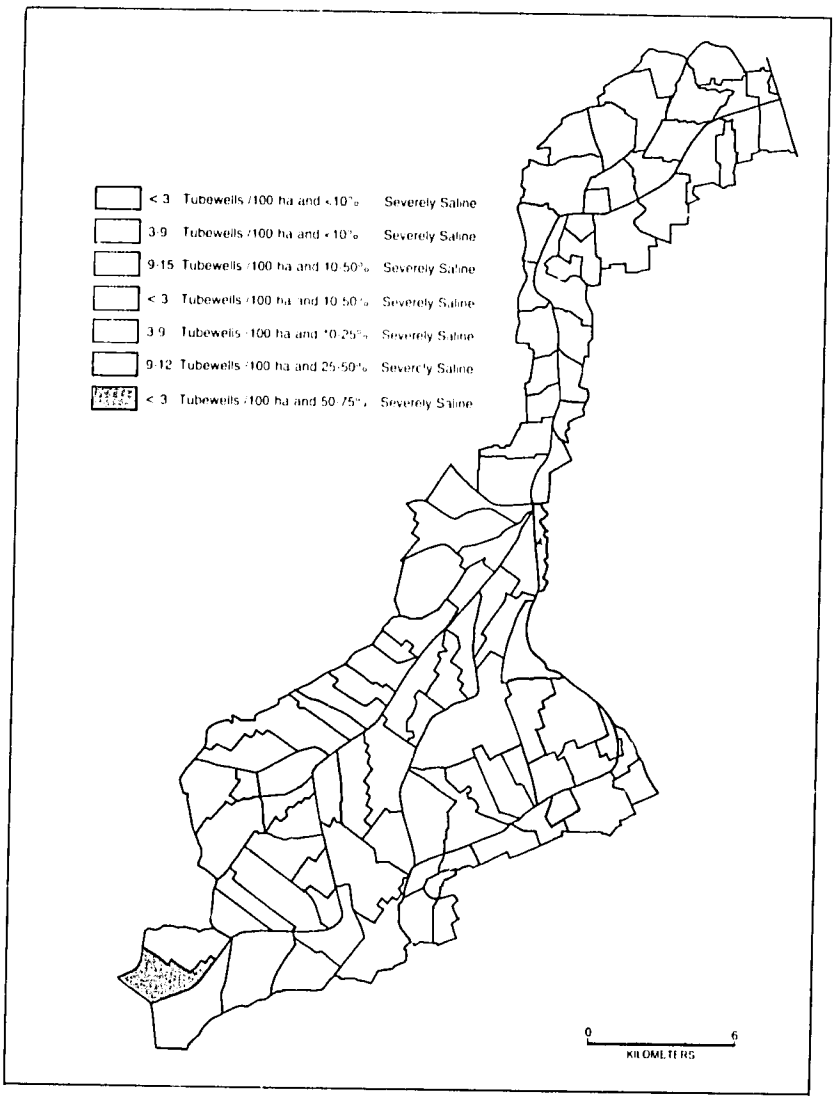


Figure 6. — Manawala Distributary Command tubewell density versus severely salinized regimes (within watercourse commands).



groundwater. This could be counterproductive, since areas that currently have better quality groundwater would simply increase their use of it — and suffer a similar decline in quality. In this way, the problem of salinization would spread to cover wider and wider areas, instead of being relatively contained, as it is at present.

A third option would be to rationalize the current trend — which is likely to continue anyway — and systematically abandon the tail-end areas of badly affected distributaries. This is a politically sensitive option, since it would dispossess an already underprivileged section of the farming community, swelling already high rates of migration to the cities. However, in view of the finite nature of the water resource, there may be no choice but to adopt it. Under this option, agriculture would be concentrated into a smaller gross area, in which water and soil resources would be used with greater efficiency. Total production would probably not increase, but it would become more sustainable, since the problem of continuing salt build-up in the soil would be effectively solved (see Figures 5 and 6).

These findings have serious implications for the long-term sustainability of Pakistan's irrigation systems. Indeed, if the trends found to be occurring in the limited area covered by the IIMI project are confirmed as widespread elsewhere in the country, and no action is taken to arrest them, the consequences could be disastrous, not only for Pakistan but also for global food supplies.

Sustainability of Rice-Based Systems in the Humid Tropics

Compared with mixed cropping systems in the arid and semiarid zones, few data are available on the sustainability of rice-based irrigation systems in the humid zone. It is generally perceived that these systems are under stress, but what are the factors responsible? Various problems have been cited, including the overuse of agrochemicals, micro-nutrient deficiency, watershed degradation, waterlogging and salinization, but the relative importance of each has never been quantified. Nor have the relationships between these potential threats

A handbook offering guidance on the special requirements of mountain irrigation systems is due for publication in 1993.

to sustainability and the apparent stagnation of rice yields been adequately investigated. IIMI has launched a modest project in its host country to examine these factors in more detail.

The project has carried out an extensive review of the literature, supplementing this with interviews with system managers, researchers and policymakers, and field visits to a number of systems. The main conclusion reached was that, in general, rice systems in Sri Lanka are surprisingly resilient. Some systems face specific threats and almost all have yields lower than their full potential, but there is no evidence to support the more alarmist claims found in the literature.

Mountain Irrigation Handbook

The design of irrigation systems in mountainous areas presents special problems. Extreme fluctuations in water discharge rates may have to be accommodated, requiring special drainage facilities for storm conditions. Mountain systems are frequently located in remote areas with difficult terrain, making communications and transport both hazardous and slow. This means they must be relatively self-sufficient, using local materials and labor wherever possible. Lastly, the terraced agriculture often associated with mountain systems complicates the allocation of water, since farmers tend to own small plots that are widely scattered.

Most engineers responsible for designing systems in mountainous areas have received orthodox training predicated on the design of straightforward plain or river valley systems. No handbook exists to offer them guidance on the special requirements of mountain systems. IIMI has set about the task of writing one.

As a first step, a workshop on the subject was held in Kathmandu, Nepal in 1992. The workshop brought together some 40 participants from mountainous countries around the developing world. Each participant brought and presented case study materials from his or her country. Together with the ensuing discussions, these materials served as the basis for preparing the first draft of the handbook. Currently under revision and review, the handbook is due for publication in 1993.

Global Climate Change

An important issue facing the irrigation sector worldwide is how changes in the global climate will affect the feasibility of irrigation in different regions. During 1992, IIMI staff visited the World Meteorological Organization to learn the views of its scientists on this issue. A report summarizing the current state of knowledge is in preparation. IIMI will not become involved in detailed research in this area, but it will maintain a watching brief. Relevant literature will be entered on IIMI's global data base for access by IIMI and internal researchers.

PUBLIC HEALTH

Introduction

Irrigation development is associated with the spread of three major vector-borne diseases: schistosomiasis, Japanese encephalitis and malaria.

For the first two of these diseases, the links with irrigation are clear. In the case of schistosomiasis, three snail genera act as intermediate hosts. The disease, which affects some 200 million people, is common in Africa, and also occurs in some countries of Latin America and East and Southeast Asia. In the case of Japanese encephalitis, the vector is a mosquito closely associated with the rice systems of Asia and the Pacific. The disease is highly localized, but when it does occur it has very high mortality rates.

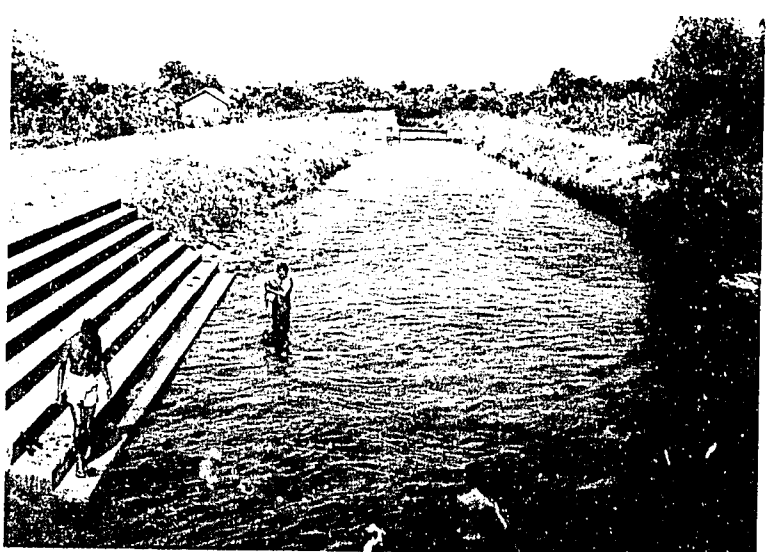
Malaria is a much more common mosquito-borne disease and is geographically far more widespread. About 800 million cases occur annually at present, resulting in some 1 million deaths. The disease is gaining ground due to the appearance of chloroquine-resistant strains of the parasite. Its links with irrigation are not fully understood, however. In several cases the installation of irrigation facilities is reported to have led to an increase in the incidence of malaria, but there are other cases in which incidence has declined. In many developing countries the main concern is the rapid spread of the disease in urban areas rather than in rural ones where irrigation is practiced.

Aside from these vector-borne diseases, gastroenteritis and diarrhoea are often also linked to irrigation. The main reason for this is the multiple use of irrigation water which, in many systems, is used for drinking, cooking, washing and recreation, as well as for agriculture. Many irrigation canals near cities contain more or less untreated sewage. It is possible that the transmission of disease by these pathways causes higher global mortalities than any of the vector-borne diseases mentioned above — but statistics are lacking.

Cross-Sectoral Links

Research on the interactions between human health, agriculture and the environment has been impeded in the past by the absence of effective institutional links between the three sectors. In 1991, IIMI became a collaborating center in the Panel of Experts on Environmental Management and Vector Control (PEEM), an interagency network under the umbrella of the United Nations. This enables IIMI to work alongside other institutions possessing expertise in such areas as epidemiology and entomology. In 1992, IIMI staff attended the first meeting of the collaborating centers of PEEM, held in Harare. The meeting provided a forum for drawing up research proposals of interest to the collaborating centers. After finalization by the PEEM Secretariat, these will be submitted to potential donors. IIMI has designed a project to study possible measures to prevent schistosomiasis in northern Nigeria.

Further work in this important field awaits the appointment of a full-time staff member. Negotiations for this are in progress.



Gastroenteric diseases are easily transmitted through the multiple use of irrigation water.

COUNTRY PROGRAMS

Four regions have been identified in IIMI's strategy. They are South and Southeast Asia, West Asia and Northeast Africa, Northwest and West Africa and Latin America and the Caribbean.

IIMI's work was initially concentrated in South and Southeast Asia, because of the significance of irrigation to its agriculture sector. In the late 1980s, IIMI's program was spread to incorporate work in countries in West Asia and Northeast Africa where agricultural production is almost entirely dependent on irrigation. The Institute has also expanded its activities in Northwest and West Africa where irrigation plays an increasingly important role in agricultural development. The Institute is currently taking steps to inaugurate programs in Latin America where there is growing pressure to improve irrigation performance to increase food production.

IIMI's collaborative field research and action research at country level are conducted through specific projects in active collaboration with national agencies. During 1992, considerable progress was made and accomplishments seen in the country programs carried out in several developing countries.

The year saw the maturing of IIMI's programs in several country operations and IIMI playing an increasingly effective role in institution building. The West Africa Regional Program made steady prograss with collaborative projects in Burkina Faso and Niger being well-established and with the Nigeria project moving forward rapidly. As a continuation of previous efforts and expressed interests, exploratory visits to Latin America, Egypt and China took place with a view to developing collaborative programs.

Presented in this section is a general description of the program and activities of IIMI's country operations. More detailed accounts of the most significant findings derived from the work undertaken in the country programs have been reported in the earlier thematic component of this report.

South and Southeast Asia

Rice-growing irrigation systems predominate this region. Climates generally display at least one season of generous rain which supports large areas of rain-fed as well as irrigated nonrice crops. Although nonirrigated production is strong, dependence on irrigation for a staple food crop is significant as the population is well in excess of the capacity of nonirrigated agriculture to feed them. But in recent years, the zone has achieved notable success in increasing its rice production more rapidly than its population growth, which has presented some new management issues such as marketing and diversifying out of rice.

The major countries of this zone are Bangladesh, Myanmar, India, Indonesia, Cambodia, Laos, Malaysia, Nepal, Sri Lanka, Thailand, the Philippines and Vietnam.

IIMI currently has country operations in Bangladesh, India, Nepal, the Philippines and Sri Lanka. Of these, Sri Lanka, the home of IIMI's headquarters, represents the Institute's largest program in this region.

Sri Lanka

THE CONTEXT

For the foreseeable future, irrigated agriculture will be the primary source of food and rural employment in Sri Lanka. Sustaining a high level of productivity in this important sector is considered crucial for the country's economic development.

With the completion of the multiphased Mahaweli River Diversion Project, the phase of expansion in the country's irrigated area has probably come to an end. The emphasis now is on increasing the efficiency of existing systems rather than on constructing new ones. There is an urgent need to rehabilitate existing systems and to improve their management. Crop diversification is also needed. Both technological innovations and institutional reforms have a major part to play in this process. The task of IIMI's Sri Lanka Program is to assist the Government of Sri Lanka in achieving these goals.

THE PROGRAM

IIMI's program in Sri Lanka consists of several interrelated projects and support activities.

In 1990, the program began activities in support of the development of a comprehensive national policy for irrigation management. Known as IMPSA — the Irrigation Management Policy Support Activity — this initiative was implemented by a Secretariat of Sri Lankan professionals guided by a high-level Irrigation Management Policy Advisory Committee (IMPAC). The IIMI program provided technical inputs and office support services. The activity was funded by the United States Agency for International Development (USAID).

Under a major project now in its second phase, the program is applying participatory approaches to strengthening the management of two major irrigation systems, the Kirindi Oya and Uda Walawe systems. Agency officials and farmers conduct activities, and the processes and outcomes are monitored and documented by IIMI researchers. Four broad areas are covered: main system management; tertiary system management; pilot studies for crop diversification; and strengthening institutions.

Under another project, completed in September 1992, the cost-effectiveness of irrigation modernization was studied at a range of locations. This work, subcontracted to various private Sri Lankan firms, was guided by a Research Advisory Committee and funded by USAID as part of its project on strengthening irrigation management.

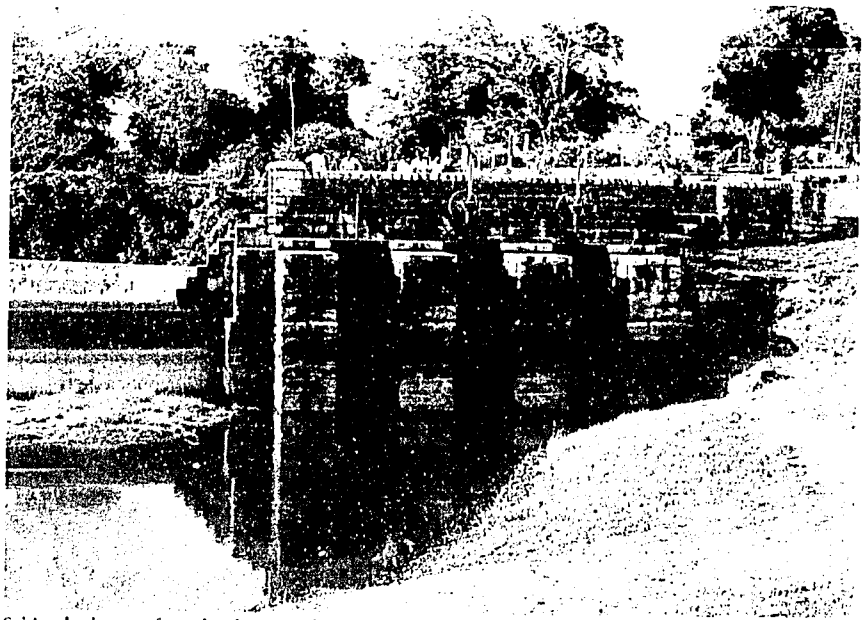
A project to monitor and evaluate the government's new participatory management policy is funded through a technical assistance grant from the Asian Development Bank (ADB). This project began in September 1992 and will continue for 2 years.

With financial support from the Commission of the European Communities (EC) and the World Bank, the Government of Sri Lanka has decided to establish an Irrigation Research Management Unit (IRMU) within the Irrigation Department. IIMI's role is to provide technical assistance to enable the unit to identify research needs, conduct research or contract it to other organizations, evaluate results and adopt them for implementation.

Finally, the program is also taking part in a novel participatory design process to develop a project on the shared control of natural resources. This project is being undertaken in collaboration with the World Conservation Union (IUCN).

ACTIVITIES IN 1992

The 2-year process of policy analysis, discussion, and paper writing under IMPSA was completed in August



Sri Lanka is now focusing its attention on increasing the efficiency of existing irrigation systems rather than on new construction.

1992. Further details of this major project are given on page 19 of this report.

Activities under the main system management component at Kirindi Oya consisted of the analysis of reservoir inflow data, simulation modeling to improve the management of the Right Bank Main Canal, water balance studies, and maintenance management at Weerawila Tank. Activities under the tertiary system component included preseasonal maintenance, the study of water-sharing practices during land preparation and crop growth, data collection on water deliveries and cultivation activities, the implementation of a pilot program for other field crops (OFCs), and various training events and field visits. Research resulted in an overall improvement in system performance, especially in terms of water use: a saving of almost 2 acre-feet per acre was achieved during the 1991/92 season compared to previous seasons.

At Walawe, activities under the main system management component included the calibration of flow gauging structures, crop water requirement computations at main delivery outlets, flow data analysis of past water deliveries, analysis of the existing data collection and transmission network and training in operations and maintenance. Under the tertiary system management component, the main accomplishments were the formation of farmers' organizations, preseasonal and mid-seasonal maintenance work, improved canal operations during the land preparation and crop growth periods, improved input coordination, and training on rehabilitation for farmers.

A study under the project on the cost-effectiveness of irrigation modernization was completed by a subcontractor. It revealed that modernization frequently suffered from the inadequate involvement of farmers and agency staff in planning, design and implementation. A workshop was held to present and discuss the findings. Another study, on the contracting of rehabilitation to farmers' organizations, analyzed data from 16 construction contracts undertaken by eight farmers' organizations whose performance had been judged as "good." The results revealed the importance of good communication between agency staff and farmers. The attitude and behavior of the Technical Assistant from the Irrigation Department assigned to supervise construction were found to be especially critical.

The results of the joint IIMI-IRRI study on rice productivity and profitability indicate that yields increased until the mid-1980s, but stagnated thereafter. The highest average rice yield was recorded in 1983 (3,606 kilograms per hectare). In the late 1980s, the average fluctuated between 3.0 and 3.5 tonnes per hectare. Over the same period crops other than rice appeared to give high profit margins, while rice farmers experienced declining net returns.

Under the project to increase users' control over the use of natural resources, consultations were undertaken with resource user groups, government officials and representatives of nongovernmental

organizations in the North Central and Southern Provinces. Valuable inputs were provided through four workshops attended by agency staff and policymakers. Selected resource personnel in Colombo were also consulted, together with three international resource consultants and representatives from USAID. A unique feature of this project is its focus on whole watersheds.

The program organized or participated in several training and information events during the year. The project at Kirindi Oya and Walawe conducted a series of workshops and training sessions for agency officials and farmer representatives. IIMI staff also contributed to the workshops of IMPSA.

A training program for 33 technical assistants and 9 irrigation engineers from the Irrigation Department was planned, implemented and evaluated. This activity was part of the USAID Project to strengthen irrigation management. Three workshops were held to review and discuss operations and maintenance. They led to plans to improve the services provided to farmers.

The program hosted a postgraduate internship for a student from Ghana, who had graduated from Silsoe College, Cranfield University, UK.

Two workshop papers were completed during the year. The first, entitled "Sustainability of Irrigated Agriculture: An Overview," was presented to a workshop on this subject organized by the Sri Lanka Association for the Advancement of Science and the Soil Science Society of Sri Lanka. The second was entitled "Institutionalization of Participatory Management: Sustainability of Farmer Organizations" and was presented to the Asian Farming Systems Symposium, held in Colombo, 2–5 November.

BANGLADESH

THE CONTEXT

Bangladesh lies on the combined delta of the Ganges, Brahmaputra and Megna rivers. Its population of 117 million (820 per square kilometer) is growing at more than 2.4 percent per year. The government places high priority on increasing agricultural production and there is also great concern with regard to equity and rural employment, as there are large numbers of landless laborers and other rural poor.

Virtually all the nine million hectares of cultivable land in Bangladesh are already in use. Efforts to increase agricultural production must therefore focus on increasing yields and/or cropping intensity. Each of these approaches requires more and better managed irrigation. Currently, about a third of the country's cultivable area is irrigated to some extent. Some 80 percent of this is served by motor-driven shallow tubewells, deep tubewells and low-lift pumps. Major canals serve only 7 percent of the irrigated area. The remaining 13 percent is irrigated using traditional manual techniques. It is believed that the country's use of irrigation could be more than doubled, particularly through the increased use of groundwater.

IIMI's country program in Bangladesh faces a somewhat different environment to that encountered elsewhere. With irrigation relying so heavily on small-scale technologies, the management of most individual systems (of which there are hundreds of thousands) is of necessity noncentralized. Each pump system is, formally or informally, autonomous. There is no single national agency with both the mandate and the means to manage the minor (non-canal) irrigation sector. The prevalence of small-scale technology allows considerable scope for privatization, which has recently been given a good deal of impetus

by the market, the government and the donors. Privatization is leading to increased local control, not only of water deliveries but also of water sources. It is also leading to pressure on government agencies to redefine their roles and to develop ways of facilitating turnover.

THE PROGRAM

IIMI's program in Bangladesh focuses on the management issues associated with turnover, particularly in the minor irrigation sector. Thus IIMI works with the Bangladesh Agricultural Development Corporation (BADC), as it seeks to change its role and to facilitate privatization. It also interacts with nongovernmental organizations, which often cater to the needs of groups traditionally outside the rural power structure, such as landless laborers and women. Lastly, the program helps to identify opportunities and problems (both transitional and long-lasting) in the market's provision of irrigation services. This interinstitutional approach, spanning the different sectors involved in irrigation, fills an important gap in Bangladesh.

IIMI has been working in Bangladesh since 1988. A consultative committee (with representatives drawn from various ministries, agencies and research institutions) works with the Institute's program in planning and reviewing activities.

Until 1992, the program consisted mainly of a collaborative project with the International Rice Research Institute (IRRI) and the Bangladesh Rice Research Institute (BRRI). This project had field research at three locations: (a) the Ganges-Kobadak Irrigation System, a major lift canal system operated by the Bangladesh Water Development Board (BWDB); (b) the North Bangladesh Tubewell Project (NBTP), also operated by BWDB but using deep tubewells located near Thakurgaon; and (c) tubewells under various forms of management — private, rental and public (BADC) — in the Rajshahi Region. Some of this research was comparative in nature, especially with regard to the different types of tubewells used, while some would be better described as action research — specifically a very successful canal rotation experiment emphasizing user-agency interaction in the Ganges-Kobadak Scheme.

Other pre-1992 activities included inputs into a joint project between BWDB and the Bangladesh University of Engineering and Technology (BUET) on irrigation management, and a series of workshops to assess training needs, conducted with BADC. These workshops provided an opportunity for BADC's top managers to explore the implications of their organization's changing roles as the minor irrigation sector becomes increasingly privatized.

ACTIVITIES IN 1992

In collaboration with the headquarters-based project on farmer-managed irrigation systems, the Bangladesh program organized a South Asian regional workshop on the sustainable use of farmer-managed groundwater irrigation systems. The workshop was held in Dhaka in mid-May. Papers drawn from various ecoregions addressed such issues as the depletion of aquifers, the development of farmers' groups and the adequacy of support services to farmer-managed systems using groundwater. On the second and third days of the workshop, the 55 participants took a field trip to western Bangladesh, where they visited deep and shallow tubewell systems under different types of farmer management.

During 1992, IIMI's staff continued to consult with BADC to help it define its new role. Until recently, the primary responsibility for distributing and installing deep tubewells (and, to a lesser extent, shallow tubewells and low-lift pumps) around the country resided with BADC. This function is now being shifted to the private sector, and BADC is attempting to find a suitable niche for itself in the provision of other irrigation support services. There is some question as to the future of this public corporation, as its new activities must not only be

approved by the government but must also attract donor support, given the scarcity of development finance in Bangladesh. In September, a workshop on strategic planning and human resources development was held with 20 of the Corporation's senior staff. The workshop discussed BADC's new mission, objectives, strategies and activities, established the staffing requirements for implementing the new program, and defined performance measures for evaluating the effectiveness of a management training program at the agency.

INDIA

THE CONTEXT

India's irrigation sector is large and highly diverse, complementing its extensive and equally diverse rain-fed sector. An estimated 76 million hectares or 46 percent of the country's arable land now receive irrigation of some kind — a higher proportion than in most other developing countries. The technology used ranges from dugwells through deep tubewells to innumerable tank and river diversion irrigation systems.

The potential for further expanding the area under irrigation is now severely limited. Increasingly — and as in so many other countries — the emphasis is on making existing irrigation systems perform more efficiently. This emphasis is driven partly by financial necessity, as public-sector funding becomes more scarce. But it is also driven, in India's case, by the urgent need to achieve further major gains in productivity. The country's population continues to rise inexorably, at some 2.1 percent a year. Meanwhile, yields of rice and wheat, which increased rapidly until the mid-1980s, have since stagnated or declined. Thus the gains of the green revolution have provided only a temporary respite and a new food crisis looms. Already, an estimated 2.5 million people are suffering from poverty and malnutrition in the drought-stricken states of Bihar and Orissa.

In India, the emphasis is placed on improving the performance of existing irrigation systems.

THE PROGRAM

IIMI's program in India began in 1989. The Institute has no resident scientist in the country, but provides assistance and support through exchange visits between its professional staff based in Colombo and some 40 collaborating Indian professionals.

The latter have conducted limited field

research to understand management approaches and performance in irrigation systems in four states — Tamil Nadu, Gujarat, Uttar Pradesh and Bihar.

In Tamil Nadu, staff from Anna University, the Irrigation Management and Training Institute, and the Public Works Department have analyzed the performance and main system management of the Tamiravaruni Irrigation System. In Gujarat, similar studies have been conducted in the Mahi-Kadana Project by professionals from the Water and Land Management Institute, the Institute for Rural Management and the Irrigation Department. Research in Uttar Pradesh concentrates on the conjunctive management of groundwater and surface water in the Madhya Ganga Project, which is still under development. This research is conducted by scientists from the University of Roorkee, the Uttar Pradesh Water and Land Management Institute and the Irrigation Department. Finally, research in Bihar focuses on conjunctive use in another unfinished project, the Eastern Gandak Project. IIMI's partners here are the Bihar College of Engineering, the Bihar Water and Land Management Institute and the Irrigation Department.

Research in Bihar focuses on conjunctive use of groundwater and surface water.

ACTIVITIES IN 1992

The year witnessed considerable progress in the implementation of research planned previously. The four collaborative projects in Tamil Nadu, Gujarat, Uttar Pradesh and Bihar completed their field work. IIMI worked closely with its national partners in each state, assisting in analyzing data and in preparing draft final reports.

In the Tamiravaruni System scientists observed and documented the decision-making and management processes of the main canal system. The role of farmers' organizations was evaluated, including their structure and interaction with government agencies. Interactions between the various government agencies involved were also studied. Flow data were collected along the main canal system.

Having identified the factors affecting system performance, the research team strongly recommended increasing the role of farmers' organizations in management. The team also recommended changes in operational strategies to take into account the diversification in cropping patterns that has taken place over the past few years, particularly the cultivation of banana, which can be a highly profitable crop for farmers (see page 30).

In the Mahi-Kadana Project, research focused on technical issues concerned with water delivery. It included documenting operations of the Right Bank Main Canal, assessing water availability in the Kadana Reservoir, analyzing changes in the groundwater table, and measuring water deliveries at the distributary canal and farm levels. The aim was to gather sufficient data to develop and implement a management information system at a distributary

level. In addition, an Indian Ph.D candidate examined the trade-offs between equity and efficiency, with a view to proposing alternative management strategies.

The team recommended various measures to enhance the conjunctive use of surface water and groundwater, especially the further development of tubewells and dugwells to ensure the reuse of water in shallow aquifers. Water allocation and distribution should be based on farmers' needs, rather than on schedules determined by government agencies. To alleviate waterlogging, the team recommended the "holidaying of water" — cutting down deliveries during the hot dry season, when the water table normally rises to reach the root zone of growing crops.

Staff of the Madhya Ganga Project evaluated the groundwater resource in the Lakhaoti Branch Command, linking this with other groundwater balance studies so as to develop a model of fluctuations in the quantity and quality of groundwater available in the system. Various soil and agronomic studies were also carried out, to gain a more accurate picture of the system's total water requirements. The team assessed the socioeconomic impact of groundwater development, and developed a model for taking groundwater use into account when allocating surface water. Testing and calibration of the model are now under way.

The team covering the Eastern Gandak Project conducted various studies on surface water availability in the Gandak River, the operation of the Eastern Main Canal, the development of private tubewells, the availability of groundwater and the problem of waterlogging. An additional study of farmer management of groundwater irrigation over six seasons began in August. The team also investigated several policy issues, including land titling and regulatory mechanisms covering the conjunctive use of groundwater and surface water. The regulatory mechanisms used are the provision of subsidies and regulations governing the spacing of wells.

The team identified poor management and inadequate canal capacities as the major reasons for the inefficient delivery of surface water in canal systems. These shortcomings, combined with the still incomplete distribution system, are the major reasons for the switch to private tubewells in this system, but this in turn is hampered by unreliable electricity supplies and the high price of diesel fuel.

A 2-day workshop to synthesize experiences across the four projects, review progress and plan future research was organized in Delhi in February 1992. It was attended by about 40 participants, including irrigation professionals, researchers, policymakers, planners and donor representatives. Project results in three of the four states were the subject of a further workshop held in September 1992.

The program arranged a 10-day study tour for 7 Indian professionals, who visited Sri Lanka to observe and adapt the field-research techniques used by IIMI in the Kirindi Oya Project, to investigate farmer participatory approaches to management, and to learn about Sri Lanka's Irrigation Management Policy Support Activity (IMPSA).

Two major reports were prepared during the year. One was the proceedings of the first (February) workshop described above. The other was entitled "The Dynamics of Irrigation System Performance: A Comparative Study of Two Secondary Canal Reaches in Mahi-Kadana." This report is currently being reviewed for possible publication as an IIMI Country/ Working Paper.

Discussions continued with the Government of India regarding the establishment of a long-term IIMI program in the country.

NEPAL

THE CONTEXT

Nepal is experiencing unprecedented changes in its political and economic climate in general, and in its irrigation sector in particular. Both are undergoing increasing democratization and privatization.

The Government of Nepal is committed to increasing the farmers' role in irrigation management.

The changes in the irrigation sector stem from the recent formulation of a national plan to meet the country's basic food needs by the year 2000. Growing annually at 2.7 percent, the population of Nepal is expected to reach 24.4 million by the year 2000. Nearly half its people are still living below the poverty line. Improving their lot depends critically on accelerating the growth of the agriculture sector, which has been sluggish in recent years. A 1989-World-Bank report states: "Perhaps the main factor responsible for the unsatisfactory agricultural growth has been the slow and ineffective development of irrigation." According to the plan, Nepal is to expand its irrigated area by an additional 816,000 hectares (from 1987 levels) to reach a projected total of 1.25 million hectares. The Department of Irrigation, which is responsible for most of Nepal's irrigation development activities, will target 589,000 hectares (72%) of this increase, while the Agricultural Development Bank of Nepal (ADBN), which offers credit for farmer-managed irrigation schemes, will be responsible for the remaining 227,000 hectares (28%).

Farmers in Nepal already manage over 60 percent of the land under irrigation. The government is committed to increasing farmer participation in management still further, and to the complete transfer of management wherever possible. In pursuit of these aims it has initiated a wide range of activities, including the formulation of appropriate policies, the adoption of modern technologies and the training of both agency staff and farmers. The objective of IIMI's country program in Nepal is to assist the government in these activities.

THE PROGRAM

IIMI established a resident scientist in Nepal in 1985, at the request of the Water and Energy Commission Secretariat (WECS). The program's initial objective was to advise the government on how best to assist existing farmer-managed irrigation systems. Funding was provided by the Ford Foundation and the International Fund for Agricultural Development (IFAD).

Between 1985 and 1989, IIMI collaborated with WECS in planning and implementing an extensive action-research project in the Hills. The project showed that, although a high degree of supervision was necessary to mobilize farmer participation at the outset, it resulted in stronger water users' organizations and in the farmers' increased ability to mobilize their own resources, leading eventually to a reduction in operation and maintenance costs. Most

important was the fact that farmer involvement in system rehabilitation led to more efficient operations and better subsequent maintenance.

The lessons of the WECS Project had important implications for the Department of Irrigation (DOI), which subsequently requested IIMI to support and strengthen its own initiative to improve irrigation management. IIMI and the DOI identified several problem areas in which IIMI could contribute, and work began in 1989 under a project funded by the United States Agency for International Development (USAID). IIMI is now affiliated with the DOI administratively through the Irrigation Management Water Utilization Division, which has responsibility for system operation and maintenance in accordance with the aims of the DOI Program.

In 1990, IIMI expanded its partnerships in Nepal still further by launching a study to document and evaluate various irrigation projects financed by the ADBN, using technical inputs from CARE-Nepal. The study assessed the technical and economic performance of such projects and the ADBN's process and procedures for project identification, development and execution. The aim was to identify any necessary modifications in the Bank's irrigation program to make it more effective in achieving national goals. This project was funded by the Ford Foundation.

ACTIVITIES IN 1992

During 1992, IIMI completed its work with the DOI on developing effective approaches to increasing farmers' participation in the management of large-scale irrigation systems. An important finding was that farmer-to-farmer training, whereby farmers unfamiliar with self-management can learn from their colleagues in other areas where it is well-established, is a highly effective approach (see box on page 25). Another finding was that having a dedicated agency manager is critical to the task of organizing farmers into groups to operate and maintain canals. This study also indicated that more equitable distribution of water can be achieved when farmers participate in maintenance tasks and the planning of water delivery schedules. This was demonstrated in particular during the winter season of 1992, when the head, middle and tail sections of the Banganga Irrigation System received deliveries that were much closer to planned targets than those of the previous year.

Activities under the DOI Project were crowned with a national workshop on participatory management, organized jointly by IIMI and DOI. Among the participants were farmers, invited to attend so as to engage them in the national debate on policy issues relating to participatory management. Farmers prepared papers, and presented and discussed them at the workshop. This was the first time in the history of the DOI that farmers had been accepted as equal partners at a national forum. A task force, which included a farmer as a member, drafted guidelines for the DOI Program. These guidelines have been adopted by the DOI.

In 1992, work began under the Ford Foundation Project on the development of a data base on Nepal's irrigation institutions and systems. The data base, which will be made available to practitioners, researchers and policymakers in the irrigated agriculture sector, already covers more than 100 farmer-managed irrigation systems. Initially, this work has been supported through an information exchange program undertaken in collaboration with the Workshop on Political Theory and Policy of Indiana University, USA. The aim is to transfer the data base to an appropriate Nepali institution in the near future.

Also in 1992, the Nepal Program supported four Nepalese researchers who attended three international workshops dealing with farmer-managed irrigation systems. In addition, two national workshops were organized jointly with DOI and ADBN. The proceedings were published in both English and Nepali. Finally, a Ph.D. candidate from Wageningen University was supported to conduct research on the Banganga Irrigation System.

THE PHILIPPINES

THE CONTEXT

The Philippines is a progressive innovator in the field of irrigation management, having taken steps earlier than most other developing countries in such areas as management turnover and crop diversification. The country's experience thus offers important lessons for other countries. Nevertheless, there is still considerable room for improvement in the performance of irrigation systems in the Philippines.

THE PROGRAM

IIMI began its work in the Philippines early in 1985, when a resident scientist was posted to Manila. Between 1985 and 1991 the program consisted of the following projects: Irrigation Management for Crop Diversification, phases I and II, funded by the Asian Development Bank (ADB); a collaborative project between IIMI and the International Rice Research Institute (IRRI) on Irrigation Management for Rice-Based Farming Systems, sponsored by the Rockefeller Foundation; a regional study on irrigation service fees; a study on organizational dynamics in a corporate type irrigation organization; and the research component of the Accelerated Agricultural Production Program (AAPP), financed by the United States Agency for International Development (USAID). In addition, IIMI provided support to various policy initiatives related to the irrigation sector.

The IIMI program in the Philippines has evolved rapidly, progressing from the diagnostic field research of its early years to the institution-building and policy-related activities of 1992.

ACTIVITIES IN 1992

In 1992, IIMI collaborated with the National Irrigation Administration (NIA) and the Bicol University Research Group to test various management innovations in two pilot-phase projects in the Bicol Region.

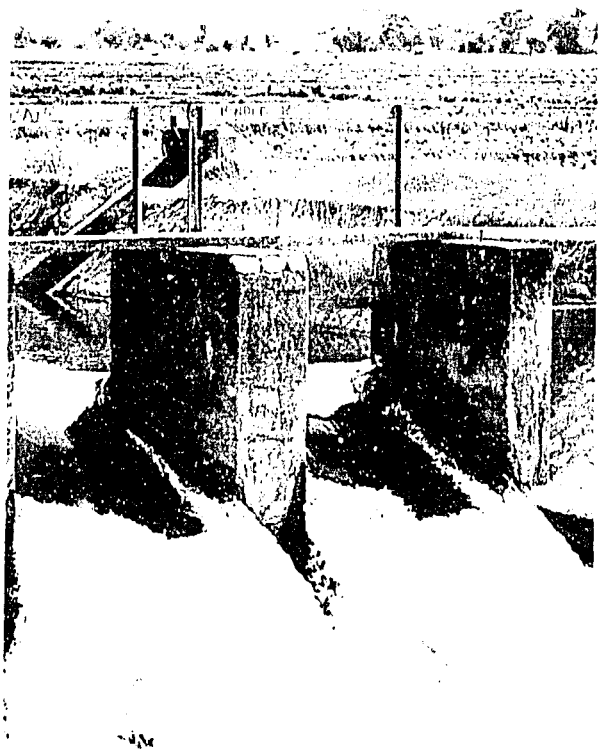
The first of these projects focused on organizational development to strengthen irrigators' associations and the interactions between these and NIA. The objectives were to increase the participation of members in the associations' activities, to enhance NIA's responsiveness to the needs expressed by the associations, and to improve management skills in the associations through farmer-to-farmer training.

Impact evaluation, based on statistical analysis, showed improved effectiveness of organizational and task structure, a higher success rate in the collection of service fees, increased farmer participation in system operations and maintenance, and increased cropping intensity.

The second project sought to strengthen the performance of irrigation associations through self-assessment techniques. Simple indicators were used by association leaders to measure and monitor their own performance as leaders, as well as that of the membership and of the irrigation system as a whole. The procedures adopted in 1991 have been modified, based on initial feedback from the farmers.

Self-assessment was quite successful in eliciting candid appraisals of the existing situation in the pilot areas. Its further use could reduce NIA's work in collecting data at grassroots level, since farmers themselves will be more able to collect and analyze the necessary data and to pass on appropriate information to the agency.

Several important information events were held during the year. The program hosted a regional workshop to standardize data collection on farmer-managed irrigation systems. A field study tour was



conducted for seven visitors from Indonesia. In addition, the program completed papers on a wide range of subjects related to its work in previous years, including the experience gained in farmer-to-farmer training, the comparative assessment of the performance of communal and state-run systems and the institutional sustainability of irrigators' associations. Seven manuals relating to various aspects of the development of irrigators' organizations were completed. Two workshop proceedings were edited.

During the year, IIMI continued its discussions with the Government of the Philippines, exploring the possibilities for a long-term collaborative program. The response of NIA and the Department of Agriculture has been encouraging.

IIMI's program in the Philippines has ranged from diagnostic field research to institution-building and policy-related activities.

West Asia and Northeast Africa

Major rivers which have their origins in mountain systems fringe this zone. These rivers carry plentiful silt and have laid down deep, level and fertile soil systems. The average rainfall is usually very low and many of the countries in the region rely almost entirely on irrigation for food and fiber. Human populations crowd the irrigated areas because nonirrigated food production capacity is weak. In many systems, almost all surface water resources have been captured so that better management of water is the only way forward.

The major irrigation countries of the zone are Pakistan, Iran, Iraq, Syria, Egypt and Sudan.

In this region, IIMI has concentrated its activities in Pakistan and Sudan. Initiatives are currently underway to extend these activities into Egypt. As part of these initiatives and following earlier missions in previous years, the Director for Research visited Egypt several times. Late in the year, a workshop was conducted with the Water Research Center with a view towards developing a joint program of activities on irrigation management in Egypt.

PAKISTAN

THE CONTEXT

Pakistan's population, estimated at more than 110 million in 1990, is likely to reach 150 million by the year 2000. About 70 percent of its people live in rural areas and are primarily dependent on agriculture, which is the mainstay of the country's economy.

With a gross irrigated area exceeding 16 million hectares, Pakistan ranks fifth in the world and third among developing countries in irrigated area. The country's Indus Basin systems constitute the world's largest contiguous irrigated area. These systems comprise over 60,000 kilometers of irrigation canals and more than 1.6 million kilometers of watercourses and field channels. The irrigation infrastructure also includes 12,500 large public tubewells, more than 300,000 small private tubewells and some 16,000 kilometers of surface drains.

Seventy percent of Pakistan's people live in rural areas and are primarily dependent on agriculture for their livelihood.

Studies of the potential of the Indus Basin have suggested that it has one of the world's most favorable environments for large-scale, intensive irrigated agriculture. In stark contrast are the predicted shortfalls in future national food and fiber production needs — 10 percent by 2000, 25 percent by 2013 — even if the national Water Sector Investment Plan's targets are met.

Good quality surface water is arguably the scarcest, most valuable agricultural resource in Pakistan. Hence, the returns to investment in the development of irrigation management innovations that will lead to its more productive and sustainable use are bound to be high.

The national Water Sector Investment Plan for the 1990s recognizes that effective plan implementation and the achievement of targets rest, in large measure, on eliminating the policy and institutional constraints that continue to depress the performance of the irrigated sector. Bold and prompt action is needed in this area.

THE PROGRAM

IIMI's program in Pakistan was launched in 1986. It now consists of four main projects and various support activities.

The first of these projects, on improving irrigation management to minimize waterlogging and salinity, was launched in 1989. Current research focuses on linking improved management of surface water supplies by irrigation agencies with the management of groundwater, which is largely in the hands of farmers.

The second major project is based in North-West Frontier Province. Its main objective is to devise and introduce an approach to the management of canal operations that is more responsive to the water requirements of crops than procedures currently followed by the Provincial Irrigation Department (PID). The project also aims to increase the understanding of agency personnel in this area thr 'raining, to evaluate the costs and 'ts of crop-based irrigation operations and to identify opportunities for implementation on a wider scale. The project was approved by the Government of Pakistan in August 1990 and funding was allocated by the Asian Development Bank (ADB) in January 1991.

Good quality surface water is arguably the scarcest, most valuable agricultural resource in Pakistan.

In 1985, a project funded by the United States Agency for International Development (USAID) on irrigation system management was initiated. This project aims to strengthen national capacities in research on irrigation management, to contribute to the more efficient use of land and water resources through relevant research, and to improve the effectiveness of existing irrigation infrastructure. Initially, technical assistance was provided through the University of Idaho, but, in 1990, USAID invited IIMI's program to fulfill this role.

IIMI's fourth project in Pakistan is also supported by USAID. Its focus is the development and pilot testing of a management support package to optimize canal operations and maintenance. Computer-based decision support technology is being used to predict the impact of different operational and maintenance inputs on the objectives of equitable and reliable water distribution. This management support research was identified by irrigation agency officials as having particularly long-term value for the Irrigation Department (ID). Hence, it is a major focus for the department's collaboration with IIMI. A primary objective is to enable PIDs to optimize the use of their limited maintenance and repair budgets which, in the current climate of financial austerity, are unlikely to be increased unless improved performance in this area can be demonstrated.

In its program in Pakistan, IIMI engages in "action" research in collaboration with provincial agencies responsible for operating and maintaining irrigation and drainage systems. It also collaborates with specialized research institutions dealing with land and water development at the national level.

ACTIVITIES IN 1992

Research to minimize waterlogging and salinity problems has shown that the sustainability of irrigated agriculture is strongly affected by the inequitable distribution of canal water and by the marginal to poor quality of groundwater pumped for irrigation (see page 33).

At the tertiary or watercourse command level, IIMI completed studies of socioeconomic factors and farming practices under variable soil salinity and groundwater conditions at three locations in Punjab. It was found that farmers are generally well aware of the problems of salinity and of whether or not the quality of groundwater is suitable for sustained

irrigation use. They modify their practices accordingly, for example by allocating water to specific fields or by purchasing tubewell water from other sources when their own is poor. In southeastern Punjab, farmers are especially active in trading tubewell water, with 20–40 percent of the total volume of pumped groundwater in some watercourse commands being exchanged.

Research on crop-based irrigation operations in North-West Frontier Province made steady progress during 1992. In the Chashma Right Bank Canal (CRBC) System, study areas were selected, comprising two distributaries in the newly developed area of Stage I and a minor distributary of the older Paharpur Canal System. Main activities included an evaluation of the current performance of the CRBC System, the introduction of a hydraulic model to assess present main canal operations, a survey of farming practices, and a general assessment of water distribution, cropping patterns and cropping intensities at various system levels.

Planned research on the Lower Swat Canal (LSC) System was prevented by the delay in completing rehabilitation work. The delay resulted from the agency's decision to discontinue the installation of gated outlets and to remove those previously installed because of breakage and vandalism. Consequently, IIMI initiated research to document the circumstances surrounding this major change in LSC rehabilitation plans, together with its policy implications.

Other studies on the LSC System conducted in 1992 included a rapid rural appraisal survey, an evaluation of a pilot demand-based watercourse level delivery system, and an assessment of the impact of system rehabilitation on farming practices. In addition, a review of institutional issues was begun.

IIMI's assistance to the USAID Project on irrigation system management included advising participating national research institutions on their annual work plans, data collection and analysis activities, and the interpretation of research findings. IIMI program staff provided support to the preparation of research reports, notably those to be presented at a symposium scheduled for April 1993. Further training of national research staff was also provided.

Efforts focused on introducing management innovations in canal operations in the Lower Chenab Canal (LCC) System. Accurate, timely information on canal flow conditions is central to taking effective decisions on system management; its absence has been identified by previous IIMI research as a significant impediment to increased efficiency. Jointly with the PID, IIMI organized flow measurement training for operational staff in the Upper and Lower Gugera Divisions of the LCC East Circle. A continuing program of systematic structure calibration was also planned and initiated.

An evaluation of main canal system performance initiated in 1991 was completed for the Fordwah and Eastern Sadiqia Canal systems in southeastern Punjab. Again, accurate and timely information on canal system flows was identified as a serious constraint to improving efficiency, particularly where the combined effects of siltation and deferred maintenance have altered physical conditions away from the design state. To predict the effects of different physical and management interventions, a computer model was calibrated, with different gate settings for variable flow conditions.

Progress continued with two other management interventions previously agreed by PID at a "retreat" held late in 1991. Two irrigation engineers were deputed to work with IIMI staff on the development and testing of computer-based decision-support systems for improving canal operations and maintenance. This work is discussed further below. Existing practices to mitigate salinity through extra canal supplies delivered to sanctioned reclamation chutes during the summer cropping season were assessed in cooperation with the PID's Directorate of Land Reclamation. A draft report of research findings and policy implications was completed and is under review by agency collaborators.

Work on developing and assessing decision-support systems focused on two canal flow simulation models. One model, Rajbah, is a result of the synthesis of previous IIMI canal modeling activities in Pakistan and elsewhere; it has proved especially suitable for use on secondary (distributary) canals. The other model, SIC, was developed at the Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts (CEMAGREF), France, as a generic version of the hydraulic model currently being used by IIMI and the Sri Lanka Irrigation Department in the Kirindi Oya Irrigation System (see page 11) SIC is particularly useful for main canal applications, although further modifications currently under way at CEMAGREF are expected to make it suitable for use at the distributary level as well. Development work continues on both models to incorporate an appropriate formula for determining seepage losses.

In 1992, Rajbah was recalibrated for the Lagar Distributary in the LCC System, for which extensive and detailed hydraulic data were already available. These data were supplemented with a physical survey before annual closure in mid-January. A survey of a second distributary, Pir Mahal, also in the LCC, was completed before extensive desilting — much of it by machinery — was carried out by the PID during annual closure.

For the Pir Mahal Distributary, pre- and post-desiltation flow conditions have been satisfactorily simulated and post-desilting channel performance is being monitored through model applications. For the Lagar Distributary, comparisons of actual post-maintenance performance with model-derived scenarios have indicated those areas where additional inputs would probably have brought a greater improvement. Results of this work will be used by the PID to plan maintenance activities during annual closure in 1993.

The SIC model was used to evaluate several operational scenarios for the Chashma Right Bank Main Canal. The results of this work were shared with PID and other agency staff. A report on this use of the SIC model was presented at an international canal modeling symposium jointly organized by IIMI and CEMAGREF in Montpellier, France, in October 1992. Also reported at the symposium were the results of earlier collaborative work on maintenance applications of the Rajbah model.

SUDAN

THE CONTEXT

More than three-quarters of Sudan's 27 million people live in rural areas and depend mainly on agriculture for their livelihood. The country's total agricultural area is 123 million hectares, of which only 7 million hectares are under cultivation at present. Of this, some 1.9 million hectares (27%) are irrigated.

The irrigated sector is immensely important to the economy of Sudan. It is a relatively secure source of food, especially in times of drought. It is also a major source of foreign exchange earnings. The sector produces all the country's wheat and sugarcane, almost all its cotton and horticultural crops, and a substantial proportion of its sorghum and food legumes.

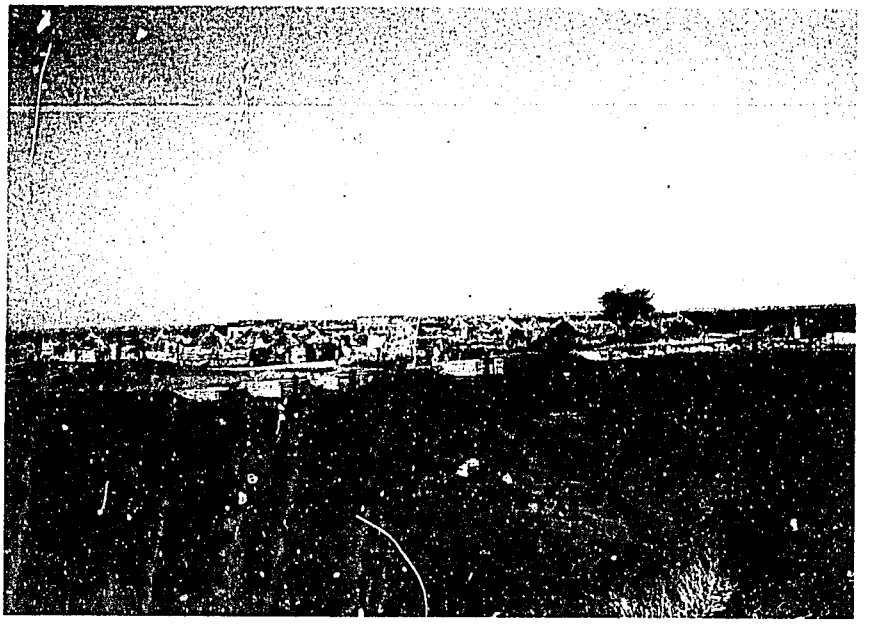
Among all the countries of the developing world in which irrigation is currently undergoing privatization, Sudan is perhaps the one in which the process is occurring most rapidly. The radical changes taking place throughout its irrigated sector are described in the box on page 16.

THE PROGRAM

IIMI's program in Sudan began in mid-1989, when the Institute recruited an international staff member

who established IIMI's office in Khartoum. In October of that year a national policy workshop was organized in Wad Medani to identify important irrigation management issues for collaborative work.

A consultative committee was established in early 1990. The seven members of the committee represent the various disciplines and agencies responsible for the irrigated sector. The committee draws up an annual work plan, coordinates its implementation, and reviews progress each year.



A project to assist Sudan's Gezira Board in promoting improved water management was completed in 1992.

A major project to assist Sudan's Gezira Board was launched in 1990 and completed in October 1992. Its principal objective was to promote improved water management. Advice in this area was based originally on the results of selected experiments conducted at the Board's pilot farm, but later the scope was extended to cover new experiments on the farm as well as in other areas of the scheme, so as to obtain results that would be more broadly applicable.

A study of irrigation management and performance in the Rahad Irrigation Scheme began early in 1991. The scheme is unusual in that water is allocated by one agency, the Rahad Agricultural Corporation, but delivered by another, the Ministry of Irrigation. The objective is to assist management agencies and farmers in developing management practices that will improve the efficiency and equity of water deliveries. Work began in 1991 with the monitoring of supplies at selected control points along Major 5, a sub-main canal.

A study on the privatization of pumping schemes on the White Nile has been initiated in collaboration with the Advisory Unit of Agricultural Corporations (AUAC) and the White Nile Agricultural Corporation (WNAC). The objectives of this study are to compare management under the existing parastatal agency (WNAC), with that under private companies and under farmers. One outcome of this preliminary study will be a proposal for a larger study on the transition to privatization of schemes along the White Nile.

As recommended by the consultative committee, IIMI is providing technical assistance to the Kenana Sugar Company. Studies on long furrow irrigation problems are being conducted to improve irrigation performance at the field level.

ACTIVITIES IN 1992

Key points of intervention to improve water management in the Gezira Scheme are summarized in the box on page 9.

Three major training activities were undertaken under the Gezira Project during the year. A 2-week in-country training course was organized for 31 senior field staff, a 1-week study tour abroad arranged for a

senior manager, and a 3-week training course conducted abroad for 3 mid-level professionals.

The preliminary findings of the Rahad study highlight four major problem areas for further research and management interventions. These are as follows: The Rahad System is not meeting its design objectives. From main canal to distributary levels, water distribution goes from bad to worse. The ratio of supplies to allocations varies from 0.2 to 2 and 0.2 to 4 at the sub-main canal and distributary levels, respectively. Inequitable water deliveries are thus a major problem.

The Rahad System was designed on the principle of night storage in minor canals. This mechanism was introduced to ensure equitable water distribution. In practice, as in the Gezira Scheme, night storage no longer exists. To save on labor costs, farmers have moved to an unattended continuous irrigation system. Systems for planning adequate and equitable deliveries according to demand exist, but no real use is made of the information gathered through them.

The surface drainage system is designed for the disposal of rainfall water only. In practice, the system is regularly serving as a conduit for the runoff of irrigation water. Runoff may be as high as 50 percent of supplies in some parts of the scheme.

Aspects of water allocations and deliveries were studied by two Sudanese M.S. students — one from Cornell University and the other from the University of Gezira. IIMI is also facilitating the field research of another M.S. student, from the University of Khartoum. He plans to document water distribution along selected minor canals.

Besides the research and training activities discussed above, the program engaged in various other activities during 1992. Seven seminars were organized at four different locations on such topics as management transfer, performance monitoring, and the planning needs of new irrigation schemes in Sudan. A work plan was devised for the Gezira Board's new Water Management Advisory Unit. Finally, the program hosted a visit of Pakistani cotton experts to Sudan.

Northwest and West Africa

In this zone, dependence on irrigation has hitherto been quite low. Population densities are usually low and over great parts of the continent rain-fed production has been adequate to feed the population with irrigation concentrated on cash crops or export crops. A trend toward more irrigation for staple food production is now emerging as populations grow and pressure on food resources increases. However, unlike in other zones, irrigation traditions and infrastructure are lacking, so institutional formation is a management issue here. Nigeria, with the continent's highest population, is the most significant irrigator country in the zone.

IIMI currently has a program for West Africa managed from a regional office in Ouagadougou, Burkina Faso. Individual country projects are carried out in Burkina Faso, Niger and Nigeria. In the Northwest, the Institute has a resident program in Morocco.

BURKINA FASO

THE CONTEXT

Burkina Faso is a landlocked Sahelian country of 274,000 square kilometers. Its population of about 9 million is currently growing at just under 3 percent a year. Especially in the drier northern areas, rainfall is unreliable, with the result that the irrigated sector assumes considerable importance for food security.

Burkina Faso has adopted a policy to transfer responsibility for the management of irrigation to farmers.

The development of irrigated agriculture around small storage reservoirs began in the 1960s, with the twin goals of increasing food production and alleviating rural poverty. The irrigated sector is now estimated to cover about 16,000 hectares, a modest area compared to the 2.6 million hectares covered by rain-fed agriculture, and only a tenth of the country's total irrigation potential, which is estimated to be about 160,000 hectares.

Irrigation schemes range from traditional valley-bottom systems with basic infrastructure and little or no means of water control to those with relatively sophisticated infrastructure ensuring total water control. The latter type includes some village schemes.

Like many other countries, Burkina Faso has adopted a policy to transfer responsibility for the management of irrigation to farmers.

THE PROGRAM

IIMI's program in Burkina Faso aims to strengthen the capacity of national institutions to improve and sustain the performance of village schemes. Its work forms part of the Institute's regional network for West Africa.

IIMI currently acts as the executing agency for a 4-year technical assistance project funded by the African Development Bank (AfDB). The project began in April 1991. IIMI provides technical, operational and administrative support, reporting to a 9-member national coordinating committee made up of representatives of all the ministries and agencies involved in irrigated agriculture. Responsibilities for irrigated agriculture in Burkina Faso are divided among various institutions belonging to either of two ministries, the Ministère de l'Eau (M-EAU) and the Ministère de l'Agriculture et des Ressources Animales (MARA).

The senior national professional staff of the IIMI program are seconded from three national institutions: the Office National des Barrages et des Aménagements Hydro-agricoles (ONBAH), the Direction pour la Promotion des Coopératives

(DPC), and the Institut d'Etudes et de Recherches Agricoles (INERA). Each of these institutions provides two staff members. This core staff of six is strengthened by one doctoral fellow from INERA and a varying number of short-term interns and fellows (at both undergraduate and postgraduate level) from the regional engineering school — the Ecole Inter-Etats d'Ingénieurs de l'Equipement Rural (EIER) — and the University of Ouagadougou.

ACTIVITIES IN 1992

In 1992, field research continued in the two irrigation systems where work began in 1991, namely Mogtédo and Itenga. The results of the diagnostic phase of this research are reported on page 9. Research was also initiated in three further systems, Savili, Dakiri and Gorgo, where studies were conducted on water storage, conveyance and distribution, on irrigation practices at farm level, and on formal and informal organizational arrangements.

Preliminary surveys of the Savili and Dakiri systems highlighted the need for greater skills in administrative and financial management within the farmers' organization. The cooperative has no legal status; there is no provision for replacing or maintaining the pumps and motors on which production depends, and the inadequate attention paid to maintenance has already resulted in two of the seven sets of pumps going out of service. A major issue to be investigated more thoroughly is the true returns to farmers from the contracts they have entered into with a private-sector company to produce green beans for export during the dry season.

In the case of Dakiri, the preliminary survey also pointed to the need to introduce rotational water distribution within secondary blocks. Pilot testing of this innovation has to await some modifications to the canal infrastructure and the training of technical staff and farmers.

The third system, Gorgo, is the most recently developed, having been irrigated for the first time during the wet season of 1991. A major constraint to system operation is the inadequate main canal discharge, caused by too small a head sluice. For the time being, a rotation between head and tail reaches is being practiced to solve the problem. The breaching of flood protection dikes following heavy September rains led to widespread floods and crop losses, aggravating the difficulties confronting the farmers of this system.

Training and information activities in 1992 included on-the-job training, research fellowships, workshops, seminars and field visits. The target audiences were agency staff, researchers and policymakers, as well as farmers.

The program organized and conducted two formal training courses. The first was a 2-week national course for agency staff organized in collaboration with the regional technician training school, the Ecole Inter-Etats des Techniciens Supérieurs de l'Hydraulique et de l'Equipement Rural (ETSHER). The objective was to improve the technical and management skills of the 26 participants. Special care was taken to include field staff from all of IIMI's research sites, enabling IIMI to strengthen its partnerships with national agencies.

The second course was a 4-week regional one on water management for irrigated rice jointly organized by the West African Rice Development Association (WARDA), EIER and IIMI. This was attended by 21 middle-level professionals from the national agricultural research institutes of 12 West African countries. IIMI planned and implemented an 8-day field-work component at two of its field sites.

Among the training materials prepared for these courses were course notes, visual supports, maps, display boards and video tapes. These constitute a valuable contribution to the Institute's stock of training materials, for use in future training events.

In 1992, field research continued in Mogtédo and Itenga irrigation systems.

In addition, IIMI staff acted as resource persons for the field-work component of a 10-week regional training course on irrigation water management in the African context organized by ETSHER and Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC).

The first in a series of exchange visits of a group of farmers and extension agents from Burkina Faso to Niger took place in December. The objective was to help them improve their irrigation management skills through observations and discussions with colleagues in a different environment.

At the request of the Ministry of Water Resources of the Gambia, IIMI organized a 1-week study tour in Burkina Faso for a group of Gambian rice farmers. The purpose was to study Burkina Faso's experience in farmer-managed irrigation systems. Besides field visits and discussions with local farmers, the visitors met staff from agencies providing support services to farmers.

The program continued to support the research of a doctoral student and to provide on-the-job training to two young engineers. In addition, three students from EIER, and two from the University of Ouagadougou wrote theses or project reports based on field research carried out at IIMI's study sites.

The program copublished the second issue of the bilingual (French-English) West African Irrigation Network Newsletter, which was devoted to irrigation in Niger.

Information exchange was further strengthened late in 1991 by the production of a national language newsletter copublished by IIMI and the World Conservation Union (IUCN) focusing on the interactions between irrigation and the environment. The points of view of the farmers at IIMI's research sites were prominently featured. In 1992, following a reorganization of the IUCN country office, IIMI had to find alternative means of production. Prospects for fund-raising through selling advertising space were explored. The next issue will be produced by the program early in 1993. IIMI also helped the IUCN representative in Burkina Faso organize workshops for local language journalists with a view to enlisting their support for the dissemination of information on irrigation and the environment.

A documentary film on Water in the Sahel, to which IIMI acted as technical advisor, was completed and shown on national television in February 1992.

NIGER

THE CONTEXT

Vast, landlocked and arid, Niger possesses limited potential for rain-fed agriculture. With its population rising by 3.3 percent a year, the country must move towards improved use of its scarce water and land resources for sustainable irrigation if it is to reach its goal of food self-sufficiency.

Current estimates place the irrigation potential of Niger at 270,000 hectares, of which around 30 percent (81,000 hectares) are being exploited at present. Irrigated production represents roughly 10 percent of total agricultural output. Recurrent droughts are only partially offset by the presence of several major sources of water. The most important of these is the Niger River, which flows for over 550 kilometers through the southwest of the country. Most of the country's modern irrigation schemes, with total water control, are found along its banks.

The size of Niger's irrigated perimeters ranges considerably, from a few hectares to several thousand, with the average size along the Niger River estimated at 200 hectares. There are currently more than 30 irrigation schemes of this kind, covering over 7,500 hectares. Development of these schemes costs an average of US$24,000 per hectare and rehabilitation approximately US$4–8,000 per hectare. Most schemes practice double-cropping of rice, with average yields of 5 tonnes of rice per hectare per crop per season (i.e., 10 tonnes per year).

The support provided to farmer-managed irrigation could be greatly improved. Cooperatives have no legal status, yet farmers shoulder an increasing share of the burden for organizing and supporting irrigated production as the government and donors steadily reduce their technical and financial contributions. Cooperatives now organize the supply of farm inputs, water distribution and irrigation system maintenance. They also market their crops, and in so doing must set aside a proportion of the profits to invest in inputs for the next season, since they cannot legally obtain credit.

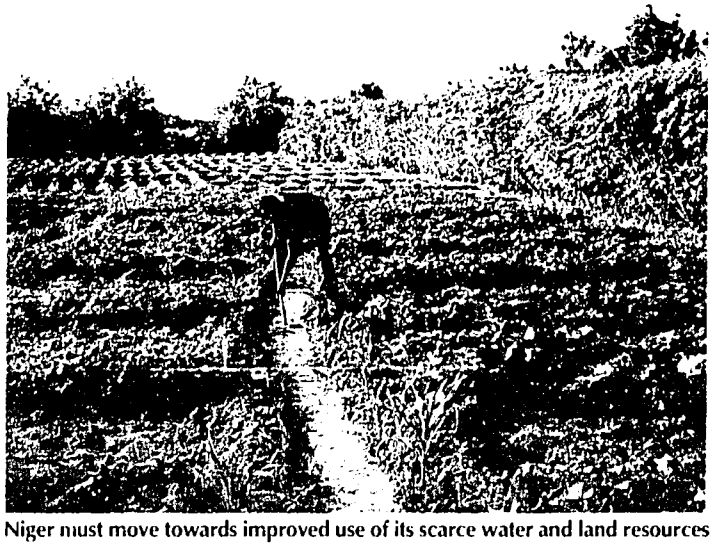
Frequently, under pressure from the very same donors that in the past promoted irrigation development, the Government of Niger is being told to reduce its role in this area, as well as in irrigation management. While farmers accept this reality they are finding it difficult to fill the void left by the state.

THE PROGRAM

IIMI's program in Niger consists of a single project supported by the African Development Bank (AfDB). Its objectives are to identify ways of reducing operating costs, diversifying crops and generally improving management in farmer-managed irrigation schemes along the Niger River. The project also pays special attention to the role of women in irrigated agriculture, and to the environmental effects of irrigation.

The project works under three national ministries: the Ministère de l'Agriculture et de l'Elevage (MAG/EL); the Ministère de l'Hydraulique et de l'Environnement (MHE) and the Ministère de l'Education Nationale, de l'Enseignement Supérieur et de la Recherche (MEN/SR). There are four national partners: the Office National des Aménagements Hydro-Agricoles (ONAHA), the Institut National de la Recherche Agronomique du Niger (INRAN), the Génie Rural (GR), and the University of Niamey (Faculté Agronomie). A 7 member committee steers and coordinates project activities.

The parastatal ONAHA plays a critical role in irrigation development in Niger. It is currently undergoing radical reorganization, as a result of which it will probably relinquish its roles in irrigation construction and rehabilitation to focus exclusively on providing support services to cooperatives.



Niger must move towards improved use of its scarce water and land resources if it is to attain food self-sufficiency.

The project was approved by the government in July 1991 and field research began in January 1992. Three representative irrigation schemes were selected to host field research and training activities — Saga, Kourani-Baria and Tillakaina.

ACTIVITIES IN 1992

The project undertook field research at all three sites in 1992. Initial data suggest that the physical, technical and socioeconomic characteristics of these irrigation schemes are representative of most of those along the Niger River. The findings are discussed in more detail on page 31.

The project sponsored 2 staff members to attend a 10-week training course on irrigation water management organized by the Ecole Inter-Etats des Techniciens Supérieurs de l'Hydraulique et de l'Equipement Rural (ETSHER), Ouagadougou and the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC), Montpellier, France. The project also hosted several students from the University of Niamey and the vocational agricultural school at Kollo. The students undertook field research at Saga and Tillakaina and prepared various reports on topics of interest to the project.

Exchange visits were arranged for project staff and cooperative members to visit Burkina Faso and Nigeria, to learn about irrigation experiences in neighboring countries. The project hosted a visit from the IIMI program in Burkina Faso.

The second issue of the bilingual West African Irrigation Network Newsletter, copublished with the Burkina Faso country program, came out during the year. It featured articles on several irrigation-related topics in Niger.

The project prepared several reports for review by the coordinating committee, national partners and the donor. These reports will serve as references for the more detailed technical studies to be published in 1993.

NIGERIA

THE CONTEXT

Nigeria has more irrigated land and greater potential for irrigation expansion than any other West African country. About 90 percent of its irrigated area consists of traditional irrigation systems and 10 percent modern.

Public-sector irrigation development and management are the responsibility of the country's 11 River Basin Development Authorities (RBDAs). When they were created, in 1976, these parastatal agencies of the federal government were given

responsibility for all agricultural production activities within their designated river-basin area.

In 1987, the Government of Nigeria adopted a policy to commercialize public-sector irrigation, as part of a broader package of reforms undertaken in the context of structural adjustment. While the government continues to provide funds for the development of irrigation infrastructure, the cost of services provided by the RBDAs is no longer subsidized but must be borne by the beneficiaries.

The policy entails far-reaching changes, including institutional reorganization, legal reforms and the development of users' organizations. Increasingly, responsibilities for operating and maintaining systems are being shared between farmers and agencies. Changes have taken place in the scope and management of the RBDAs. They have been partially commercialized and agricultural production activities have been withdrawn from their mandate.

Both the size of Nigeria's irrigated sector and these rapid changes in management make the country an important one for IIMI, allowing opportunities both to study the process of change and to provide inputs from experiences elsewhere that will help to guide that process and ensure its successful outcome.

THE PROGRAM

IIMI established its field office in Kano, Northern Nigeria, in August 1991, at the invitation of the Federal Ministry of Water Resources. The program aims to promote farmer participation in the management of public-sector irrigation. It works in collaboration with the Hadejia-Jama'ara River Basin Development Authority (HJRBDA). The collaborative research forms part of the Kano River Irrigation Project (KRIP), and is funded by the Ford Foundation.

The action research undertaken by the program in support of turnover in KRIP will be used as a model to assist other RBDAs in establishing similar participatory management systems. Activities focus on institutional aspects, modes of management, operation and maintenance methods, and the mobilization of labor and other resources. IIMI staff work closely with HJRBDA and KRIP to create the legal basis for joint management and to develop procedures for the formation of users' organizations. Special attention is devoted to the collection of water charges, with the aim of increasing the success rate in this area. Data are collected at three pilot sites in the head, middle and tail sections of KRIP on the socioeconomic status of farmers, on the crops they grow, their access to water, the moisture status of soils and growing crops, and the development and activities of farmers' organizations.

Nigeria has more irrigated land and greater potential for irrigation expansion than any other West African country.

ACTIVITIES IN 1992

Initial findings at the three pilot research sites are summarized in the box on page 13.

Joint management between the farmers' groups and KRIP appears feasible. As a first step, it is proposed to hand over responsibility for the distributary canals. Above this level, KRIP will retain responsibility for the time being.

During the year, efforts were made to involve the users' associations in a broader range of activities besides those related to water deliveries. These include the supply of inputs and marketing services. At each pilot site care is being taken to identify the cementing factors that will bind the farmers together and keep them acting as a group.

It is estimated that a 70-percent success rate in the collection of water charges would enable the associations to break even, meeting the costs of operations and maintenance. Data collected in 1992 showed that the current level is well below this — only 30 percent. More detailed studies to specify operation and maintenance costs are under way.

Efforts are also being made to specify the sharing of responsibilities between the farmers' associations and the agency. The management of HJRBDA has approved a proposal on a trial basis to authorize the farmers' associations in the pilot areas to collect water charges on behalf of KRIP and to retain 15 percent of the sums collected in their accounts when the collection rate exceeds 90 percent.

The first phase of the IIMI-Nigeria Program ended in December 1992. A second phase is proposed, focusing primarily on the continued strengthening of joint management. A special study on the social and institutional aspects of improving the productivity of *fadamas* (lowlands or flood plains with a low water table) will also be included. Efforts to improve the management of public-sector irrigation organizations in Nigeria will continue, and collaborative research with Nigerian universities and research institutes will be vigorously promoted.

Morocco

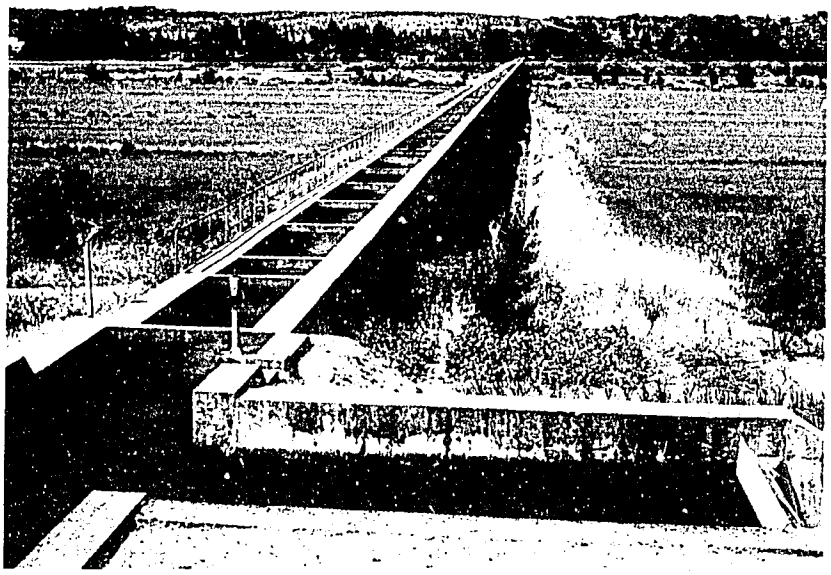
THE CONTEXT

Morocco has the third largest irrigated area in Africa (after Egypt and Sudan). It uses its irrigated sector not only to feed its own rapidly rising population but also to earn a substantial proportion of the hard currency it needs to finance overall economic development.

Morocco provides valuable examples of the Western Mediterranean approach to irrigation, which is characterized by fairly sophisticated technology, decentralized management, considerable diversity of irrigated crops and close integration with rain-fed agriculture and agro-industry. Yet Morocco's experience remains unfamiliar to many countries which might benefit from it, particularly those outside the Arab world and Francophone Africa. There is therefore considerable potential for the broader dissemination of information and for training activities for visitors from abroad.

Although Morocco manages large irrigation systems relatively well, agricultural production still falls well short of its potential. For instance, yields of irrigated wheat — the country's major food staple — are around 3–4 tonnes per hectare (about 1 kg per cubic meter of water) in the most productive areas, whereas they are at least double this level in Southern Europe, often under less favorable climatic conditions. Small-scale irrigated agriculture seems to perform far less well than large-scale, although this cannot be proved since reliable data are lacking.

Various studies have concluded that the way forward for irrigated agriculture in Morocco is to improve on-farm irrigation practices and increase the



Morocco has the third largest irrigated area in Africa.

involvement of farmers in irrigation management. Thus, Morocco stands to benefit from the experiences of other countries more advanced in these areas.

IIMI is well-placed to assist these two-way exchanges of information and results. In 1988, the Institute therefore decided to accept the invitation of the Government of Morocco to launch a program in its country.

THE PROGRAM

IIMI's program conducts research on several themes of interest to both Morocco and IIMI, including irrigation management in mixed farming systems, the relationships between system design and management, performance assessment and farmer participation in management.

The program's first projects were developed in collaboration with the Offices Régionaux de Mise en Valeur Agricole (ORMVAs). These are regional public-sector organizations responsible for overall agricultural development, including irrigation management, in specific command areas. There are nine such organizations in the country, covering most of its high-potential cropping areas. However, over the coming years, IIMI expects to diversify its partnerships to include farmer-managed irrigation systems falling outside the command areas of the ORMVAs. These systems cover a third of the country's irrigated area and are underdeveloped at present.

Besides the ORMVAs, IIMI has collaborated with various research organizations, including relevant university departments and the Service des Expérimentations d'Hydraulique Agricole (SEHA). This is an irrigation and drainage research center under the Ministère de l'Agriculture et la Réforme Agraire (MARA).

After establishing its office in Rabat in 1989, IIMI began the first phase of a project investigating the performance of a traditional farmer-managed irrigation system within the command area of an ORMVA. The reasons for the system's disappointing performance following modernization by the ORMVA were diagnosed, and suggestions made for improving the situation.

In September 1991, IIMI, the ORMVA of the Tadla Region and SEHA launched a collaborative project on irrigation extension services for gravity systems in Tadla. The objective is to improve the profitability of irrigated wheat, alfalfa and paprika by increasing yields per unit of water. Besides having obvious direct economic benefits, this project should also solve waterlogging and salinization problems.

ACTIVITIES IN 1992

The preliminary phase of the Tadla Project was completed by the end of 1992. Details of the results are provided on page 31 of this report.

As in previous years, the Morocco Program provided much short-term assistance and advice to ORMVAs other than those with which it collaborates on an ongoing basis. The director of one ORMVA requested and received advice on the application of mathematical models to the diagnosis of canal maintenance requirements and the planning of rehabilitation works.

The Program also hosted the Moroccan segments of two study tours. One tour came from Pakistan to study water delivery in relation to crop requirements. The other was organized by IIMI headquarters for eight irrigation managers from four countries of Southeast Asia, who came to study irrigation management for crop diversification (see page 30). These two tours were encouraging first steps towards the broader dissemination of Moroccan experience to other countries.

Latin America

The area under irrigated agriculture in Latin America is about 16 million hectares. The countries in the region with large irrigated agricultural areas are Mexico, Brazil, Argentina, Chile, Peru, Cuba, Ecuador and Colombia. These countries account for almost 90 percent of the total irrigated area of the region. Although, in several countries, irrigation is concentrated on market crops rather than on staple cereal crops, there are substantial pockets like northeast Brazil, northwest Peru, and central Chile where irrigation plays an important role in food production.

IIMI began taking steps in 1990 to initiate programs in Latin America where there is a growing need to improve irrigation performance to increase food production.

To establish its program in the region, IIMI has fielded three missions to Latin America. The first mission, undertaken in the latter part of 1991, involved visits to Argentina, Brazil, Chile, Colombia, Ecuador and Mexico to interact with irrigation agencies and professionals on the possible scope of IIMI's program in the region. The outcome of the mission is a report on Guidelines for an IIMI Program in Latin America (Bertranou and Schulze, 1992) which describes the key issues facing irrigated agriculture in Latin America and outlines a possible IIMI approach to address these issues in collaboration with Latin American institutions. In December of the same year, IIMI and the Instituto Nacional de Ciencia y Tecnica Hidrica (INCYTH), organized a workshop in Mendoza, Argentina, on farmer-managed irrigation systems. Although this was a global workshop, the location gave considerable prominence to Latin American concerns and promoted considerable interchange between Latin American and other, particularly Asian, specialists. IIMI's first mission to the region was followed by a visit to Mexico in August 1992 by the Director General. A further two-member mission to Mexico was undertaken in October to identify program possibilities, including possible collaborating partner organizations.

Following the Bertranou/Schulze report, and in consultation with experts on irrigation management in the region, the Institute has prepared a broad outline of a program for the region designed to fill some of the most critical irrigation management gaps. The objectives of the program are to devise region-specific methods to address irrigation management needs such as more and better information, increased irrigation-management research capacity, and the introduction of irrigation-management improvements. The program would make a significant contribution to generic research that forms the core of IIMI's research mandate, as well as making contributions to the site-specific needs of the countries.

With strong donor interest in supporting programs in Latin America, prospects for initiating activities in 1993 are bright.

CAPACITY BUILDING

IIMI's capacity-building activities are designed to strengthen national irrigation management and research. They are of two major kinds — training and information.

MANAGEMENT TRAINING

Training activities at IIMI operate differently to those of other centers in the CGIAR system. Most other centers have, *in the past,* conducted many training activities at their headquarters locations and are only *now* engaged in a process of decentralizing them and devolving responsibility for them to national research groups. IIMI, in contrast, *has always run* its training activities in a decentralized mode — using the farm or the agency itself as at once the setting and the subject of the training process, as well as the partner in it. No group courses are held at headquarters. The Institute's full-time training staff consists of a single training specialist with a "roving" mandate to visit irrigation institutions in IIMI's partner countries. The purpose of these visits is to develop local training skills, act as a catalyst in the diagnosis of organizational constraints to successful job performance, and assist in the development and institutionalization of improved management techniques and approaches. These activities complement the training activities conducted by IIMI's other professional staff, which are described in the thematic and in-country sections of this report.

The Training Cycle

To ensure that training activities lead to real and lasting gains in performance, IIMI has developed a six-stage training cycle. The objective is to take a holistic approach to the national irrigation and research development system, allowing key management constraints to be identified and appropriate interventions planned and implemented on a consensual basis. Special attention is paid to the links between system components, and to the strengthening of participatory approaches. Presented here in a generalized form, the cycle can of course be adapted to suit the needs of specific countries or organizations. The first stage of the cycle is to identify organizational constraints and training needs. This is done interactively, through group seminars held with staff at all levels of the organization, who are subsequently interviewed individually where necessary. The aim is to "open up" the organization and its staff, so as to encourage free and frank discussion of problems and their potential solutions.

The second stage is to prepare a training plan. This is done in consultation with the organization's senior managers, often through a small workshop. Sometimes the workshop serves as an "eyeopener" — confronting senior managers with defects in their own management style and performance, as perceived by those who work for them. This is particularly true in agencies where a "top-down" management style has prevailed in the past, but is no longer perceived to be appropriate. The workshop usually leads to the identification of the management changes necessary at all levels of the organization, and of the priority groups and topics to be addressed.

The third stage is the development of detailed training curricula. The curricula comprise comprehensive guidelines enabling the trainer to direct the learning process. Separate curricula may be developed for different professional groups within the organization, such as engineers and technicians, as well as for the trainers — the representatives from each group who will lead the training process.

The fourth stage is the training of trainers. This usually takes the form of a course lasting 2 to 3 weeks. Often, the first task in these courses is to convince participants from professional backgrounds who may lack any past experience in training and management that they have latent skills in these areas. The course

then aims to bring out these skills and to exercise them, so that they become stronger. Participants are divided into three groups, each of which is asked to organize a 1-day training session for the other two groups, which act as "trainees." These sessions are video-taped, enabling participants to assess their own strengths and weaknesses after the event. Feedback is also received via the other two groups which, in their capacity as trainees, evaluate the trainers through a questionnaire.

The fifth stage is the production of training materials. These are developed by the trainers themselves, with the support of agency and IIMI staff, using a combination of existing IIMI and agency publications as sources. Translations into local languages are arranged according to need.

The sixth and last stage of the IIMI training cycle is to monitor the results of the previous five stages. IIMI staff assess whether local trainers have shown themselves capable of applying training methods and techniques with confidence, whether the training materials developed are adapted to local needs, and other indicators of success.

Activities in 1992

The year 1992 saw the application of various stages of the training cycle in Malaysia and Bangladesh. Activities in Bangladesh, where IIMI has a program is reported in the country programs section. This section therefore deals only with activities in Malaysia (see box below).

INSTITUTIONAL DEVELOPMENT AT THE DEPARTMENT OF IRRIGATION AND DRAINAGE IN MALAYSIA

IIMI has been involved in Malaysia since 1989, when the Department of Irrigation and Drainage (DID) requested the Institute's assistance in a comprehensive review of its approach to management, including client orientation, outputs and performance, as well as the adequacy of existing training programs. Three workshops for senior managers of the agency were held in October 1991 to redefine the agency's mission statement, major objectives and strategies. Two major outputs in 1992 were the completion of a strategic planning exercise and a human resources development plan. In addition, two irrigation schemes — Besut and Kerian — were selected as a testing ground for the reorientation of agency activities at field level. Workshops were held for field staff, and interviews conducted with farmers to assess their views on the department's performance. Lastly, management research at the department was strengthened through the creation of a new division for this purpose. This followed training by IIMI which increased both the awareness of the importance of research and the research skills of senior staff.

The Malaysian experience was rated as successful by all its participants, and IIMI will be looking forward to further opportunities to apply a similar approach elsewhere.

INDIVIDUAL TRAINING

In the area of Individual Training, IIMI hosted over 20 scholarships and fellowhips whose details are given in Annex III. These training activities were carried out in several countries including Burkina Faso, Niger, Pakistan and Sudan.

COLLABORATIVE RESEARCH ACTIVITIES

IIMI's collaborative research activities in the field are designed to contribute to strengthening national research capacity. These collaborative research activities are therefore an important aspect of IIMI's training activities.

In 1992, collaborative research activities were initiated in several countries, some examples of which are given below.

AGREEMENTS AND RESEARCH CONTRACTS

Organization	*Purpose*
India	
Water and Land Management Institute, Bihar	To document the distribution and management performance of different types of institutional arrangements for obtaining and utilizing tubewells for irrigation in Bihar and to develop a practical methodology for inventorying and developing groundwater irrigation institutions, within the area of the Eastern Gandak Canal Irrigation System.
	To collaborate in developing and implementing a research methodology and work plan involving collection and analysis of data on technical, agricultural, environmental, socioeconomic and institutional aspects of groundwater irrigation.
Nepal	
Agricultural Development Bank of Nepal	To strengthen the technical capability of ADB/N staff under its Community Surface Irrigation Program.
Institute of Agriculture and Animal Science, Tribhuvan University of Nepal	To undertake collaborative research and training activities in irrigation management.
Institute of Agriculture and Animal Science, International Centre for Integrated Mountain Development and Workshop in Political Theory and Policy Analysis, Indiana University	To establish a cooperative relationship in order to implement the access and use of the Nepal Irrigation Institutions and Systems (NIIS) database.
Sri Lanka	
People's Bank of Sri Lanka	To collect and synthesize information on projects and programs dealing with natural resources management in Sri Lanka.
Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.	To collaborate on a sub-study at Inginimitiya System under the Irrigation Management Improvement Project.
Engineering Consultants Ltd., Sri Lanka.	To study cost-effective modernization strategies for the 1990s.
Agrarian Research and Training Institute, Sri Lanka.	To carry out the first phase of the study on Monitoring and Evaluation of Participatory Irrigation System Management policy.
Department of Agricultural Engineering, University of Peradeniya, Sri Lanka.	To design and test a low-cost-level data logger.

Organization	Purpose
Sudan	
Rahad Agricultural Corporation and Hydraulics Research Station	To assess irrigation performance in the Rahad Irrigation Scheme.
Ministry of Irrigation, Nile Agricultural Corporation and White Nile Private Holding Company	To evaluate privatization operations in the White Nile Pumping Scheme.

WORKSHOPS AND CONFERENCES

IIMI's workshops and conferences provide opportunities for researchers in developing countries to meet and exchange ideas both among themselves and with irrigation managers and policymakers. In 1992, the Institute organized or co-organized 31 workshops and conferences in several countries including Bangladesh, Burkina Faso, Nepal, Nigeria, Pakistan and Sri Lanka. IIMI was represented at 32 workshops and conferences organized by other institutions. The details of these events are given below.

WORKSHOPS AND CONFERENCES ORGANIZED OR CO-ORGANIZED BY IIMI

Title	Date(s)	Location
Le Management en Irrigation — Training Course for irrigation agency field staff (co-organizer: ETSHER, Ouagadougou, Burkina Faso).	6–18 January	Ouagadougou, Burkina Faso.
Clients' Workshop on Strategy and Medium-Term Plan.	8–9 January	Colombo, Sri Lanka.
Crafting Irrigation Institutions in Nepal (co-organizers: IAAS/DOI, Nepal).	12 January	Kathmandu, Nepal.
International Workshop on Design of Irrigation Structures for Hill and Mountainous Environments (co-organizer: ICIMOD, Kathmandu, Nepal).	13–17 January	Kathmandu, Nepal.
AIT/IIMI International Workshop on Soil and Water Engineering for Paddy Field Management.	28–30 January	Bangkok, Thailand.
Donor Workshop on Strategy and Medium-Term Plan.	3 February	The Hague, Netherlands.
IIMI-India Collaborative Research in Irrigation Management (co-organizer: WALMI, India).	13–14 February	New Delhi, India.

Title	Date(s)	Location
Orientation on the Role of Water Users' Association in the Kano River Irrigation System (co-organizer: Hadejia Jama'ara River Basin Development Authority, Kano, Nigeria).	27 February	Kano, Nigeria.
Gestion de l'Eau et de l'Irrigation pour la Riziculture — Training Course for Research Staff of NARS in West Africa (co-organizers: WARDA, Côte d'Ivoire/EIER, Ouagadougou, Burkina Faso).	2–28 March	Ouagadougou, Burkina Faso.
Planning Retreat for Draft 8th Five-Year Plan — Irrigation and Agriculture Component.	14 April	Islamabad, Pakistan.
Participatory Management in Agency-Managed Irrigation Systems in Nepal (co-organizer: DOI).	29–30 April	Kathmandu, Nepal.
DSE/IIMI Workshop on Monitoring and Evaluation of Irrigation Performance.	4–22 May	Chiang Mai, Thailand.
South Asian Regional Workshop on Groundwater Farmer-Managed Irrigation Systems and Sustainable Groundwater Management.	18–21 May	Dhaka, Bangladesh
Discussion of Draft Final Report on Study of Strategies for Cost-Effective Modernization.	2 June	Colombo, Sri Lanka.
Cost-Effective Strategies for Irrigation System Modernization.	16–18 June	Ahungalle, Sri Lanka.
First National Level Participatory Project Design Workshop for Shared Control of Natural Resources (SCOR) (cosponsors: USAID and the Ministry of Lands, Irrigation and Mahaweli Development, Sri Lanka).	3–4 July	Negombo, Sri Lanka.
Second National Level Participatory Project Design Workshop for SCOR (cosponsors: USAID and the Ministry of Lands, Irrigation and Mahaweli Development, Sri Lanka).	7–8 August	Seeduwa, Sri Lanka.
Workshop for Technical Assistants on Performance Improvement and Sustainability of Irrigation Systems under the Irrigation Systems Management Project (ISMP).	2–8 September	Katunayake, Sri Lanka.
IUCN/IIMI Workshop on An Integrated Approach to Natural Resource Management in Two Types of Watersheds.	9 September	Colombo, Sri Lanka.
Strategic Planning and Human Resources Development at Bangladesh Agricultural Development Corporation (BADC).	15–17 September	Dhaka, Bangladesh.

Title	Date(s)	Location
Workshop on Strategic Planning and Human Resource Development Plan for Managers of Besut and Kerian Irrigation Schemes in Collaboration with Universiti Pertanian Malaysia and Department of Irrigation and Drainage, Malaysia.	21–23 September	Kota Bharu, Malaysia.
Informative Workshop on DID Mission, Objectives and Strategies as well as Objectives and Strategies for the Besut Scheme in Malaysia.	24 September	Besut, Malaysia.
Workshop on Research on the Performance of Irrigation Systems in Collaboration with Universiti Pertanian Malaysia and Department of Irrigation and Drainage, Malaysia.	28 September-1 October	Besut, Malaysia.
The Role of NGOs in Irrigation Development and Management (co-organizer: ADB/N).	29–30 September	Kathmandu, Nepal.
DSE/IIMI Strategy Workshop on Irrigated Agriculture in Southeast Asia Beyond 2000.	5–9 October	Langkawi, Malaysia.
DSE/IIMI Asian Regional Workshop on the Inventory of Farmer-Managed Irrigation Systems and Management Information Systems in Collaboration with NIA.	13–15 October	Tagaytay City, Philippines.
Formation of Water Users' Association in the Kano River Irrigation System (co-organizer: Hadejia Jama'ara River Basin Development Authority, Kano, Nigeria).	19–23 October	Kano, Nigeria.
International Workshop on Application of Mathematical Modeling for the Improvement of Irrigation Canal Operations (co-organizer: CEMAGREF, France).	26–28 October	Montpellier, France.
Workshop on Irrigation Management in Egypt (co-organizer: Water Research Centre, Cairo, Egypt).	14 December	Cairo, Egypt.
Institutions, Incentives and Irrigation in Nepal (co-organizers: IAAS/DOI, Nepal).	21 December	Kathmandu, Nepal.
Formation of Water Users' Association in Hadejia Valley Project (co-organizer: Hadejia Jama'ara River Basin Development Authority, Kano, Nigeria).	21–22 December	Hadejia, Nigeria.

SELECTED WORKSHOPS AND CONFERENCES AT WHICH IIMI WAS REPRESENTED

Sixth Meeting of the Moroccan Conseil Supérieur de l'Eau (organizer: Conseil Supérieur de l'Eau, Morocco).	22–23 January	Rabat, Morocco.
Fourth Irrigation Management Policy Advisory Committee Policy Workshop (organizer: IMPSA Secretariat, Colombo, Sri Lanka).	24–26 January	Habarana, Sri Lanka.

Title	Date(s)	Location
International Conference on Water and the Environment (ICWE) (organizer: FAO)	26–31 January	Dublin, Ireland.
Maitrise de l'Eau en Agriculture et Réalité Africaine (organizers: ETSHER, Ouagadougou, Burkina Faso/CNEARC, Montpellier, France).	3 February - 11 April	Ouagadougou, Burkina Faso and Montpellier, France.
National Environmental Action Plan Workshop (organizer: Institute of Fundamental Studies, Sri Lanka).	21 February	Kandy, Sri Lanka.
Consultation on Legal Issues Relating to Water Resources Development and Management in Sri Lanka (organizer: IMPSA Secretariat, Colombo, Sri Lanka).	20–21 March	Negombo, Sri Lanka.
Fifth Irrigation Management Policy Advisory Committee Policy Workshop (organizer: IMPSA Secretariat, Colombo, Sri Lanka).	24–26 April	Beruwala, Sri Lanka.
La Conception des Aménagements Hydroagricoles en Aval des Barrages et sa Relation avec la Mise en Valeur (organizer: Ministry of Water, Burkina Faso).	28–30 April	Ouagadougou, Burkina Faso.
Methods of Measuring Sustainability through Farmer Monitoring: Applications to the Rice Wheat Cropping Pattern in South Asia (organizers: CIMMYT, IRRI and Nepal Agricultural Research Council, Nepal).	6–9 May	Kathmandu, Nepal.
First National Water Resources Forum (organizer:.National Water Resources Institute, Nigeria).	26–28 May	Kaduna, Nigeria.
Farmers' Role in Irrigation System Management (organizer: Centre for Water Resources, Anna University, Madras).	29 May	Madras, India.
Annual Sessions of the Sri Lanka Agricultural Economics Association (organizer: Sri Lanka Agricultural Economics Association, Kandy, Sri Lanka).	6 June	Kandy, Sri Lanka.
Indigenous Management of Agriculture and Natural Resources (organizer: Winrock International).	8–9 June	Kathmandu, Nepal.
Seminar on Water and Land Laws in Irrigated Areas of Africa and Madagascar (organizer: Centre d'Études Juridiques et Politiques du Monde Africain, Morocco).	8–11 June	Kenitra, Morocco.

Title	Date(s)	Location
43rd International Executive Council Meeting and 16th European Regional Conference on the European Strategy in Irrigation, Drainage and Flood Control in the '90s (organizer: ICID).	21–27 June	Budapest, Hungary.
Meeting of CGIAR Social Scientists (organizer: CGIAR).	17–20 August	The Hague, Netherlands.
Symposium on Irrigation and Society: The Mahaweli Project, Sri Lanka (organizers: Department of Social Anthropology, University of Zurich and Department of Sociology, University of Colombo, Sri Lanka).	24–29 August	Ticino, Switzerland.
Expert Consultation of the Asian Network on Irrigation/Water Management (organizer: Regional Office for Asia and the Pacific of the FAO, Bangkok, Thailand).	25–28 August	Bangkok, Thailand.
Workshop to Begin Work on Irrigation Research Management Unit (IRMU) (organizer: Irrigation Department, Sri Lanka).	27 August	Colombo, Sri Lanka.
Meeting of PEEM Collaborating Centres (organizers: WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control).	1–4 September	Harare, Zimbabwe.
International Conference on Advances in Planning, Design, and Management of Irrigation Systems as Related to Sustainable Land Use (organizer: The Center of Irrigation Engineering).	17–20 September	Leuven, Belgium.
Third Common Property Conference (organizer: International Association for the Study of Common Property).	17–20 September	Washington D.C., USA.
The Impact of Irrigation Projects on Nigeria's Environment (organizer: Obafemi Awolowo University, Ile-Ife, Nigeria).	27–30 September	Ile-Ife, Nigeria.
Framework for Modernization of Mexican Irrigation Systems (organizer: IPTRID).	5–6 October	Mexico City, Mexico.
59th Meeting of the Technical Advisory Committee of the CGIAR (organizer: CGIAR).	19–24 October	Washington D.C., USA.
International Workshop on Gender Concerns in Rice Farming (organizers: IRRI, Farming Systems Institute and Department of Agriculture, Bangkok, Thailand).	20-25 October	Chiang Mai, Thailand.
International Centers Week (organizer: CGIAR).	26–30 October	Rome, Italy.
Second Mediterranean Conference on Water (organizer: EC, Italy).	28–31 October	Rome, Italy.
Asian Farming Systems Symposium (organizer: Asian Farming Systems Association).	2–5 November	Colombo, Sri Lanka.

Title	Date(s)	Location
Third Pan-American Regional Conference on Modernization of Irrigation Districts (organizer: ICID).	9–11 November	Mazaltan, Mexico.
Irrigation in the Year 2000: A New Approach of Irrigation in France and in the World (organizers: Association Française pour l'Etude de l'Irrigation et du Drainage, Réseau National Expérimentation et démonstration — Hydraulique Agricole and Sociéte Hydrotechnique de France).	18–19 November	Paris, France.
Workshop on Irrigation Systems Management Project 1993 Annual Workplan (Organizer: ISMP, Sri Lanka).	24–25 November	Colombo, Sri Lanka.

INFORMATION

INTRODUCTION

IIMI's information activities are designed to disseminate research findings and experiences to IIMI and its national research partners, to the wide range of people holding key positions in national irrigation agencies and research systems, and to other interested parties including donors, policymakers and trainees.

The Information Office at IIMI headquarters comprises the units of Library and Documentation, Publications, Editorial and Production, Public Awareness, Distribution and Computer Services.

REVIEW OF ACTIVITIES DURING 1992

Since the beginning of 1992, the Library holdings at headquarters have increased by 1,897 items, bringing the total up to 10,480 items. Of these, 3,961 are monographs, 1,575 unpublished manuscripts, and the remaining 4,871 analytical entries and journal articles. The IIMI Library subscribes to 147 periodicals of which 40 are primary journals. Many of the secondary journals are obtained through gifts and exchange agreements with other libraries.

1992 saw the introduction of the Selective Dissemination of Information (SDI) service to IIMI program staff. This service has been extended to include partners and collaborators, initially in the Sudan. IIMI's SDI service is based on interrogating databases, IIMI's own database together with a range of international databases held on CD-ROM, against the customized profiles of IIMI staff and partners.

In Sri Lanka, libraries concerned with agriculture are members of a national network AGRINET, the Agricultural Information Network. Not only has IIMI extended its SDI and interlibrary loan services to AGRINET members but the Head Librarian and Documentalist have served as resource persons on AGRINET training programs. These programs have been conducted to improve the abilities of mid-level library personnel in the local agricultural libraries.

IIMI researchers publish their work in international journals and in formal IIMI publications. The list of IIMI publications for 1992 is displayed in ANNEX II.

At the beginning of 1992, IIMI established its own in-house typesetting and layout systems

employing PC desktop computer applications and postscript laser printout. Printing of the finalized manuscripts is undertaken locally in Colombo. 1992 saw the completion and introduction of IIMI's new Logo to the institute which now appears on all IIMI stationary and publications.

Most lay audiences are unaware of the importance of irrigation management and the work of IIMI. The program during 1992 focused on getting IIMI better known in its host nation, Sri Lanka. A number of press releases on specific events have been reinforced by radio and newspaper interviews of IIMI Directors, Board Members and researchers to provide a wider understanding of the role of irrigated agriculture and what IIMI is doing. These activities have been supplemented by articles published in the local press about specific activities. "News Briefs," very short impact articles, were initiated and distributed to IIMI's stakeholders and partners, in addition to a number of other targeted outlets around the world. Longer stories about IIMI's work and impacts have been prepared and are being posted in "IIMI News" for wider distribution.

IIMI's computer services unit was brought under the administration of the Information Office late in 1992 with the intention of bringing the use and operation of computer systems, throughout the institute, into a coherent framework. The plan is to provide an integrated computer system for IIMI staff to access and share common data. The unit is now in the process of identifying common databases and resources of wide interest to IIMI staff, specifying standardized software packages, and defining the configuration of the hardware necessary to run the systems. It is anticipated that the developments in this area will move quickly over the next two years.

FINANCE AND ADMINISTRATION

In 1992, the Institute's income of US$9.7 million was applied to net operating expenditures of US$9.1 million (see Figures 7 and 8). Thus, IIMI ended the year with a net operating surplus of US$643,878 of which US$461,180 were allocated for new capital purchases, US$58,080 to the capital fund established in 1991 for replacement of core assets, and the balance US$124,618 to the operating fund. In 1992, IIMI employed US$3.3 million in core unrestricted resources, US$3.8 million in core restricted support, and US$2.6 million in complementary support. IIMI's unencumbered cash assets at the end of 1992 were over US$2.0 million.

At the close of 1992, IIMI had 31 internationally recruited staff. Some 132 national and international professionals were engaged in IIMI's research, training and information activities in headquarters and overseas units. IIMI's total staff numbered 367, more than half of them based outside Sri Lanka (see Figure 9 in Annex IV).

The financial Tables that follow distinguish between IIMI's core programs and its complementary programs. (Previous IIMI Annual Reports did not make this distinction, since before joining the CGIAR system, IIMI did not differentiate between core and complementary activities.) The set of definitions adopted for the Medium-Term Plan is given in the box. Since the Medium-Term Plan period will only commence in 1994, a "transition definition" has been adopted for 1992 and 1993; under this "transition definition," all ongoing research activities carried out in India and Pakistan (whether country-specific or transnational) are considered part of IIMI's core program, rather than of its complementary program.

IIMI defines as core those activities deemed essential for meeting the Institute's mission of fostering the development, dissemination and adoption of lasting improvements in the performance of irrigated agriculture in developing countries. These activities are those which:

- Involve research or research-related activities.
- Address one or more of IIMI's five program areas.
- IIMI is better-qualified to undertake than others.
- Generate transnational rather than country-specific results.

IIMI's complementary program covers activities of a similar type, but their results are country-specific rather than transnational in scope.

CORE UNRESTRICTED, CORE RESTRICTED & COMPLEMENTARY — 1992.

Donor		*1992 Grant US$*
CORE UNRESTRICTED		
Australia	... ...	113,985
CIDA	... ...	293,501
EEC	... ...	363,000
Ford Foundation	... ...	350,000
Government of China	... ...	10,000
Government of Germany	... ...	193,221
Government of Netherlands	... ...	134,738
India	... ...	25,000
Japan	... ...	242,496
USAID	... ...	425,000
World Bank	... ...	575,000
Subtotal (Unrestricted)	... ...	2,725,941
OTHER REVENUE		
Sundry Income	... ...	33,266
Bank Interest	... ...	51,279
Recovery of Overheads (charged to complementary projects)	... ...	509,845
Subtotal (Other Revenue)	... ...	594,390
Total Core (Unrestricted Resources)	... ...	3,320,331

CORE UNRESTRICTED, CORE RESTRICTED & COMPLEMENTARY — (Continued).

Donor	*Project*	*1992 Grant US$*
CORE RESTRICTED		
ADB	Proposed Management Improvements to Undertake Crop-Based Irrigation Operations in Pakistan	307,388
AFDB	Support for IIMI Activities in Africa —1991	31,215
AUSTRALIA	Collaboration with Australian Institutions	7,999
BMZ	Enhancement of Research on Irrigation and Drainage Technology (IPTRID)	156,678
CEMAGREF	Mathematical Modeling/Flow Measurements for Improving Canal Management	4,169
DANIDA	Gender Issues in Irrigation Management	4,329
DSE	IIMI Inventory Workshop	18,000
DSE	Crop Diversification Study Tour to Egypt & Morocco	45,000
ETSHER	Training Course of ETSHER	6,449
Ford	IIMI Inventory Workshop	14,810
Ford	Collaborative Research in India	22,603
Ford	Irrigation Management for Latin America	147,788
Ford	South Asian Regional Workshop — Participants from India	50,000
Ford	South Asian Regional Workshop — Participants from Indonesia	11,914
Ford	Support for Research on Farmer Contributions to Irrigation Costs	2,070
Ford	Regional Workshop on Design Issues in Small-Scale Irrigation in Mountain Environments	58,837
France	Support for Morocco and West Africa — 1992	147,140
France	Model Applications at Kirindi Oya, Sri Lanka	52,045
France	Support for Morocco & West Africa — 1991	3,433
GTZ	Privatization and Self-Management of Irrigation	64,101
IFAD/BMZ	Assistance to Farmer-Managed Irrigation Systems — Phase II	385,241
ILO	National Workshop on Nongovernmental Organizations (NGOs)	3,205
Japan	Performance Assessment Program	207,847
Netherlands	Environment Program	149,054
Netherlands	Waterlogging and Salinity Project, Pakistan	535,149
ODA	Collaboration with Hydraulics Research	157,441
Rockefeller	Grant for Performance & Research Direction in Bangladesh — Phase I	114,571
Rockefeller	Grant for Performance & Research Direction in Bangladesh — Phase II	200,000
UNDP	Workshop on Performance Measurement in Farmer-Managed Irrigation Systems	60,000
USAID	Collaborative Research in India	195,872
USAID	Irrigation Systems Management Project	531,855
WARDA	Training Course of WARDA	46,434
PRIVATE	Study on Projected Requirements for Agricultural Production	23,000
	Subtotal Restricted	3,765,637
	Total Core	7,085,968

CORE UNRESTRICTED, CORE RESTRICTED & COMPLEMENTARY — (Continued).

Donor	*Project*	*1992 Grant US$*
COMPLEMENTARY		
ADB	Sri Lanka Technical Assistance: — Phase II	277,484
ADB	Monitoring & Evaluation of Participatory Irrigation and Systems Management	104,379
AFDB	Irrigation Management Development in Burkina Faso	176,980
AFDB	Irrigation Management Development in Niger	204,213
CCCE	Rabat FMIS Workshop	(1,957)
EC	National Irrigation Rehabilitation Project (NIRP)	193,156
Ford	Strengthening the Capacity of Institutions and Personnel in Bangladesh to Manage Irrigation Systems	157,703
Ford	Support for an Irrigation Management Program in Nigeria	193,929
Ford	IIMI Mission to Egypt	12,311
Ford	Study of ADBN's Irrigation Program	12,075
Ford	Irrigation Management Program in Sudan	53,193
Ford	Supplementary Support for Sudan	71,802
Ford	Support for Collaborative Activity in Nepal	174,577
FRANCE	Trust Fund for Staff Secondment, 1991	39,963
FRANCE	Trust Fund for Staff Secondment, 1992	84,043
ILO	National Workshop on Nongovernmental Organizations (NGOs)	4,997
IUCN	Project Preparation	2,003
TARC	Tank Cascade Systems Study	19,341
USAID	Irrigation Management Policy Support Activity (IMPSA) — Phase II	87,409
USAID	Irrigation Systems Management Project (ISMP) Sri Lanka	127,861
USAID	Action Research Program in Bangana Irrigation System	111,762
USAID	Strengthening National Capacity to Improve the Performance of Irrigation Systems in Pakistan	265,927
USAID	Rights to Resources Project	134,007
WORLD BANK	Appointment of a Senior Water Management Advisor	129,210
	Subtotal Complementary	2,636,368
	Total	9,722,336

See ANNEX I for an explanation of the projects listed above.

CONSOLIDATED STATEMENT OF FINANCIAL POSITION (BALANCE SHEET) AS OF 31 DECEMBER 1992

ASSETS	1992 / US$	1991 / US$
Current Assets —		
Cash and Cash Equivalents	2,021,718	2,019,854
Accounts Receivable:		
Donors	1,086,841	502,600
Employees	56,229	38,070
Others	199,300	291,077
Inventories	68,417	49,623
Prepaid Expenses	392,627	313,496
Total Current Assets	3,825,132	3,214,720
Cash Deposit Offered as Collateral for PRI Loan	308,897	250,271
Deposit against Finance Lease	3,270	Nil
Fixed Assets		
Property, Plant and Equipment	4,127,770	3,461,977
Less: Accumulated Depreciation	2,056,058	1,624,843
Total Fixed Assets — Net	2,071,712	1,837,134
Total Assets	6,209,011	5,302,125
LIABILITIES AND FUND BALANCES		
Current Liabilities		
Contribution Received in Advance	1,766,628	1,437,069
Other Accounts Payable	900,503	946,213
Accrued Expenses	32,789	16,938
	2,699,920	2,400,220
Provision for Liabilities & Charges		
Severance and Gratuity Benefits	236,968	98,687
International Staff Repatriation	60,751	Nil
	297,719	98,687
Long-Term Debt		
PRI Loan	871,056	1,014,121
Liability against Finance Lease	20,078	Nil
	891,134	1,014,121
Total Liabilities	3,888,773	3,513,028
Fund Balances		
Capital Invested in Fixed Assets:		
Center Owned	1,017,554	817,508
In Custody	48,857	99,986
Capital Fund	668,782	411,176
Operating Fund	585,045	12,332
Reserve	0	448,095
Total Fund Balances	2,320,238	1,789,097
Total Liabilities & Fund Balances	6,209,011	5,302,125

IIMI's consolidated balance sheet as of 31 December 1992 reflects the fact that, as per a decision taken by IIMI's Board of Governors, reserves and operating fund was consolidated. Accordingly, the brought forward balance in the reserves of $448,095 was transferred to the operating fund in 1992.
Source: 1992 Audited Accounts.

Figure 7. — Income, 1984–92 (US$ millions).

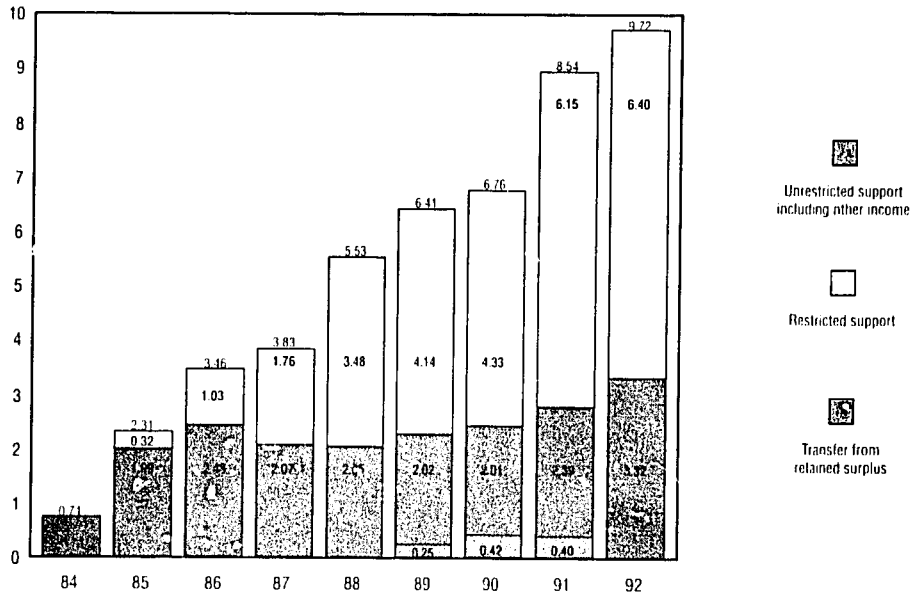
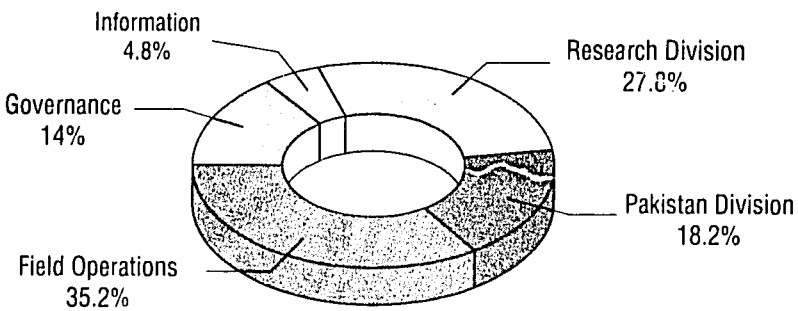


Figure 8. — Net Operating Expenditure, 1992.



In US$ millions

Information	0.44
Governance	1.27
Field Operations	3.20
Pakistan Division	1.66
Research Division	2.53
Total	9.10

ANNEX I
RESTRICTED PROJECTS 1992

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
CORE					
PROPOSED MANAGEMENT IMPROVEMENTS TO UNDERTAKE CROP-BASED IRRIGATION OPERATIONS IN NWFP, PAKISTAN To identify and assist in the implementation of proposed management improvements to undertake crop-based irrigation operations in North-West Frontier Province of Pakistan.	Asian Development Bank	860,000	36 months	268,102	307,388
SUPPORT FOR IIMI ACTIVITIES IN AFRICA — 1991 To assist in financing the expenditure relating to the implementation of a program in Africa.	African Development Bank	150,000	12 months	118,785	31,215
COLLABORATION WITH AUSTRALIAN INSTITUTIONS Assistance of the Australian International Development Assistance Board (AIDAB) for collaboration between IIMI and Australian institutions.	Australia	Aust.$ 40,000	12 months	24,837	7,999
ENHANCEMENT OF RESEARCH ON IRRIGATION AND DRAINAGE TECHNOLOGY (IPTRID) To provide a framework for collaborative action for assessment of technology research & development (R&D) needs; assist developing countries and external supporting agencies in identifying priorities in R&D related irrigation and drainage technology; support the formulation of R&D policies and programs in line with sectoral plans; facilitate training and exchange of information and experience.	BMZ	DM 900,000	36 months	158,860	156,678
MATHEMATICAL MODELING/FLOW MEASUREMENTS FOR IMPROVING CANAL MANAGEMENT To develop and field-test a mathematical flow simulation model to study the hydraulic behavior of irrigation canals and also to serve as a decision-support tool for managing manually operated irrigation systems.	CEMAGREF	F.Francs 135,000	11 months	—	4,169

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	Donor	Pledged amount* US$	Duration	Cumulative expenditure to 31/12/1991 US$	Expenditure 1992 US$
GENDER ISSUES IN IRRIGATION MANAGEMENT	DANIDA	50,000	12 months	—	4,329
To increase the knowledge and understanding of gender issues in irrigation, especially the role of women in irrigated agriculture as well as its impact on women's lives, facilitate the incorporation of gender issues and analysis in ongoing IIMI activities with a view to develop a comprehensive statement on the linkages between gender issues and the performance of irrigated systems.					
IIMI INVENTORY WORKSHOP	DSE	18,000	3 days	—	18,000
To create a database of various items of information which can be analyzed and make irrigation system development and management planning easier, more effective and efficient.					
CROP DIVERSIFICATION STUDY TOUR TO EGYPT AND MOROCCO	DSE	45,000	1 month	—	45,000
Study tour on irrigation management for diversified cropping for senior managers and policymakers from Southeast Asia.					
TRAINING COURSE OF ETSHER	ETSHER	6,449	12 months	—	6,449
To participate as scientific coordinator during the training session on irrigation management in a program organized by ETSHER.					
IIMI INVENTORY WORKSHOP	Ford Foundation, Indonesia	17,400	6 months	—	14,810
Support for Indonesian participation in the Asian Regional Workshop on the Inventory of Farmer-Managed Irrigation Systems and Management Information Systems and a field trip to irrigation sites in the Philippines.					

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	Donor	Pledged amount* US$	Duration 31/12/1991	Cumulative expenditure to US$	Expenditure 1992 US$
COLLABORATIVE RESEARCH IN INDIA TO STRENGTHEN THE CAPACITY OF INDIAN INSTITUTIONS TO IMPROVE IRRIGATION SYSTEMS To explore and initiate collaborative projects between IIMI and Indian institutions through research, professional development, and information exchange. This work is designed to strengthen the capacity of Indian institutions to contribute to the improvement of irrigation systems.	Ford Foundation, India	200,000	67 months	6,758	22,603
IRRIGATION MANAGEMENT FOR LATIN AMERICA Support to design and initiate irrigation programs in Latin America.	Ford Foundation, New York	300,000	24 months	59,259	147,788
SOUTH ASIAN REGIONAL WORKSHOP — PARTICIPANTS FROM INDIA Support for holding a South Asian regional workshop on Groundwater Farmer-Managed Irrigation Systems and Sustainable Groundwater Management in Dhaka, Bangladesh.	Ford Foundation, India	50,000	18 months	—	50,000
SOUTH ASIAN REGIONAL WORKSHOP — PARTICIPANTS FROM INDONESIA Support for Indonesian participation in the South Asian Regional Workshop on Groundwater Farmer-Managed Irrigation Systems and Sustainable Groundwater Management.	Ford Foundation, Indonesia	20,000	18 months	—	11,914
SUPPORT FOR RESEARCH ON FARMER CONTRIBUTIONS TO IRRIGATION COSTS IIMI consultancy expenses grant to Kasetsart University, Faculty of Economics and Business Administration.	Ford Foundation, Thailand	3,925	24 months	—	2,070
REGIONAL WORKSHOP ON DESIGN ISSUES IN SMALL-SCALE IRRIGATION IN MOUNTAIN ENVIRONMENTS Support for a regional workshop on Design Issues in Small-Scale Irrigation in Mountain Environments.	Ford Foundation, New York	75,000	18 months	16,163	58,837

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
SUPPORT FOR MOROCCO AND WEST AFRICA — 1992 Support for activities undertaken by IIMI in Morocco & West Africa.	France	F.Francs 800,000	12 months	—	147,140
MODEL APPLICATIONS AT KIRINDI OYA, SRI LANKA To support research on Main Canal System Management through the application of mathematical flow simulation models using microcomputers.	France	142,000	12 months	68,887	52,045
SUPPORT FOR MOROCCO AND WEST AFRICA — 1991 Support for activities undertaken by IIMI in Morocco & West Africa.	France	F.Francs 800,000	12 months	156,999	3,433
PRIVATIZATION AND SELF-MANAGEMENT OF IRRIGATION To support case studies; to conduct research & development programs for turnover in selected countries where turnover is underway with a view to develop decision-support packages for governments that are considering transfer to local management, develop a center of information & facilitate exchange of information among countries engaged in the turnover process.	GTZ	1,701,900	36 months	—	64,101
ASSISTANCE TO FARMER-MANAGED IRRIGATION SYSTEMS PHASE II For continuing research on farmer-managed irrigation systems with the aim of identifying and evaluating ways by which farmer-managed irrigation systems can be sustained and improved.	IFAD BMZ	US$150,000) DM970,000)	36 months	253,707	385,241
NATIONAL WORKSHOP ON NONGOVERNMENTAL ORGANIZATIONS (NGOs) Workshop on the Role of Nongovernmental Organizations in Irrigation Development and Management.	International Labour Organization, Nepal	3,205	12 months	—	3,205

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
PERFORMANCE ASSESSMENT PROGRAM Support for the performance assessment program which aims to develop and validate generally accepted conceptual frameworks, methodologies and indicators that can be used for assessing and improving the performance of irrigated agriculture.	Japan	J.Yen 25,800,000	12 months	199,074	207,847
ENVIRONMENT PROGRAM To study the impact of irrigation on the environment including health issues, explore ways to minimize and if possible eliminate negative impacts of irrigation on the environment and to respond to external changes in the environment that threaten the sustainability of irrigation systems.	Netherlands	DFL 250,000	12 months	—	149,054
WATERLOGGING AND SALINITY PROJECT, PAKISTAN Support to IIMI Pakistan to implement, in collaboration with national agencies, a program of applied research on waterlogging and salinity. Research will focus on irrigation strategies designed to prevent waterlogging and salinity.	Netherlands	DFL 4,009,000	60 months	527,532	535,149
COLLABORATION WITH HYDRAULICS RESEARCH Drainage and irrigation management collaborative project.	Overseas Development Administration	Sterling Pounds 175,000	36 months	—	157,441
GRANT FOR PERFORMANCE AND RESEARCH DIRECTION IN BANGLADESH — PHASE I To test irrigation management approaches that improve coordination between irrigation agencies and farmers in Bangladesh; to initiate a major effort to quantify measures of irrigation performance; and to expand IIMI's capacity for multidisciplinary research.	Rockefeller Foundation	500,000	24 months	449,450	114,571
GRANT FOR PERFORMANCE AND RESEARCH DIRECTION IN BANGLADESH — PHASE II To conclude support for its research to develop quantifying measures of irrigation performance.	Rockefeller Foundation	200,000	12 months	—	200,000

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	Donor	Pledged amount* US$	Duration	Cumulative expenditure to 31/12/1991 US$	Expenditure 1992 US$
WORKSHOP ON PERFORMANCE MEASUREMENT IN FARMER-MANAGED IRRIGATION SYSTEMS To compile and edit workshop and working group session papers of the participants; for translation and to arrange for the publication and distribution of the workshop proceedings.	United Nations Development Programme	60,000	18 months	—	60,000
COLLABORATIVE RESEARCH IN INDIA To explore and initiate collaborative projects between IIMI and Indian institutions through research, professional development & information xchange. This work is designed to strengthen the capacity of Indian institutions to contribute to the improvement of irrigation systems.	USAID, India	500,000	42 months	165,866	195,872
IRRIGATION SYSTEMS MANAGEMENT PROJECT To improve the capacity and relevancy of water management research in Pakistan.	USAID, Pakistan	2,000,000	22 months	138,463	531,855
TRAINING COURSE OF WARDA Four-week training course on Water Management for Rice Irrigation for research staff from NARS of 12 West African countries.	WARDA	46,434	12 months	—	46,434
STUDY ON PROJECTED REQUIREMENTS FOR AGRICULTURAL PRODUCTION To carry out a study on the subject "Projected Requirements for the Production of Food and other Agricultural Products from Irrigated Lands: How Can They be Met on a Sustainable Basis?"	PRIVATE	23,000	12 months	—	23,000
SUBTOTAL — CORE					3,765,637

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
COMPLEMENTARY					
SRI LANKA TECHNICAL ASSISTANCE PHASE II To strengthen the longterm viability of irrigation systems and to optimize use of existing land, water and infrastructure resources through implementing, refining and evaluating management recommendations developed under Phase I for system management, operation and maintenance; system rehabilitation and improvement; and strengthening irrigation agencies and farmer organizations, with particular attention to the requirements for crop diversification.	Asian Development Bank	750,000	27 months	209,365	277,484
MONITORING & EVALUATION OF PARTICIPATORY IRRIGATION & SYSTEMS MANAGEMENT To assist the Government of Sri Lanka and the irrigation agencies in the implementation of the government's new participatory irrigation system management policy through a comprehensive monitoring and evaluation of the Turnover Program being implemented in selected schemes.	Asian Development Bank	595,000	24 months	—	104,379
IRRIGATION MANAGEMENT DEVELOPMENT IN BURKINA FASO Program to strengthen the capacity of national institutions to improve and sustain the performance of small-scale reservoir-based village irrigation schemes through collaborative research.	African Development Bank	877,117	48 months	129,455	176,980
IRRIGATION MANAGEMENT DEVELOPMENT IN NIGER Evaluation of performance of Farmer-Managed Irrigation Systems on the Niger River Valley.	African Development Bank	829,924	48 months	146,040	204,213

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
RABAT FMIS WORKSHOP Define strategies for developing and improving experiences of Farmer-Managed Irrigation Systems North and West Afrcia.	CCCE	FCFA 4,470,150	6 months	—	(1,957)
NATIONAL IRRIGATION REHABILITATION PROJECT (NIRP) To assist the Irrigation Department of Sri Lanka to identify research needs, support research and programs which yield results of immediate interest to the irrigated-agriculture sector and to assist the Irrigation Department to establish an Irrigation Research Management Unit (IRMU) which will contribute to the quality of planning and implementation of projects of the Department.	Commision of the European Communities	ECU 843,840+ SL Rupees 21,684,800	48 months	—	193,156
STRENGTHENING THE CAPACITY OF INSTITUTIONS AND PERSONNEL IN BANGLADESH TO MANAGE IRRIGATION SYSTEMS Partial support for an IIMI resident scientist to work on irrigation management in Bangladesh.	Ford Foundation, Bangladesh	394,000	36 months	127,430	157,703
SUPPORT FOR AN IRRIGATION MANAGEMENT PROGRAM IN NIGERIA Assist in developing a viable joint (RBDA) farmer-management model in the Kano River Project of the Hadejia Jama'ara River Basin Development Authority (RBDA).	Ford Foundation, New York	425,000	24 months	175,180	193,929
IIMI MISSION TO EGYPT Exploratory mission to assess the possibility of establishing a collaborative program on irrigation research and development in Egypt.	Ford Foundation, Egypt	30,000	12 months	—	12,311
STUDY OF ADBN'S IRRIGATION PROGRAM Support for a study of the irrigation program of the Agricultural Development Bank of Nepal.	Ford Foundation, New York	75,000	19 months	12,055	12,075

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
IRRIGATION MANAGEMENT PROGRAM IN SUDAN Support for an irrigation management program in the Sudan.	Ford Foundation, New York	478,000	24 months	338,225	53,193
SUPPLEMENTARY SUPPORT FOR SUDAN Supplementary support for an irrigation management program in the Sudan.	Ford Foundation, New York	450,000	36 months	—	71,802
SUPPORT FOR COLLABORATIVE ACTIVITY IN NEPAL Support for IIMI to assist the Government of Nepal in developing participatory programs for irrigation development.	Ford Foundation, New York	405,000	36 months	61,175	174,577
TRUST FUND FOR STAFF SECONDMENT Government of France trust fund for staff secondment.	France	84,043	24 months	124,006	124,006
NATIONAL WORKSHOP ON NONGOVERNMENTAL ORGANIZATIONS (NGOs) Workshop on the Role of Nongovernmental Organizations in Irrigation Development and Management.	International Labour Organization, Nepal	4,997	12 months	—	4,997
PROJECT PREPARATION Identification of the most efficient and effective development alternatives for river basins, and protection & management of water sheds and catchment areas of resevoirs.	IUCN	2,003	12 months	—	2,003
TANK CASCADE SYSTEMS STUDY Studies on improvement of irrigation management in minor tank cascade systems in the dry zone of Sri Lanka.	Japan	19,341	5 months	2,360	19,341
IRRIGATION MANAGEMENT POLICY SUPPORT ACTIVITY (IMPSA) — PHASE II Project aimed at supporting the Government of Sri Lanka's policy initiatives in the irrigation sector through a participatory approach to building policy concensus on what should be done over the next decade and beyond.	USAID, Washington	136,619	10 months	49,210	87,409

*In US dollars unless otherwise stated.

ANNEX I (Continued)

Project	*Donor*	*Pledged amount** US$	*Duration*	*Cumulative expenditure to 31/12/1991* US$	*Expenditure 1992* US$
IRRIGATION SYSTEMS MANAGEMENT PROJECT (ISMP) To assist USAID's Irrigation Systems Management Project through the development and implementation of research on key irrigation management questions, and to strengthen Sri Lankan national capacity for irrigation management research. This work will build on IIMI's collaborative relationships with Sri Lankan irrigation-related research institutions and agencies.	USAID, Sri Lanka	590,718	58 months	145,744	127,861
ACTION RESEARCH PROGRAM IN BANGANGA IRRIGATION SYSTEM IN NEPAL To provide support for IIMI's action research program with the Department of Irrigation of the Government of Nepal in the Banganga Irrigation System.	USAID, Nepal	218,474	12 months	106,712	111,762
STRENGTHENING NATIONAL CAPACITY TO IMPROVE THE PERFORMANCE OF IRRIGATION SYSTEMS IN PAKISTAN To improve the capacity and relevancy of water management research in Pakistan.	USAID, Pakistan	2,000,000	22 months	69,231	265,927
RIGHTS TO RESOURCES PROJECT To provide overall support and specific analyses which will be the basis of the design of the new program to support participatory approaches to resources management currently entitled the Rights to Resources Project.	USAID, New Delhi	134,007	4 months	—	134,007
APPOINTMENT OF A SENIOR WATER MANAGEMENT ADVISOR, SUDAN GEZIRA BOARD Support for the appointment of a Senior Water Management Advisor to the Sudan Gezira Board under a World-Bank-assisted rehabilitation project.	World Bank	Sud.Pds. 567,400) US$395,500)	30 months	180,637	129,210
SUBTOTAL — COMPLEMENTARY					2,636,368
TOTAL — CORE AND COMPLEMENTARY					6,402,005

* In US dollars unless otherwise stated.

ANNEX II
PUBLICATIONS 1992

GENERAL PUBLICATIONS

International Irrigation Management Institute. 1993 Program & Budget. Colombo, Sri Lanka: The Institute. 52p. (October).

SERIALS

International Irrigation Management Institute. A selected bibliography on irrigation management (Documents entered in the Irrigation Management Information Network database in 1990). Vol.4. Nos.1 & 2. Colombo, Sri Lanka: The Institute. 156p. (March). ISSN:1015-1680

International Irrigation Management Institute. A selected bibliography on irrigation management (Documents entered in the Irrigation Management Information Network database January — June 1991). Vol.5. No.1. Colombo, Sri Lanka: The Institute. 106p. (June). ISSN:1015-1680

PERIODICALS

International Irrigation Management Institute. Annual Report 1991. Colombo, Sri Lanka: The Institute. 64p. (October). ISSN:1017-5954

International Irrigation Management Institute. IIMI Review. Vol.6. No.1. Colombo, Sri Lanka: The Institute. 20p. (June). ISSN:1012-8318X

International Irrigation Management Institute. IIMI Review. Vol.6. No.1. (Edicion En Español). Colombo, Sri Lanka: The Institute. 20p. (November). ISSN:1012-831X

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NEWSLETTERS

International Irrigation Management Institute. FMIS. No.10. Newsletter of the Farmer-Managed Irrigation Systems Network. Colombo, Sri Lanka: The Institute. 24p. (July). ISSN:1012-988X

International Irrigation Management Institute. FMIS. No. 10. Boletín de la Red de Sistemas de Riego Administrados por los Agricultores. Publicado por el International Irrigation Management Institute. (Edicion En Español). 24p. (November). ISSN:1021-0849

International Irrigation Management Institute. FMIS. No. 11. Newsletter of the Farmer-Managed Irrigation Systems Network. Colombo, Sri Lanka: The Institute. 24p. (December). ISSN:1012-988X

Institut International du Management de l'Irrigation . Bulletin du Réseau Irrigation Afrique de l'Ouest. No.002. Burkina Faso/Niger, West Africa. (June). 48p. ISSN 1017-110X

International Irrigation Management Institute. IMCD News. Vol.3. No.1. Newsletter of the Research Network for Irrigation Management for Crop Diversification in Rice-Based Systems. Colombo, Sri Lanka. 16p. (December). ISSN:1016-7927

ANNEX II (Continued)

RESEARCH PAPERS

Basnet K. Beyond the Chadar and Chardiwari: Women in the irrigated areas of Punjab. Lahore, Pakistan: International Irrigation Management Institute. 37p. (June).

International Irrigation Management Institute. Advancements in IIMI's research 1989-1991: A selection of papers presented at the Internal Program Reviews. Colombo, Sri Lanka: The Institute. 274p. (July). ISBN:92-9090-144-6

Baume, J.P.; H. Sally; P.O. Malaterre and J. Rey. Development and field installation of a mathematical simulation model in support of irrigation canal management. (October). ISBN:92-9090-158-6

COUNTRY PAPERS

Malaysia

Valera, Alfredo and Mohd. Nor Bin Hj. Mohd. Desa. Design-management interactions of Malaysia's Kerian Irrigation scheme. Colombo, Sri Lanka: International Irrigation Management Institute. 92p. (IIMI Country Paper — Malaysia — No. 1). (September). ISBN:92-9090-141-1

Pakistan

Bandaragoda D.J. and G.R. Firdousi. Institutional factors affecting irrigation performance in Pakistan: Research and policy priorities. Colombo, Sri Lanka: International Irrigation Management Institute. 98p. (IIMI Country Paper — Pakistan — No.4). (August). ISBN:92-9090-154-3

The Philippines

Valera, Alfredo. Irrigation management for diversified cropping in rice-based systems in the Philippines. Colombo, Sri Lanka: International Irrigation Management Institute. 90p. (IIMI Country Paper — The Philippines — No. 1). (December). ISBN:92-9090-142-X

Sri Lanka

Nijman, C. Irrigation management processes and conditions: A case study of Sri Lanka's Walawe Irrigation Improvement Project. Colombo, Sri Lanka: International Irrigation Management Institute. 312p. (IIMI Country Paper — Sri Lanka — No. 8). (March). ISBN:92-9090-134-9

WORKING PAPERS

Vander Velde, Edward J. and Robert L. Johnson. Tubewells in Pakistan distributary canal commands: Lagar Distributary, Lower Chenab Canal System, Punjab. Colombo, Sri Lanka: International Irrigation Management Institute. 52p. (Working paper No. 21). (May). ISBN:92-9090-161-6

ANNEX II (Continued)

Kuper, M. and P. Strosser. The appropriateness of canal water supplies: The response of the farmers: A case study in the Fordwah/Eastern Sadiqia Area, Punjab, Pakistan, IIMI-Pak Discussion Paper 6. 38p. (September).

Waijjen, E.G. van and D.J. Bandaragoda. The Punjab desiltation campaign during 1992 canal closure period: Report of a process documentation study, IIMI-Pak Discussion Paper No. 7. 32p.

Oswald, Odile. An expert system for the diagnosis of tank irrigated systems. A feasibility study. Colombo, Sri Lanka: International Irrigation Management Institute. 56p. (Working Paper No. 22). (December). ISBN:92-9090-145-4

PROJECT REPORTS

Garces-Restrepo, C.; D.J. Bandaragoda and P. Strosser. Progress report No.1: Rabi 91/92 on the technical assistance study TA 1481-Pak crop-based irrigation operations in the NWFP. Lahore, Pakistan: International Irrigation Management Institute. 40p. (June).

IIMI Sri Lanka Field Operations. Proposed GOSL/USAID project for Shared Control of Natural Resources (SCOR): Colombo, Sri Lanka: IIMI, SLFO. xixv, 187p. (Final report under USAID-IIMI Cooperative Agreement:383-0499-A-00-2044-00). (September).

IIMI SLFO; Irrigation Department; Irrigation Management Division; Department of Agriculture and Land Commissioner's Department. Technical Assistance Study (TA 1480 SRI). Irrigation Management and Crop Diversification (Sri Lanka) — Phase II: Seasonal report — Kirindi Oya, Maha 1991/92. Colombo, Sri Lanka: IIMI, SLFO. iii, 83p. (October).

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PROCEEDINGS OF IIMI'S WORKSHOPS & CONFERENCES

Pant, Shiva Raj; Alfredo Valera and Ujjwal Pradhan (Eds.). Proceedings of the National Workshop on Participatory Management in Agency-Managed Irrigation Systems in Nepal. Kathmandu, Nepal, 29–30 April. Department of Irrigation and International Irrigation Management Institute, Nepal Field Operations. 196p. (October). ISBN:92-9090-180-2

Pradhan, U.; A. Valera and S. Rana (Eds.). Proceedings of the National Workshop on the Role of NGOs in Irrigation Development and Management in Nepal. Jawalakhel, Lalitpur, Nepal, 29–30 September. International Irrigation Management Institute, Nepal Field Operations and Udaya-Himalaya Network. 212p. (December). ISBN:92-9090-181-0

International Irrigation Management Institute. Proceedings of the Workshop on IIMI-India Collaborative Research in Irrigation Management. New Delhi, India, 13–14 February. Colombo, Sri Lanka: The Institute. 264p. (December).

ANNEX II (Continued)

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PUBLICATIONS BY IIMI STAFF IN OUTSIDE JOURNALS, CONFERENCE PROCEEDINGS, ETC.

Abernethy, C. L. Management constraints on diversification in rice-based irrigation systems. In Murty, V.V.N. and Koga, K. (Eds.). Soil and water engineering for paddy field management: Proceedings of the International Workshop on Soil and Water Engineering for Paddy Field Management, 28–30 January 1992. Bangkok, Thailand: AIT. pp.346–354.

Amarasekera, N. Environmental consequences on Menik Ganga Diversion. Water International, 8(4):286–291.

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Asghar, C.M.; M.A. Bhatti and J.W. Kijne. Management of salt-affected lands for crop production in Punjab of Pakistan. Paper presented at the International Symposium on Strategies for Utilizing Salt Affected Lands, Bangkok, Thailand, 17–25 February.

Bandaragoda, D. Jayatissa. Importance of irrigation policy for sustainability, in Jan Feyen et al. (Eds.). Proceedings of the International Conference on Advances in Planning, Design, and Management of Irrigation Systems as Related to Sustainable Land Use, Leuven, Belgium, 14–17 September. Leuven Belgium: Center for Irrigation Engineering.

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Baume, J.P.; F. Certain; P.O. Malaterre; J. Rey and H. Sally. Utilisation d'un modèle informatique hydraulique pour améliorer la gestion des canaux d'irrigation: application au canal de Kirindi Oya, Sri Lanka. Paper presented at the 16th European Regional Conference on the European Strategy in Irrigation, Drainage and Flood Control in the '90s. ICID. Budapest, Hungary, 21–27 June.

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ANNEX II (Continued)

Bhutta, M.N. and J.W. Kijne. Application of a hydraulic model for testing management decisions at distributary level. Irrigation Science, 13(1):15–20.

Fuchs Carsch, M.; C. Nijman and R. Lenton. The research program of the International Irrigation Management Institute. In Diemer G.; Slabbers, J. (Eds). Irrigators and Engineers: Essays in honor of Lucas Horst. Amsterdam, Netherlands: Thesis Publishers. pp.33–50.

Garces-Restrepo, C. and D.J. Bandaragoda. Modernized irrigation in Pakistan: The case of the Chashma Right Bank Canal Irrigation System. Paper presented at the 3rd Pan-American ICID Regional Conference, Mazatlan, Mexico, 9–11 November.

Garces-Restrepo, C. and D.J. Bandaragoda. La modernizacion del riego en Pakistan: El caso del sistema de riego de la margen derecha del canal Chashma (CRBC) Trabajo presentado en el 3er Congreso Regional Pan Americano del ICID, Mazatlan, Mexico, Noviembre 9 al 11. 15p.+ Tables.

Habib, Z.; B.A. Shahid and M.N. Bhutta. The utility of a simulation model for Pakistan canal systems: Application examples from North-West Frontier Province and Punjab. A paper presented at the International Workshop on the Application of Mathematical Modeling for the Improvement of Irrigation Canal Operations, Montpellier, France, 26–28 October.

Kijne, J.W. Issues and options in design and management of irrigation networks: Tertiary level. Lecture notes for 2nd Mediterranean Conference on Water, Rome, Italy, 28–31 October. 38p.

Lenton, R. Irrigation management strategies for the 21st century. In Schiller, E.J. (Ed.). Sustainable water resources management in arid countries: Middle East and Northern Africa — Special issue, Canadian Journal of Development Studies. pp.121–129.

Lenton, R. Presentation to the Consultative Group on International Agricultural Research, Washington, DC, 29 October, 12p.

Merrey, D.J. Overcoming artificial institutional barriers: Linking farming systems research with irrigation management research. Paper presented at the Asian Farming Systems Symposium, Colombo, Sri Lanka, 2–5 November.

Merrey, D.J. and D.J. Bandaragoda. IIMI's mandate for institutional strengthening, linking research to policy and the role of social sciences. Paper presented at the Meeting of CGIAR Social Scientists, ISNAR, The Hague, Netherlands, 17–20 August. 5p.

Murray-Rust, D.H. Strategic and operational management in irrigation systems. Paper presented at the Expert Consultation of the Asian Regional Network on Irrigation/Water Management, Bangkok, Thailand, 25–28 August.

Murray-Rust, D.H. and D.J. Merrey. Irrigated agriculture beyond 2000: Institutional adaptation and institutional change. Paper presented at the Strategy Workshop on Irrigated Agriculture in Southeast Asia Beyond 2000, Langkawi, Malaysia, 5–9 October.

Nijman, C.M. Performance evaluation and control in water delivery decision-making processes: Who cares? Irrigation and Drainage Systems, 6(2):85–112.

Pradhan, U. and K.C. Durga. Indigenous knowledge and organizational processes: Experiences and lessons from local Nepali irrigation systems. Paper presented at the Workshop on Indigenous Management of Agriculture and Natural Resources, Kathmandu, Nepal, 8–9 June. Winrock International, Kathmandu, Nepal.

ANNEX II (Continued)

Rey, J. and U.S. Wijesekera. Use of a simulation model as part of a management information system to improve the operations on an irrigation canal in Southern Sri Lanka. Paper presented at the Workshop on Application of Mathematical Modeling for the Improvement of Irrigation Canal Operations, Montpellier, France, 26–28 October.

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Rosegrant, M.W. and M. Svendsen. Irrigation investment and management policy for Asian food production growth in the 1990s. Forthcoming paper for Food Policy, IFPRI. 49p.

Samad, M.; D.J. Merrey; D. Vermillion; M. Fuchs-Carsch; K. Mohtadullah and R. Lenton. Irrigation management strategies for improving the performance of irrigated agriculture. Outlook on Agriculture. Vol. 21 No.4. December. pp. 279–286.

Small, L.E. and M. Svendsen. A framework for assessing irrigation performance. Washington, DC, USA: IFPRI. vi, 38p. (IFPRI working papers on Irrigation Performance 1).

Svendsen, M. Assessing effects of policy change on Philippine irrigation performance. Washington, DC, USA: IFPRI. vi, 24p. (Working papers on Irrigation Performance 2).

Svendsen, M. Sustainability in irrigated agriculture. Rome, Italy: IFAD. 8p. (IFAD staff working paper 10).

Vander Velde, E.J. Water-induced land degradation: Salinity and roles for farmer monitoring. Paper presented at the Workshop on Methods of Measuring Sustainability through Farmer Monitoring: Applications to the rice wheat cropping pattern in South Asia, Kathmandu, Nepal, 6-9 May.

Vander Velde, E.J. Socioeconomic databases: What are the prospects for effective Inter-IARC social science collaboration? A discussion paper for the meeting of CGIAR Social Scientists, ISNAR, The Hague, Netherlands, 17–20 August.

Verdier, Jean. Présentation générale de l'IIMI. Paper presented at a seminar on Water and Land Laws in Irrigated Areas of Africa and Madagascar organized by Centre d'Études Juridiques et Politiques du Monde Africain, Kenitra, Morocco, 8–11 June.

Verdier, Jean. Management et performances des périmètres irrigués dans les pays en développement; Présentation de l'Institut International de Management de l'Irrigation. Paper presented at a seminar on Irrigation in the Year 2000: A New Approach of Irrigation in France and in the World organized by the Association Français pour l'Étude de l'Irrigation et du Drainage, Réseau National Expérimentation et Démonstration — Hydraulique Agricole and Société Hydrotechnique de France, Paris, France, 18–19 November.

Vermillion, D. Users' perspectives for participatory research and development. Paper prepared for the Meeting of CGIAR Social Scientists, ISNAR, The Hague, Netherlands, 17–20 August. 5p.

Wijayaratne, C.M. Sustainability of irrigated agriculture — An overview. Inaugural theme paper presented at the Workshop on Sustainability of Irrigated Agriculture, Sri Lanka Association for the Advancement of Science and the Soil Science Society of Sri Lanka, Colombo, Sri Lanka, 18 September.

Wijayaratne, C.M. Institutionalization of participatory management: Sustainability of farmer organization. Invited theme paper presented at the Asian Farming Systems Symposium, Colombo, Sri Lanka, 2–5 November. 19p.

Zwarteveen, M.Z. Gender and irrigation management: A new IIMI program. Paper presented at the International Workshop on Gender Concerns in Rice Farming, Chiang Mai, Thailand, 20–25 October.

ANNEX III
FELLOWSHIPS AND SCHOLARSHIPS 1992

Name	Dates	Case Study	Location
		Ph.D. Research Fellowships	
Youssouf Dembélé	August 1991 – August 1994	Optimization of the Hydraulic Management of a Reservoir	Burkina Faso
V. Muralidharan	December 1991 – August 1992	The Dynamics of Irrigation System Performance: A Comparative Study of Two Secondary Canal Reaches in Mahi-Kadana	India
Akmal Siddiq	March 1992 – August 1992	Sustainability of Indus Basin, Impact of Groundwater Salinity on Agricultural Productivity	Pakistan
		Master's Degree Scholarships	
Amadou Allahoury	November 1991 – June 1992	Identifying the Causes for the Low Intensity of Dry Season Cropping in the Itenga Irrigation Scheme and Proposals for Improvement	Burkina Faso
Anton van Essen and Casper van der Feltz	October 1991 – April 1992	Water Management in the Fordwah Branch, Bahawalnagar Circle, Punjab	Pakistan
		Visiting Researchers	
Gilbert Bassolé	July 1992 – May 1993	Hydraulic Diagnosis of the Gorgo Irrigation Scheme	Burkina Faso
André Da	November 1990 – February 1992	Contribution to the Diagnostic-Analysis of Two Irrigation Schemes in Burkina Faso	Burkina Faso
Youssouf Diarra	January 1992 – June 1992	Hydraulic Diagnosis of the Itenga Irrigation Scheme	Burkina Faso
Jean-Michel Malé	August 1992 – October 1992	Use of a Mathematical Flow Simulation Model to Study the Canal Hydraulics of the Itenga Irrigation Scheme	Burkina Faso
Zacharie Zida	July 1992 – May 1993	Study of the Water Management in the Mogtédo Irrigation Scheme	Burkina Faso
Mossi Abdou	June 1992 – June 1993	Soil-Plant Relationships on the Tillakaina Perimeter	Niger

ANNEX III (Continued)

Name	*Dates*	*Case Study*	*Location*
Kongo Gbiatene	September 1992 – February 1993	Study on the Process of Integrating Nigerian Women into the Modern Agricultural Sector Situated along the Niger River: Case of the Tillakaina Perimeter	Niger
Yousoufou Hamani	September 1992 – February 1993	Production of Green Beans on the Tillakaina Perimeter, Agro-Economic Diagnostic Analysis	Niger
Zachari Issoufou	June 1992 – June 1993	Diagnostic Research on Agricultural Techniques and the Hydraulic and Chemical Behavior of Soils on the Saga Perimeter	Niger
Fatima Massalachi	September 1992 – February 1993	Integrating Women into Irrigation Schemes: Case of the Saga Perimeter	Niger
Hector Sedar H.C.	September 1992 – February 1993	Study of Cassava: Socio-Agro-Economic Factors	Niger
Joseph S. Omotowoju	September 1992 – October 1992	Effective Irrigation Management	Nigeria
Gilbert Ayariga	October 1992 - March 1993	On-Farm Water Management — Impact of S and P Values on Water Scheduling	Sri Lanka
Arno Hiemcke	October 1991 – March 1992	Program for Canal Operations Management Assessment (COMA) Computer Model	Sri Lanka
Jean-Michel Malé	April 1992 – July 1992	The Roughness Coefficient: An Indirect Witness to Observe a Canal?	Sri Lanka
John L. Meriam	January 1992	To Evaluate the Pilot Project Studies on Flexible Water Supply System Established in Sri Lanka	Sri Lanka
Emile Ndiaye	October 1991 – January 1992	General Framework for the Effectiveness Analysis of Innovations at the Kirindi Oya Project	Sri Lanka
Abdel Bagi Abdalla	October 1991 – October 1993	Irrigation System Performance in the Rahad Scheme	Sudan
Hashim Ali	May 1992 – September 1993	Water Performance along Minors in the Rahad Scheme	Sudan
Abdel Aziz Mohammed	March 1992 – February 1993	Management of Field Course 'ABXX' in Rahad	Sudan

ANNEX IV
IIMI SENIOR STAFF 1992

(The country, in the case of internationally recruited staff, is given in italics)

OFFICE OF THE DIRECTOR GENERAL

Lenton, Roberto — *Argentina*
Director General

Nugawela, Dewaki
Executive Secretary

RESEARCH DIVISION

Mohtadullah, Khalid — *Pakistan*
Director, Research

Abernethy, Charles — *United Kingdom*
Senior Technical Advisor

Amarasekera, Nalini
Research Associate

Amarasinghe, Upali
Research Data Analyst (from April)

Dassanaike, Lalith
Research Associate (from October)

França, Zenete — *Brazil*
Training Specialist

Gamaathige, Amarasena
Research Associate (from May)

Gosselink, Paulus — *The Netherlands*
Associate Expert (seconded from the Directorate General International Cooperation (DGIS), Ministry of Foreign Affairs of the Government of the Netherlands) (from December)

Hemakumara, H.M.
Research Officer

Itakura, Jun — *Japan*
Associate Expert (seconded from Tropical Agriculture Research Center, Ibaraki, Japan)

Kuruppuarachchi, Tilak
Research Associate (until January)

Manor, Shaul — *Israel*
Senior Irrigation Specialist (until December)

Merrey, Douglas — *USA*
Actg. Leader, Performance Program

Murray-Rust, Hammond — *United Kingdom*
Senior Irrigation Specialist

Mutukumarana, P.
Asst. to the Training Specialist

Nijman, Charles — *The Netherlands*
Associate Expert (until March)

Rey, Jacques — *France*
Associate Irrigation Specialist

Samad, Madar
Assistant to the Director for Research

Somasundaram, Vasumathy
Administrative Officer (from September)

Svendsen, Mark — *USA*
Research Fellow[1]

Vermillion, Douglas — *USA*
Irrigation Specialist

Wasantha Kumara, W.A.U.
Research Officer (from August)

Wolter, Hans – *Germany*
Irrigation Specialist[2]

Yashima, Shigeo — *Japan*
Irrigation Specialist (from April)

Zwarteveen, Margreet — *The Netherlands*
Associate Expert (seconded from the Directorate General International Cooperation (DGIS), Ministry of Foreign Affairs of the Government of the Netherlands) (from March)

FIELD OPERATIONS DIVISION

Abeywickrema, Nanda — *Sri Lanka*
Director, Field Operations

Ratnayake, Ranjith
Assistant to the Director, Field Operations

Bangladesh

Parker, Donald — *USA*
Head, Bangladesh Field Operations

Hakim, M.A.
Economist

Rahman, Abdur
Administrative Officer

Burkina Faso

Legoupil, Jean-Claude — *France*
Regional Representative, West Africa Field Operations

Lingani, Séni
Accountant/Administrative Officer

Pouya, André-Marie
Information and Communications Specialist

Sally, Hilmy — *Sri Lanka*
Irrigation Specialist and Project Leader

ANNEX IV (Continued)

Morocco

Verdier, Jean — *France*
Head, Morocco Field Operations

Nepal

Valera, Alfredo — *The Philippines*
Head, Nepal Field Operations

Durga, K.C.
Research Officer

Pradhan, Ujjwal — *Nepal*
Asst. Irrigation Specialist (from January)

Rayamajhi, Udaya
Administrative Officer

Shrestha, S.R.
Office Manager

Niger

Lonsway, Kurt — *USA*
Irrigation Specialist and Project Leader

Nigeria

Pradhan, Prachanda — *Nepal*
Irrigation Specialist and Project Leader

Babura, Alh. Rabiu Abubakar
Rural Sociologist

Olanrewaju, M.S.
Administrative Assistant

Omotowoju, Joseph S.
Agriculture Engineer

Oyedepo, F.D.
Research Assistant

Sondangi, A.I.
Research Assistant

Philippines

Manangan, Celso
Accounts and Administrative Officer

Marino, Ma Delia
Research Assistant

Sri Lanka

Wijayaratna, Chandrasekera M. — *Sri Lanka*
Head, Sri Lanka Field Operations

Abeywardena, A.D.
Research Officer (from December)

Aluwihare, Parakrama
Research Officer

Ariyaratne, B.R.
Research Officer

Brewer, Jeffrey — *USA*
Social Scientist

Ekanayake, Ratnasiri
Research Officer

Haq, Azharul K. — *Bangladesh*
Technical Advisor,
National Irrigation Rehabilitation Project (NIRP) (from August)

Hemakeerthi, K.A.
Research Officer

Jinapala, K.
Research Associate

Karunasena, H.A.
Research Associate

Maheswaran, Kalaranjani
Research Officer (from December)

Nanayakkara, Chandrasiri
Research Associate (from December)

Perera, L.R.
Research Officer

Sakthivadivel, Ramaswamy — *India*
Senior Irrigation Specialist

Samarakoon, Dharshana
Administrative Officer

Somaratne, P.G.
Research Officer

Upasena, W. J. J.
Research Officer

Withana, Chulawansa
Research Officer

Sudan

Shafique, Muhammad S. — *Pakistan*
Head, Sudan Field Operations

Ali Dingle, Mohamed A.
Senior Agricultural Economist (from November)

Edward, Magdi
Research Coordinator

Haq, Azharul K. — *Bangladesh*
Irrigation Specialist and Senior Water Management Advisor
(transferred to SLFO in August)

Maryuud, Salah
Assistant Accountant/Office Manager

PAKISTAN DIVISION

Kijne, Jacob — *The Netherlands*
Director, Pakistan

Afaq, Rana Mohammad
Irrigation Engineer

Anwar, Haroon
General Manager,
Finance and Administration

Babar, Khurshid
Field Research Engineer

Badruddin, Mohammad
IIMI Pakistan Associate

ANNEX IV (Continued)

Bandaragoda, Jayatissa — *Sri Lanka*
Senior Management Specialist

Bhatti, M. Akhtar
Principal Irrigation Engineer

Garces-Restrepo, Carlos — *Colombia*
Irrigation Engineer

Habib, Zaigham
Systems Analyst

Haider, Sayed Daniyal
Accountant

Hussain, Irfan
Field Research Engineer (until April)

Khan, Hakeem
Field Research Engineer

Kuper, Marcel — *The Netherlands*
Associate Expert

Miranda, Senen — *The Philippines*
Senior Irrigation Specialist

Rehman, Gauhar
Civil Engineer (GIS Specialist) (from April)

Rehman, Saeed-ur
Senior Field Research Economist

Safdar, Ahmed Saleem
Field Research Engineer

Saleem, Mohammad
Field Research Social Scientist

Sendhu, Faiz Hanif
Senior Field Research Hydrologist

Shahid, Bagh Ali
Principal Irrigation Engineer

Shahid, Sarwar
Field Research Hydrologist (from April)

Strosser, Pierre — France
Agricultural Economist

Van Waijen, Erik — *The Netherlands*
Associate Expert

Vander Velde, Edward J. — *USA*
Senior Irrigation Specialist

Zaman, Waheed-uz
Senior Field Research Engineer

INFORMATION OFFICE

Lenahan, James — *United Kingdom*
Head, Information

De Silva, Ramya
Documentalist

Fernando, K. Nimal A.
Chief Production Editor

Karunaratne, D.C.
Artist/Cartographer

Kurukulasuriya, Kingsley
Editor

Nanayakkara, Charith
Computer Services Manager (from July)

Rabindranath, Susila
Press Officer

Somasundaram, Vasumathy
Administrative Officer (transferred to Research Division in September)

Sri-Nammuni, Shanthi
Assistant Librarian

Sufian, A. C. M.
Production Manager

Umagiliya, Nargis
Writer (from February)

Van Eyck, David
Distribution Manager

Yapa, N. U.
Head Librarian

PROJECT DEVELOPMENT OFFICE

Fuchs-Carsch, Marian — *USA*
Project Development Officer

Blok, Sharmini
Asst. Project Development Officer

FINANCE AND ADMINISTRATION DIVISION

Goodman Jr., Daniel C. — *USA*
Director, Finance and Administration (until June)

Abeysekera, Laksiri
Actg. Director, Finance and Administration (June to December) and Controller

Abayasekera, Mohan
Travel and Conference Coordinator

Abeysekera, Fred
Personnel Manager

Bahar, Omar
Personnel Officer

Ekanayake, Somasiri
Assistant Accountant

Halvitige, Gamini
Senior Accountant

Nanayakkara, Charith
Computer Services Manager (transferred to Information Office in July)

Perera, K. S. C.
Maintenance Engineer

Samaraweera, Daya
Manager, Administrative Services

Weerasekera, Shanthi
Manager, Office Support Systems

Wettasinghe, Udaya
Budget Officer

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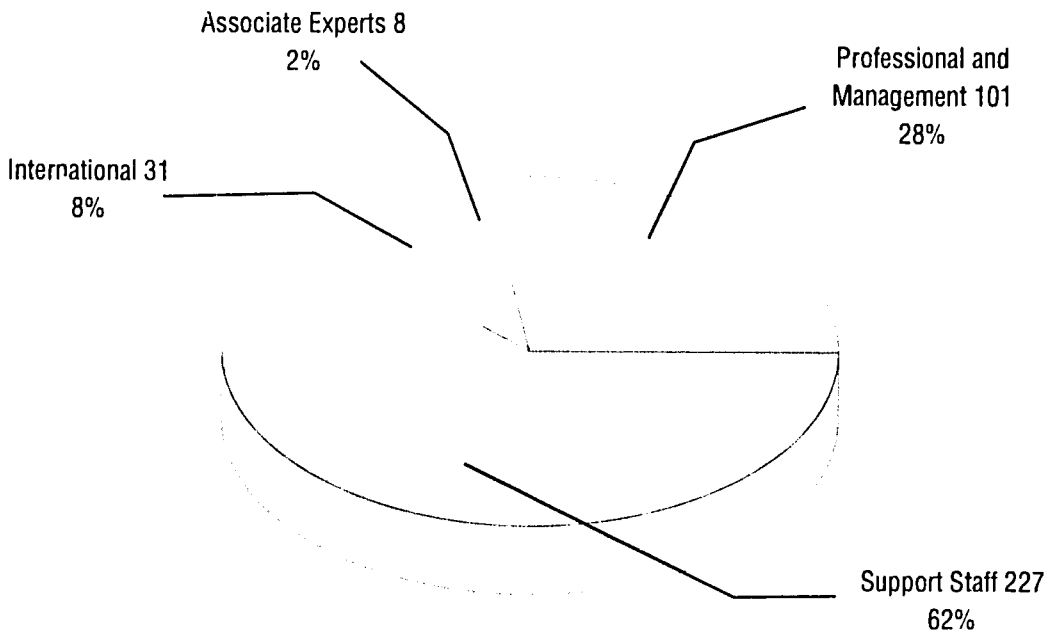
[1]. Based at IFPRI, under IIMI-IFPRI Collaborative Program.

[2]. Based at IPTRID (on secondment from IIMI).

Figure 9. — Composition of IIMI Staff.



Total = 367

ANNEX V
CONSULTANTS 1992

Name	*Country in which the Consultancy was Conducted*	*Mission*
	Research Division	
Dr. Bryan Bruns	Thailand	To provide comments and suggestions on the proposed Data Collection Guide (DCG) and the Comparative Database on Irrigators' Organizations and to provide suggestions for a comparative framework for assessing and facilitating irrigation management transfer.
Prof. David Constable	Bangladesh	To advise the IIMI training team during a 3-day workshop on Strategic Planning and Human Resources Development in the Bangladesh Agricultural Development Corporation.
	Malaysia	To advise the IIMI training team during a week's activities on strategic planning and human resources development for Besut and Kerian irrigation schemes in Malaysia.
Ms. Iman El-Banhawy	Sri Lanka	To assist in preparing background material for the Cairo Workshop.
Dr. Daya Hewapathirana	Sri Lanka	To report on sustainability of rice-based irrigated agricultural systems: Case study of Sri Lanka.
Dr. H. B. Kotagama	Sri Lanka	To draft a proposal to survey farmer attitudes to existing planning operation procedures of irrigation systems, expectations for improvement and appropriateness of computer software management support technology in improving irrigation system performance.
Mr. B. Maier	U.S.A.	To obtain additional data on staff and personnel changes as a result of management transfer in the Columbia River Basin Project.
Dr. Elinor Ostrom	Sri Lanka India	To review comments on the Data Collection Guide (DCG) on Irrigation Organizations.
Dr. Richard Palmer-Jones	U.K.	To prepare a report on research and development issues concerning groundwater irrigation institutions and water markets in South Asia and a research methodology.

ANNEX V (Continued)

Name	*Country in which the Consultancy was Conducted*	*Mission*
Mr. David Purkey	Sri Lanka India Pakistan	To assist IIMI develop a practical and effective methodology for rapid appraisal of existing groundwater irrigation systems, institutions, and their hydrological and economic performance. To provide guidance on locally practical methods for more intensive research on groundwater irrigation performance assessment.
Dr. K.V. Raju	India	To carry out research on groundwater irrigation in Bihar, India.
Dr. P.S. Rao	Bangladesh	To participate in a workshop to design a strategic planning and human resources development plan for Bangladesh Agricultural Development Corporation.
Dr. P.S. Rao	Malaysia	To participate in workshops in Malaysia to define performance indicators for the managers of Kerian and Besut schemes, and to conduct a special training program on research issues for personnel of the two schemes.
Dr. P.S. Rao	Sri Lanka	To revise, update and finalize a draft paper entitled "Review of Selected Literature on Indicators of Performance" for publication by IIMI.
Ir. F.E. Schulze	Argentina, Brazil, Chile, Colombia, Ecuador & Mexico	To work as a team leader in collaboration with Ing. Armando Bertranou to develop an IIMI Strategy and Work Plan for Latin America.
Dr. Ganesh Shivakoti	Sri Lanka	To help revise the Data Collection Guide (DCG) in collaboration with Dr. Elinor Ostrom.
Dr. Robert Yoder	Philippines Nepal	To assist in revising the Data Collection Guide (DCG). To organize an international workshop to be held in Kathmandu, Nepal, together with IIMI staff and to identify the decision criteria used to prioritize and allocate resources or support services among Farmer-Managed Irrigation Systems in discussion with DOI and other related parties.

ANNEX V (Continued)

Name	*Country in which the Consultancy was Conducted*	*Mission*
Mr. Montague Yudelman	U.S.A	To prepare a report entitled "Projected Requirements for the Production of Food and Other Agricultural Products from Irrigated Lands: How Can They Be Met on a Sustainable Basis?"
	Field Operations Division	
Dr. Peter Bloch	Sri Lanka	To serve as a Team Member in the preparation of Government of Sri Lanka/USAID Project for Shared Control of Natural Resources (SCOR).
Mr. Henri Boumendil	Morocco	To enhance a Report on the first phase of the Tessaout Project and prepare it in a form suitable for publication in French.
Mr. Neil Fernando	Sri Lanka	To develop a Paper for IIMI Internal Program Review 1992 on "Strengthening National Capacity — a Review of IIMI's Experience."
Dr. Gilbert Levine	Sri Lanka	To serve as the Chief Resource Person and a Team Member in the preparation of a project entitled "Rights to Resources."
Mr. V. Muralidharan	Sri Lanka	To examine the relationship between equity and efficiency in irrigation system performance and determine under what conditions a trade-off between the two is necessary.
Dr. C.R. Panabokke	Sri Lanka	To act as Secretary of the Sri Lanka-IIMI Consultative Committee, and to contribute to the Project on Irrigation Management and Crop Diversification.
Mr. David Purkey	Sudan	To prepare technical parameters for performance assessment of the White Nile Pumping schemes.
Dr. P.S. Rao	Sri Lanka	To develop a paper for IIMI Internal Program Review 1992 on "Strengthening National Capacity."
Dr. S.P.F. Senaratne	India	To help IIMI-India collaborating institutions in Tamil Nadu to collect and analyze social science and management-related data.

ANNEX V (Continued)

Name	*Country in which the Consultancy was Conducted*	*Mission*
Dr. Mark Svendsen	Nigeria	To assist in resource mobilization in HJRBDA, Kano.
Dr. Derrick J. Thom	Nigeria	To function as member of IIMI-Nigeria Review Mission.
Dr. Norman Uphoff	Sri Lanka	To serve as a Team Member in the preparation of the Government of Sri Lanka (GOSL)/USAID Project for Shared Control of Natural Resources (SCOR).
Mr. I. K. Weerawardena	Sri Lanka	To serve as a Team Member in the preparation of the GOSL/USAID Project for Shared Control of Natural Resources (SCOR).
Dr. Henry West	U.K.	To review and comment on the 1st draft of the SCOR Project paper and provide inputs to the project through discussions with the Director, Field Operations.
Mr. A. Widanapathirana	Sri Lanka	To serve as a Team Member in the preparation of the GOSL/USAID Project for Shared Control of Natural Resources (SCOR).
	Pakistan Division	
Ms. N. Gijsen	Pakistan	To advise on the applications of Geo-Information Systems for IIMI's research in Pakistan.
Dr. Richard Palmer Jones	Pakistan	To advise on Water Market Studies and private tubewell development.
Prof. G Levine	Pakistan	To advise on the implementation of three ongoing programs.
Mr. J. Wind	Pakistan	To conduct a training course on Geo-Information Systems.
	Information Office	
Mr. Seth Beckerman	U.S.A.	To write script for IIMI video.
Mr. John Colmey	Sri Lanka	To write Annual Report 1991.
Mr. W.A.L. Fernando	Sri Lanka	To copyedit a manuscript entitled "Proceedings of the IIMI-India Workshop."
Mr. Barry Hall	Sri Lanka Pakistan	To produce a video presentation.

ANNEX V (Continued)

Name	*Country in which the Consultancy was Conducted*	*Mission*
Mr. Sumith Meegama	Sri Lanka	To typeset IIMI publications, in English, Spanish or French.
Ms. Renuka O'Kelly	Sri Lanka	To copyedit and proof read "Tubewells in Pakistan Distributary Canal Commands: Lagar Distributary, Lower Chenab Canal System, Pubjab" by Ed Vander Velde.
Mr. C.S. Ranasinghe	Sri Lanka	To copyedit and proof read "Moving Towards Demand-Based Operations in Modernized Irrigation Systems in Pakistan" by Bandaragoda and Baddrudin.
Mr. K.P.S.V. Silva	Sri Lanka	To copyedit the following: Proceedings of the Privatization Workshop held in Sudan, Flow Measurements at Drop Structures for Irrigation System Management in Sri Lanka, Proceedings of the Tri-Country Workshop, and The Turning Over of a Pump Irrigation System and Its Acceptance by Farmer Irrigators' Associations in the Philippines.
Other Offices		
Mr. Raj Bhatia	Sri Lanka	To test network version and other modifications to FA System, Payroll Program and Budget Office program.
Ms. Wendy Daudrumez	Sri Lanka	International Recruitment Consultant.
Ms. M.P.R. Fernando	Sri Lanka	To provide interpretation and translation from English to French at IIMI's Clients' Workshop.
Ms. Claire Francy	Sri Lanka	To develop bio-sketches for existing Board members and review all IIMI approved Governing Board minutes, and select and make reference to the key Board decisions therein.
Mr. Klaus Fussing	Sri Lanka	To complete the design for the IIMI headquarters building.
Mr. P.A. Luckshman	Sri Lanka	To develop a data base system for international recruitment.
Mr. Declan Walton	Sri Lanka	To assist in the preparation of IIMI's 1994–1998 Medium-Term Plan.
Mr. L. S. Wanigatunga	Sri Lanka	To supervise gardeners and provide job training at IIMI headquarters.

ACRONYMS AND SYMBOLS

ADB/N	Agricultural Development Bank of Nepal
AIT	Asian Institute of Technology (Bangkok, Thailand)
BMZ	Bundesministerium für Wirtshaftliche Zusammenarbeit (Germany)
CABI	Commonwealth Agriculture Bureau International
CCCE	Caisse Centrale de Corporation Economique
CEMAGREF	Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts (France)
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maize y Trigo
CNEARC	Centre National d'Etudes Agronomiques des Régions Chaudes (Montpellier, France)
DANIDA	Danish International Development Association
DID	Department of Irrigation and Drainage (Malaysia)
DOI	Department of Irrigation (Nepal)
DSE	Deutsche Stiftung für Internationale Entwicklung (Germany)
EC	Commission of the European Communities
EIER	Ecole Inter-Etats d'Ingénieurs de l'Equipement Rural (Ouagadougou, Burkina Faso)
ETSHER	Ecole Inter-Etats des Techniciens Supérieurs de l'Hydraulique et de l'Equipement Rural (Burkina Faso)
FAO	Food and Agriculture Organization of the United Nations
FMIS	Farmer-Managed Irrigation Systems
GTZ	Gesellschaft für Technische Zusammenarbeit (Germany)
HJRBDA	Hadejia Jama'ara River Basin Development Authority (Nigeria)
IAAS	Institute of Agriculture and Animal Science (Nepal)
IARC	International Agricultural Research Center
ICARDA	International Center for Agricultural Research in Dry Areas
ICID	International Commission on Irrigation and Drainage
ICIMOD	International Center for Integrated Mountain Development
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILO	International Labour Organization
IMPAC	Irrigation Management Policy Advisory Committee (Sri Lanka)
IMPSA	Irrigation Management Policy Support Activity (Sri Lanka)
IPTRID	International Program for Technology Research in Irrigation and Drainage
IRRI	International Rice Research Institute
ISMP	Irrigation Systems Management Project
ISNAR	International Service for National Agricultural Research
IUCN	World Conservation Union
NARS	National Agriculture Research System
NGOs	Nongovernmental Organizations
NIA	National Irrigation Administration (The Philippines)
NWFP	North-West Frontier Province
ODI	Overseas Development Institute (UK)
OFC	Other Field Crops
PEEM	Panel of Experts on Environmental Management and Vector Control
SCOR	Shared Control of Natural Resources
TA	Technical Assistance
TAC	Technical Advisory Committee of the CGIAR
TARC	Tropical Agriculture Research Center
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
WALMI	Water and Land Management Institute (India)
WARDA	West Africa Rice Development Association
WHO	World Health Organization

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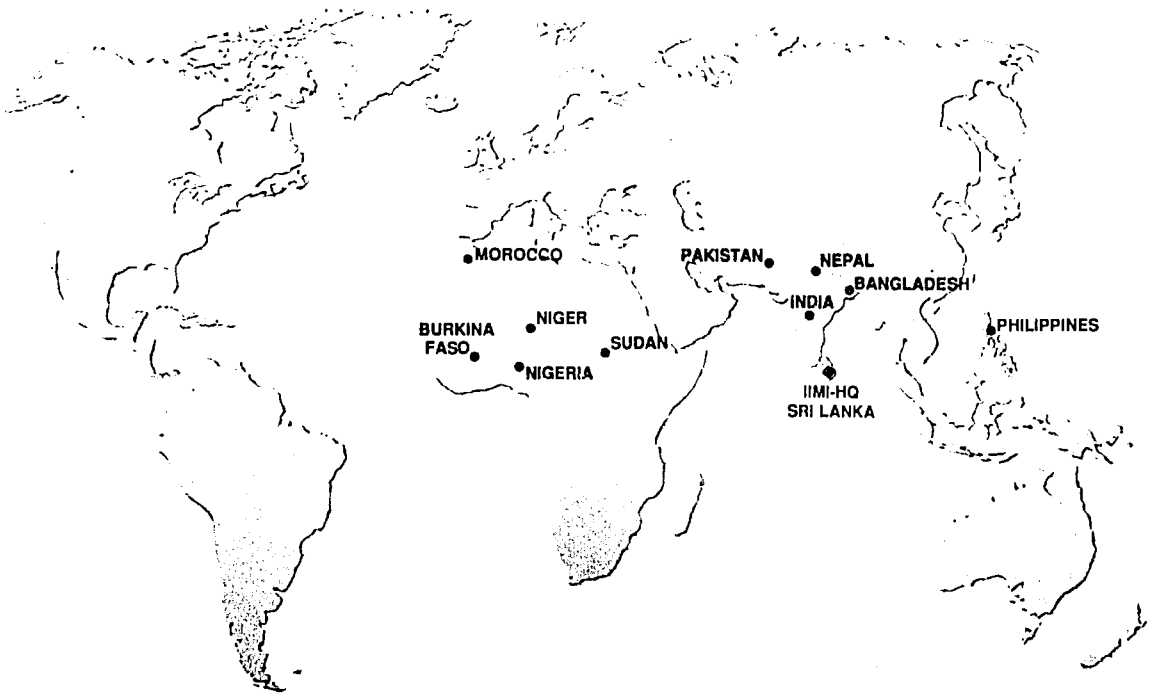
Fax : 234-64-669051 Attn: Fax Box No. 480 P. Pradhan, IIMI-ICRISAT Program, Kano

IIMI WORLDWIDE



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