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RESEARCH PRIORITIES FOR IRRIGATION MANAGEMENT IN ASIA

By Leslie E. Small

AN OVERVIEW OF RESEARCH IN IRRIGATION MANAGEMENT IN ASIA

By Randolph Barker

JOINT IIMI/WMS II WORKSHOP ON RESEARCH PRIORITIES FOR IRRIGATION MANAGEMENT IN ASIA

INTRODUCTION

A workshop on the research priorities for irrigation management in Asia was held from January 6–11, 1985, at the headquarters of the International Irrigation Management Institute (IIMI) near Kandy, Sri Lanka. The workshop was jointly sponsored by IIMI and the Water Management Synthesis II Program, which is funded by the United States Agency for International Development and implemented by Cornell University, Colorado State University, and Utah State University.

Thirty-five delegates from Sri Lanka, Pakistan, Malaysia, Bangladesh, India, Thailand, Nepal, Australia, West Germany, the Netherlands, and the United States reviewed the state of irrigation management research in Asia in order to identify priorities for future research. Six informal issues papers and nine country status reports were presented at the workshop.

This first issue of IIMI's Research Paper Series presents two papers that provide interpretative summaries of the discussion and results of the workshop. "Research priorities for irrigation management in Asia" by Dr. Leslie Small, Agricultural Economist at IIMI, provides a conceptual framework for irrigation management research and outlines criteria for IIMI's selection of research topics. "An overview of research in irrigation management in Asia," by Dr. Randolph Barker, Agricultural Economist at Cornell, summarizes the conceptual evolution of irrigation management in terms of both conventional disciplinary and holistic, systems-oriented approaches.

It is hoped that these two papers will stimulate ideas among readers and result in information exchanges with the workshop participants, whose names and addresses are appended.

Robert Cowell
Editor

RESEARCH PRIORITIES FOR IRRIGATION MANAGEMENT IN ASIA

Leslie E. Small[1]

A workshop on research priorities for irrigation management in Asia was held during the week of January 6, 1985, at the headquarters of the International Irrigation Management Institute (IIMI) near Kandy, Sri Lanka. The workshop was sponsored jointly by IIMI and the Water Management Synthesis II Program, which is funded by the United States Agency for International Development and implemented by Cornell University, Colorado State University, and Utah State University. The objectives of the workshop were to review the state of research on irrigation management in Asia and to identify priorities for future research, with special emphasis on the role of IIMI. To focus discussions, six informal issue papers were distributed to the participants before the workshop. This report is an interpretive summary of the major ideas presented both in the issue papers and in the workshop discussions.

This report is divided into four sections. The first presents a conceptual framework for irrigation management. The second discusses suggested criteria for the selection of IIMI's research topics. The third section identifies IIMI's research boundaries. The final section examines suggestions regarding specific types of research.

THE NATURE OF IRRIGATION MANAGEMENT: A CONCEPTUAL FRAMEWORK

Irrigation management involves six **processes:** planning and design (P&D), construction, operation and maintenance (O&M), irrigated farming (the activities that occur on individual farms), performance evaluation, and rehabilitation. Activities in each of these are carried out in five interrelated **management dimensions:** 1) a physical dimension (moving, storing, maintaining, and using materials and structures), 2) a biological dimension (maintaining the biological environment), 3) a human and institutional dimension (influencing the behavior of individuals and institutions), 4) an information dimension (acquiring, processing, and disseminating information), and 5) a financial dimension (acquiring, managing, and using financial resources). Figure 1 shows a matrix comprising the six processes carried out over the five dimensions.[2]

A discussion of cells in the matrix which do not represent important irrigation management activities helps clarify the nature of the matrix. For example, the planning and design of physical structures involves very little manipulation of physical materials. As a result, the physical dimension of the planning and design process does not represent an important activity of irrigation management. Likewise, the process involves little manipulation of the biological environment. Although financial resources must be obtained and used for planning and design, acquisition and utilization are not usually major constraints on the process (compared to the construction and O&M processes). Thus, the financial dimension of the P&D process is relatively unimportant to irrigation management. Similar reasoning applies to the financial dimension of the performance evaluation process.

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2 Strong interactions among the six processes exist; however, it is not feasible to depict them in Figure 1. Perhaps the most important of these interactions, as far as IIMI's research program is concerned, is between P&D and O&M.

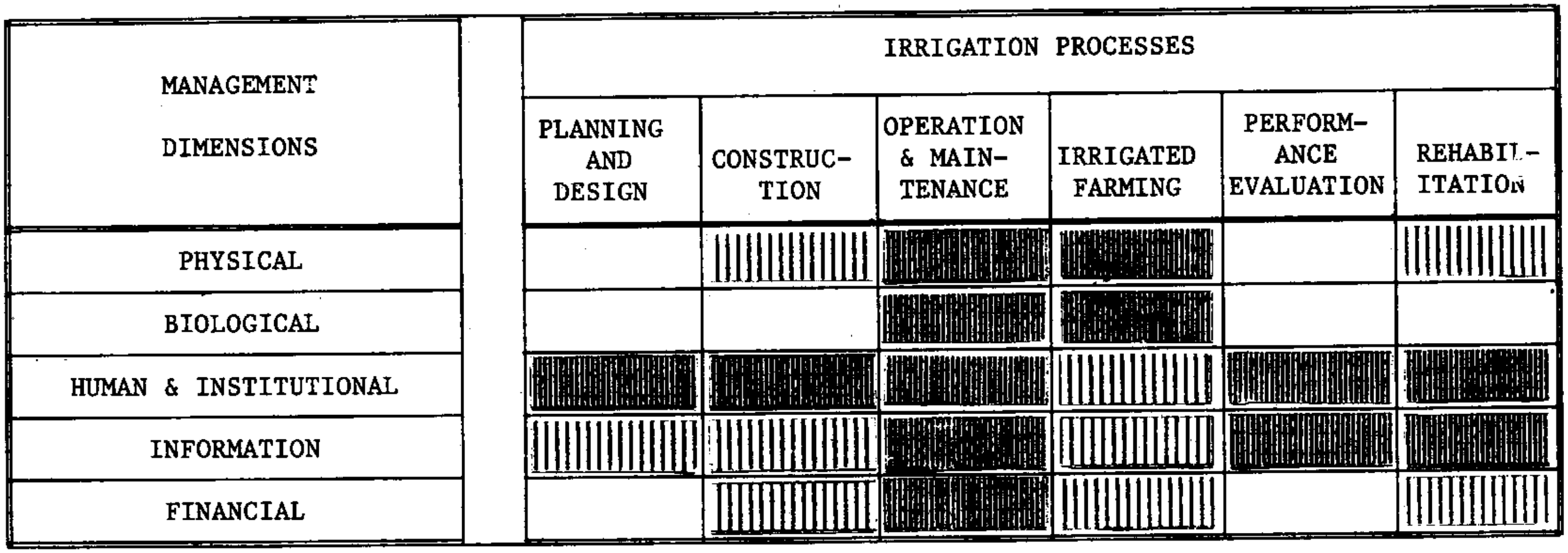

Figure 1. Matrix of important irrigation management activities

||||||| – Important irrigation management component.

(dense hatching) – Component of major importance to IIMI.

During the performance evaluation process little manipulation occurs in either physical materials or the biological environment, thus both these are considered unimportant[3].

The remaining cells in Figure 1 considered unimportant to irrigation management activities involve the biological dimension of both the construction and rehabilitation processes. Although these processes have some biological impact, neither deliberately nor significantly manipulates the biological environment.

IIMI is mandated to help strengthen national capacities to better manage irrigation systems. Thus, IIMI research focuses on those irrigation management activities which involve decisions that will improve the performance of irrigation systems. Of the 22 important irrigation management activities indentified in Figure 1, 9 are not of major importance to IIMI. For example, management of the physical dimension of both the construction and rehabilitation processes affects the quality of infrastructure and subsequent system performance. These have been excluded because the management solutions to construction problems lie more in the realm of human management (proper incentives and controls) than with the physical management of materials. Similar reasoning underlies the exclusion of the financial dimension of the construction and rehabilitation processes.

IIMI excludes the information dimension of the P&D and construction processes from its focus because existing techniques for gathering and processing information used in these processes are adequate. On the other hand, an effective rehabilitation process requires information regarding prior project experience. Because this information comes from widely scattered water users and field personnel, managing information flow is difficult. The generally unsatisfactory approaches to managing information flow justify including in IIMI's focus the information dimension of the rehabilitation process.

The management of irrigated farming primarily involves individual farmer decisions, and efforts to improve the quality of these decisions is beyond IIMI's mandate. Thus, the human and institutional, information, and financial dimensions of the irrigated farming process are not of major importance to IIMI[4]. On the other hand, the physical and biological demensions (e.g., decisions about when to prepare land and about cropping patterns) interact closely with how irrigation systems are operated, and this is important to IIMI.

As is shown in Figure 1, IIMI's mandate calls for research into all six processes of irrigation, including planning and design. Important interactions among the processes also need research. For this research to effectively address the major problems of irrigation performance, IIMI needs to give attention to all five management dimensions.

CRITERIA FOR IIMI'S SELECTION OF RESEARCH TOPICS

The broad criteria for IIMI's selection of research topics emerged from the workshop:

1. Research findings should have a major policy impact either on irrigation investments or on irrigation management strategies within the nations of the region.

3 The management dimension of a process must not be confused with the objectives of the process. For example, objectives of performance evaluation include evaluation of physical and biological components (e.g., water flows, yields), but the process does not involve management of these components.

4 Although the information management dimension of the irrigated farming process interacts with the operation of the irrigation system and is thus important to IIMI, many aspects of information (e.g., effectiveness of pest control methods and nature of fertilizer response under varying water conditions) bear little relation to system operation and are outside IIMI's mandate.

2. Research topics should be selected that may lead to broad understanding of irrigation system performance. Such results generally involve cross-cultural or cross-national comparisons.

3. Attention should be given to research to develop methodologies for answering questions which are important to countries.

4. Priority should be given to research for which IIMI has a comparative advantage, such as multidisciplinary studies, studies where international networking is important, and studies that need substantial amounts of field data.

RESEARCH BOUNDARIES FOR IIMI

A small institute such as IIMI must develop and maintain a well-focused research program. Thus, certain important research areas will be excluded even though they are related to irrigation performance. Workshop participants identified four areas of inquiry that are beyond the scope of IIMI's research program:

1. **Watershed management.** Proper watershed management is important for long-term stability of both storage systems and run-of-the-river systems. However, they involve management issues which are fairly distinct from those of the irrigation processes themselves. Furthermore, although the consequences of watershed management practices will affect irrigation project performance, it is not clear that understanding watershed management will enhance the general understanding of irrigation management or help identify methods for improving irrigation management performance.

2. **Aquifer management.** Although aquifer management is important to the long-term stability of irrigation in areas which rely on pumping groundwater, the technical questions involved are specialized and distinct from other aspects of irrigation management.

3. **Water as a resource for non-agricultural purposes.** Water is an important economic and environmental resource. Although there are inter-relationships between irrigation management and such non-agricultural uses of water as hydropower, aquaculture, navigation, and support for the biological environment in coastal areas, linkages with irrigation management are limited.

4. **Long-run social and political consequences of irrigation not closely linked to irrigation management.** IIMI should do research in areas where the long-run social and political consequences of irrigation are related to management. However, the issues fall outside IIMI's mandate where they are generic to irrigation (or to rural development activities generally), and are related only marginally to questions of irrigation management.

PRIORITY RESEARCH TOPICS

Discussion focused on three research areas: broad conceptual understanding of the dynamics of irrigation management, research methodology, and applied field research. As an international institute, IIMI's comparative advantage lies in its ability to focus on the first two of these. Progress in conceptual and methodological areas would improve the general understanding of irrigation management relationships and identify effective research techniques. The results would be useful to many nations. The specific topics selected for field research should support those conceptual and methodological issues taken up by IIMI.

CONCEPTUAL UNDERSTANDING OF THE DYNAMICS OF IRRIGATION MANAGEMENT

Participants identified three elements needed to develop a better conceptual base for understanding the dynamics of irrigation management and performance. Much of this broad understanding would be synthesized from knowledge gained from applied field research.

1. **Development of an analytically useful taxonomy of irrigation.** The absence of a general, analytically-based system for classifying the types of irrigation systems makes insightful thinking about irrigation difficult.

2. **Development of a conceptual framework regarding the dynamics of irrigation management and performance.** The social, economic, and political context in which irrigation takes place comprises an "external environment" which is an important determinant of the type of management and levels of performance prevailing in irrigation systems. Identifying the variables that together represent this external environment is important in developing a conceptual framework of the dynamics of irrigation management and performance. Such variables may include price ratios for land, labor, and capital; population density; land tenure patterns; legal codes; the extent farming is commercialized; and the strength of the economic ties between the producers and irrigated agriculture.

The development and subsequent testing of hypotheses is critical to developing a conceptual framework for understanding the dynamics of irrigation management and performance. One hypothesis suggests that an evolutionary pattern in the development of irrigation management relates to the relative availability of land, labor, management skills, and water. Management abilities at the national and system levels are initially so limiting that the irrigation agency can emphasize only the capture and conveyance of water. As land and water become scarce, the emphasis shifts first toward improving the productivity of land and later toward increasing the productivity of water (see Barker, footnote 3).

Other hypotheses for development and testing deal with: 1) relationship between perceptions of equity within an irrigation system and the resulting levels of farmer cooperation and system efficiency, 2) the conditions under which different types of water rights develop, and 3) the role of uncertainty in determining agency and farmer behavior.

3. **Understanding the relationships among irrigation components.** Although understanding such individual components as physical structures, water supplies, government agencies, and farmers is important, it should lead to a better grasp of the inter-relationships and interactions among these components. For example, it might be useful to investigate the relationships between the strength of farmers' organizations and the volume and reliability of water, or the relationships between the power structure of the village and the design of the irrigation system.

RESEARCH METHODOLOGY

An important role for IIMI is the development of methodologies which can be used by other researchers and by irrigation managers to find answers to specific problems.

1. **Understanding and measuring system performance.** Measurement of system performance is fundamental to most research on irrigation management, yet serious conceptual and practical problems exist. Two types of problems were discussed.

Frequently irrigation system boundaries are different from the mapped project boundaries, which suggests a need to analytically define boundaries. For example, it is conceptually important to account for irrigation that relies on return flows, even though these sub-systems and their areas may not be officially recognized. There may also be a need to account for the conjunctive use of canal water and groundwater which is replenished from seepage and percolation from other parts of the system. Systems with reservoirs need to account for the activity of farmers in the catchment area who cultivate the upper reaches of the reservoir bed.

Second, work is needed in performance evaluation to identify both the appropriate dimensions and the appropriate measures of these dimensions. Dimensions of performance include water delivery performance, agricultural production performance, and social performance in terms of the achievement of the system's social objectives.

2. **Evaluating the consequences of efforts to improve management.** Work is needed to develop an analytical approach for examining the consequences of any specific effort to improve irrigation management. Efforts to improve management are often related in only a general way to the observed performance of the system, without careful attention to other factors which can affect system performance.

Figure 2 illustrates the management and cost consequences of efforts to improve irrigation management. Cost consequences, which include the opportunity cost of water saved and the costs of organization (which may be opportunity costs borne by farmers), are frequently overlooked or ignored. Once the effects on system management of the innovation being evaluated are understood, the system performance consequences of these effects must be separated from other factors which influence the observed performance of the system. Unless rigorous methodological approaches are developed and used, research results from efforts to improve management performance will remain uncertain and unconvincing.

3. **Developing field methodologies.** Methodologies for field research need to be developed or improved, particularly the general strategy for collecting data with a view to improving its utility and efficiency. Specific needs include developing simple sets of procedures for collecting data on water flows, water adequacy in the fields, and yields, and procedures for selecting where to place devices which measure water flow.

4. **Developing procedures for diagnosing the management of irrigation systems.** Sound approaches are needed to diagnose irrigation system problems. Such diagnoses depend on identifying the basic assumptions underlying the development and operation of an irrigation system, followed by an assessment of the original and current validity of these assumptions. Techniques are needed for determining the validity of the diagnosis. Understanding diagnostic analysis as a management tool might be enhanced by evaluating the results of previous diagnoses.

5. **Developing simulation models.** Simulation modelling can be a useful tool for analyzing the types of management issues which concern IIMI, particularly if the models are based on the type of field data IIMI will be collecting.

6. **Assessing procedures for action research.** Care is needed to avoid three common and interrelated problems if IIMI's research program includes **action research**; that is, research involving a management intervention deliberately introduced as part of the research process. First, action research designs are often faulty, information on pre-intervention activities inadequate to enable clear conclusions about the results of the intervention. Second, researchers may become more

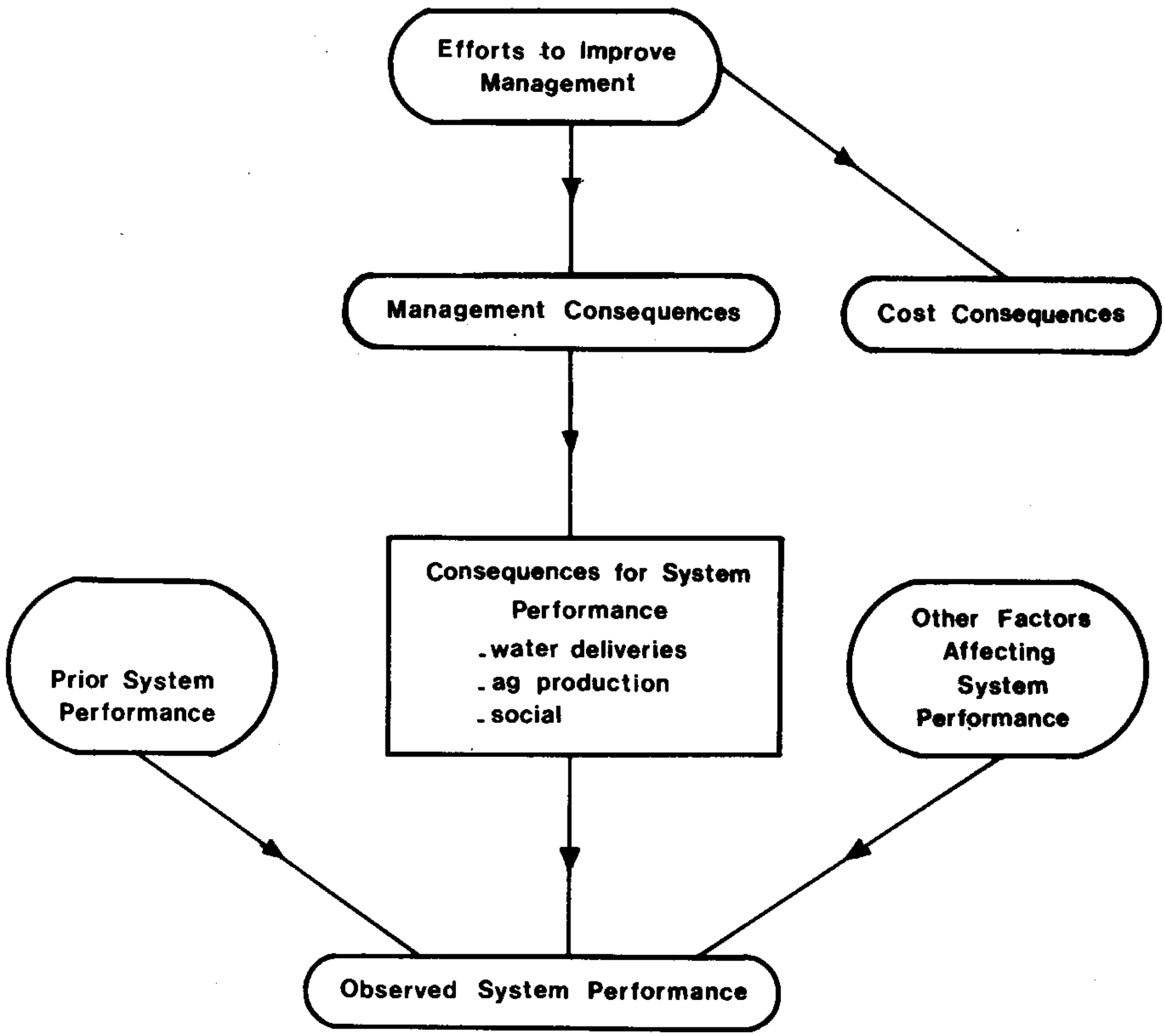

Figure 2. Identifying the consequences of efforts to improve irrigation management.

concerned with implementing the designed intervention than with the research. Third, researchers may not be objective about the research results if they are heavily involved in implementing the action component.

The methodology used to identify appropriate issues for action research is also important. Because it takes a long time for a system to fully adjust to the new set of conditions brought about by the intervention, action research may be a poor tool for assessing the overall impact of such interventions. However, it may be useful for assessing the **process** of change initiated by such interventions.

SUGGESTIONS FOR APPLIED FIELD RESEARCH

The first five suggestions below regarding applied field research relate to the five management dimensions of irrigation identified in Figure 1. The last two relate to processes rather than to single management dimensions.

1. **Physical dimension of irrigation management.** The suggested research involves the O & M process and includes analysis and evaluation of: methods for scheduling irrigation; methods of allocating water, with special attention to methods based on factors other than land area; managing irrigation for crop diversification; designs for simplifying management of irrigation operations; alternative maintenance strategies, such as normal maintenance versus periodic rehabilitation; factors affecting the optimal size and location of the area receiving irrigation water; the role of drainage in system operations, including the re-use of drainage water; and, methods of reducing farmer dependence on the operation of the main irrigation system.

2. **Biological dimension of irrigation management.** Suggested research deals with the O & M process, and addresses system management for crops other than rice and for improving human health by reducing the threat of disease.

3. **Human and institutional dimension of irrigation management.** Many suggestions for research topics relate to the O & M process. They can be grouped into three overlapping categories: behavioral issues, organizational issues, and administrative issues.

   a) **Behavioral issues.** It would be useful to examine the incentives that affect the behavior of individuals involved in an irrigation system. At the societal level, research could address alternative systems of incentives appropriate to the social objectives of irrigation and their effects on irrigation performance. At the irrigation system level, research could address specific incentives to promote desired management outcomes. Examples include identifying incentives that overcome design biases in specifying an area to irrigate with a given water supply, finding incentives for farmers in the head reaches of an irrigation system to accept a reduction in their water supply, examining the incentives that influence farmers' cropping decisions, and identifying incentives that encourage diversified cropping.

   Additional research could look at how incentives associated with periodic activities, such as rehabilitation, could achieve desired changes in the behavior of participants in the system. For example, in situations where the historical development of an irrigation system leads to perceptions of water rights which are at variance with national productivity objectives, the incentives associated with financial subsidies for rehabilitation might lead to adjustments in the farmers' perceptions of their water rights.

Another important behavioral issue involves bringing the initiative of irrigation water users into the various irrigation processes. Suggested research includes technical, financial, and organizational support for local initiative; roles that farmers play in the various irrigation processes (discussed in the next section); the relationship between farmer initiative and the methods of delivering water to them; and, the ways village systems (including lift irrigation systems) operate.

b) **Organizational issues.** A key organizational issue involves the interface between irrigation water users and the agency responsible for operating the irrigation system. Research would investigate the feasibility and desirability of incorporating farmers' knowledge into the design process. Detailed tertiary-level designs (including the design and location of turnout structures) can frequently be improved when farmers' detailed local knowledge is brought effectively into the design process. Various national programs which have attempted to do this may be evaluated. In the O & M process, research is needed on the roles that farmers play in the operation of the main irrigation system – both in the daytime and at night. The farmer-agency interface is also important where farmers are involved in decisions and the supervision of rehabilitation and construction.

Other suggested research involves farmer organizations, both in terms of the technology and tasks which farmers can effectively manage and in terms of the environment in which specific technology is appropriate. For example, research into the relative effectiveness of farmer organizations to undertake maintenance activities as opposed to water distribution activities might hypothesize that maintenance which leads to a greater or more assured supply of water is a more unifying activity than water distribution which tends to be divisive. Research on farmer organizations also needs to assess the full range of organizational costs, including the specific costs borne by farmers. Research is also needed on the effects of irrigation design on the performance of farmers' organizations.

c) **Administrative issues.** Research can identify and compare different types of administrative systems for irrigation, and outline the requirements for the effective implementation of each type. The Warabandi system of India and Pakistan is an example of one such administrative system.

Another suggestion pointed to the relationship between length of service of irrigation project officers and the management performance of the systems they administer.

4. **Information dimension of irrigation management.** Very little research has been carried out that investigates the communication and information flows **within** irrigation agencies. The literature on information and communication theory might provide useful insights. Another research area is the information flows **between** farmers and irrigation agencies. Important to the O & M process, these information flows are facilitated by farmers' organizations. But farmer-agency communication is also important in the design and rehabilitation processes, especially if detailed knowledge about local conditions is incorporated into the design. Ways to reduce the need for direct communication was also suggested as a research topic.

5. **Financial dimension of irrigation management.** Once an irrigation project has been built, the acquisition and utilization of financial resources to operate and maintain the project become central issues in irrigation management. As O & M costs mount, governments find it increasingly difficult to finance these costs centrally. Research was suggested on ways to manage irrigation systems with reduced central resources. To do this efficiently requires an investigation of

the interface between farmers and the irrigation agency, including relationship that involve the willingness and ability of farmers to pay for the costs of O & M, the types of farmer involvement in O & M, the total costs of O & M, and the quality of management performance.

6. The performance evaluation process of irrigation. Monitoring and evaluating performance provides information to demonstrate the utility of recommended management improvements. Without rigorously identifying economic inefficiency in irrigation projects, the utility of recommendations is suspect.

Monitoring and evaluation can provide agencies with a potential diagnostic tool for improved management. However, to be effective, the measurement techniques must be such that an irrigation agency can implement them with modest resources. Research was suggested that would assess the design implications of the performance monitoring system. New and rehabilitated irrigation systems could then be designed to facilitate a more systematic evaluation of irrigation performance.

7. The rehabilitation process of irrigation. Given the magnitude of resources likely to be committed to irrigation rehabilitation in Asia over the next 20 to 30 years, research should be directed at the management of the rehabilitation process. Methods are needed that incorporate the changing conditions of a system into the plans for its rehabilitation. Also needed are methods of designing and implementating rehabilitation which will avert the rapid return of the system to its deteriorated state.

AN OVERVIEW OF RESEARCH IN IRRIGATION MANAGEMENT IN ASIA

Randolph Barker[1]

This paper summarizes reports presented at a workshop on Research Priorities in Irrigation Management held in Sri Lanka on January 6–11, 1985, and sponsored jointly by the International Irrigation Management Institute (IIMI) and the Water Management Synthesis II Program, which is funded by the United States Agency for International Development and implemented by Cornell University, Colorado State University, and Utah State University. The reports were presented by representatives from nine countries and covered the status of irrigation management research in those countries.

This summary is divided into four sections. The first describes the evolution of research in irrigation management in a conceptual context. The second section focuses on conventional disciplinary research activities. The third section covers more holistic, or systems-oriented, research activities. The concluding section discusses areas that workshop participants identified as research priorities, but which appear to be receiving little attention at present.

THE EVOLUTION OF IRRIGATION MANAGEMENT RESEARCH

Levine[2] describes irrigation development as passing through three distinct stages: hydrologic-hydraulic, agricultural-based, and farmer-oriented. The first stage emphasizes the capture and allocation of water. Where water is plentiful relative to the area of land irrigated, it is usually not managed as a scarce resource. In such situations, there is little need for research on irrigation management. This was the case in much of South and Southeast Asia before World War II. At that time, most of the region could be characterized as land surplus, and normally it was more appropriate to expand the land area under cultivation than to intensify production through irrigation. There were, of course, notable exceptions, such as Java, where population pressure on the land was already very intense.

In the second stage of irrigation development the agricultural utility of water is realized, and information about soils, crops, and other agronomic elements is needed for the design and operation of the system. There is also a demand for conventional irrigation management research to determine water duties, or the amounts of water required at various points in the system to provide an adequate supply to the plants. This requires information on such factors as consumptive use by plants, conveyance losses, and losses due to seepage and percolation. Scientists trained in hydrology and plant-water relationships carry out most of this research. Economic analysis, although potentially important, is relatively rare at this stage. Research of this type has been conducted in many parts of Asia for a long time as the following section will point out.

The third stage of irrigation development recognizes the farmer as an active participant in system design and operation. As a growing population increases pressure on the land and agricultural production intensifies in response, water rises in value and becomes a scarce resource. There is then a strong demand for research that will support better water management and conservation, and provide technical or engineering opportunities that will increase water use efficiency (i.e., minimize the water use per unit of crop production). Achieving a high level of

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1 Agricultural Economist, Cornell University, Ithaca, NY, USA.

2 Gilbert Levine. 1981. Prospects for integrating findings from research on irrigation systems in Southeast Asia, in **Investment Decisions to Further Develop and Make Use of Southeast Asia's Irrigation Resources.** Bangkok, Thailand: August.

water use efficiency requires knowledge that must be generated from an interdisciplinary, holistic, systems approach to research.[3] In Asia, this type of research is still in its formative stages.

CONVENTIONAL DISCIPLINARY RESEARCH ACTIVITIES

There are two broad categories of conventional disciplinary research in irrigation management. The first focuses on technical issues of irrigation in hydrology and agronomy. The second concentrates on the social science aspects of irrigation management and operations.

Although most of the papers presented at the workshop did not refer to research activities during the pre-war period, both technical and social science research was conducted in South and Southeast Asia prior to World War 11. Pasandaran (Indonesia).[4] noted that research carried out by the Dutch in Java in the 1920s and 1930s included water requirement studies for different crops. He considered the Dutch concept of water allocation very similar to the concept of "relative water supply" used widely in irrigation management research today. . Research similar to that conducted in Java was being performed in the Indo-gangetic plain during the latter part of the 19th century.

Ashraf's (Pakistan) discussion of water management research in Pakistan shows clearly that the technical issues of management (rather than systems management) still tend to dominate the research agenda today. For example, the list of research activities proposed for the Mona Reclamation Project under Pakistan's sixth plan period (1983–88) include: 1) design of tubewells for drainage and irrigation; 2) regulation of canals to schedule flow so that water could be supplied when needed; 3) provision of surface and sub-surface tile drainage, with particular emphasis on reducing installation costs; 4) surface and sub-surface storage of water in both irrigated and **barani** (rainfed) areas; 5) determination of critical water table depths and the maintenance of the water table at acceptable levels; 6) control of salinity/sodicity by biological, chemical, and engineering means; 7) reduction of seepage in canals; 8) use of saline water for reclamation and crop production through amendments and management; 9) studies of salt and water balance; and, 10) integrated (systems) development of irrigation management/command area management.

This heavy emphasis on the technical issues of water management was confirmed by workshop participants who made a field visit to Pakistan. Extensive research continues on such topics as crop water consumption and lining of canals even though there appears to be adequate knowledge on these topics. However, systems management (item 10 above) is being investigated only at the watercourse or field channel level where water is under the control of farmers.

The research listed above is also being carried out in other semi-arid parts of the Indian subcontinent. Despite efforts to improve water use efficiency through such research, Rao (India) reports:

> "The overall project efficiencies (the proportion of water diverted from its source that actually reaches the plant) in several southern projects is found to be 25% to 30%, while planning assumptions typically have been in excess of 50%, usually 60–65%."

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3 It is arguable whether the association of different values of land, water, and information with different irrigation management regimes is a result of specific combinations of factors or a result of an evolutionary process in which the management (and, hence, the nature of research demanded) changes in response to changes in the relative values of the basic resources (Levine, 1981). We have couched the discussion in terms of the latter hypothesis, and contend that the change in the orientation of research reflected in the country reports, which will be discussed in the next two sections, lends further support to this evolutionary hypothesis.

4 The Workshop Papers are listed at the end, and readers are invited to write to the respective authors for copies.

Water use efficiencies of 25–30% are, in fact, common throughout Asia. Those who quote such percentages seem to imply, however, that these statistics indicate water mismanagement or waste. But where water is plentiful, as it is in many run-of-the-river systems or during the wet season, such low technical efficiencies may not be an inefficient use of a society's resources.

Although disciplinary research conducted by engineers and agronomists has dominated irrigation management studies, some work has been done by sociologists, anthropologists, and geographers. Most has tended to focus on the operation and maintenance of small-scale systems, such as the **subaks** in Bali, Indonesia, and the **zamandaras** in Northern Luzon, Philippines. Alwis (Sri Lanka) cites the work of B. H. Farmer on colonization schemes. The work of Sir Edmund Leach on a small tank system in Sri Lanka is well known. Until the 1970s, the orientation of social scientists toward small communal systems, and the orientation of agricultural scientists and engineers toward large government-operated systems, resulted in little dialogue between these two groups.

Economists have played a different role by focusing on project justification, on water rates, and, more recently, on the distribution of costs and benefits of irrigation. Lim (Malaysia) cites the work of Taylor on irrigation performance. World Bank economists extensively studied the socio-economic impact of the Muda River project in Malaysia.

All of these disciplinary studies have provided insights into some irrigation management issues, but they have not come to grips with many of the problems inherent in managing an irrigation system. These problems cannot be studied from a strictly disciplinary standpoint. Pradhan (Nepal) sums up the issue:

> "Until now irrigation is considered more as a civil construction of dams and canals. Social science impact in water management, water distribution, and farmers' participation have been overlooked in the bureaucratically operated irrigation systems."

INTERDISCIPLINARY RESEARCH

Recent literature and the references to irrigation workshops reported in several of the country papers demonstrate a significant increase in interest in interdisciplinary research issues related to systems management. Initially, the perception seems to have been that the greatest mismanagement of water and, hence, the largest potential benefits of improved management, were at the farm level. Therefore, interdisciplinary research initially focused on irrigation management below the turnout — the point at which the farmers take control of the water. For example, Pakistan's Mona Project, begun in the early 1970s, took this approach. Considerable attention was devoted to organizing farmers in order to rehabilitate their watercourses or field channels.

Rotational water supply at the watercourse level (Warabandi system) is practiced widely in Pakistan and Northern India, and was recommended as a policy by the Indian Government in all irrigation projects. Rao notes that the Command Area Development Authority (CADA) was originally designed to take a holistic view of irrigation systems management in India. But, as was the case with the Mona Project in Pakistan, CADA ultimately focused on functions below the turnout. To quote Rao:

"The diluted concept of CADA seemed to have deflected the attention of almost everyone to 'below the outlet' for far too long. The problem of organization for integrated irrigation management and coordination of all activities is yet to find a satisfactory solution."

The cooperative research begun in the early 1970s by the Philippines' National Irrigation Administration (NIA) and the International Rice Research Institute (IRRI) represented one of the first efforts in South and Southeast Asia to study the problems of main systems management. According to Miranda (Philippines), the study was done because little possibility of helping farmers with on-farm water management existed until the problem of equitable water delivery was resolved. Studies showed both that farmers at the tail ends of canals did not receive enough water and that water is frequently not delivered to the farm turnouts with any degree of reliability or predictability. Initial research findings suggested that improved water management in the main laterals could lead to greater productivity and equity. However, Weaver (USA), argues that further research is needed before accepting the proposition that productivity can be increased by improving management and the allocation of water. The Philippine studies, nevertheless, have drawn attention to the need for further research of main systems management.

These studies of main systems management used a relatively new methodology called **action research.** This approach deliberately introduces and analyzes a management intervention as a part of the research process. Miranda notes that one such intervention in the Philippine studies was a scheduled check of the flows along the length of the lateral canal to give greater priority to farmers at the tail of the system.

Another type of action research used "irrigation organizers" to stimulate farmer participation in the planning and management process. Alwis describes how this approach was used in the Gal Oya Project. A group of young men and women were trained by the Agrarian Research and Training Institute (AR&TI) to work in the project area as catalysts to help develop farmer organizations at the field channel level. An important feature of this strategy was to involve farmers in the preparation of the rehabilitation designs. This involvement created the opportunity for communication between irrigation officials and farmers, and drew on the experience and practical knowledge of farmers.

Research on farmer participation in managing communal systems was undertaken in order to understand the potential role of farmers in the design and management of national systems (Miranda). Research was also undertaken to determine the appropriate role of national irrigation administrations in developing communal systems (Pasandaran). The Indonesian research concluded that government intervention must be indirect in the organization of irrigation tasks and the rules of water allocation must not be changed.

IMPLICATIONS FOR RESEARCH PRIORITIES

In the final analysis, most problems in irrigation management begin with poor design. There is a vital need for research in the planning and design stage. But the country status reports suggest that there is virtually no research on design at either the national or international levels. The review of the country papers on the status of research in irrigation management reveals that there has been a significant amount of research on technical issues related to irrigation management dating back more than half a century. It is probably fair to say that even today much of the research being conducted in Asia is directed toward very specific technical issues, such as consumptive use of water or conveyance losses.

Over the past fifteen years, however, there has been a significant growth in research based upon a more interdisciplinary and holistic view of the irrigation system. This has led in some instances to interventions which have involved both irrigation administrators and farmers in the research process. However, research of this type and the methodological approaches utilized are still very much in the formative stages of development.

We can now compare the country status reports on research with the set of priorities for research discussed by conference participants and summarized by Small[5]. Small defines three broad categories of research priorities: 1) general conceptual understanding of the dynamics of irrigation management, 2) research methodology, and 3) applied field research. Research at the national level falls largely into the third category, and to a very limited extent, into the second category. The comparative advantage of international research organizations such as the International Irrigation Management Institute lies in the conceptual and methodological areas.

With respect to applied research, however, the status reports suggest that more attention should be given to establishing research priorities in each country or region. In general, considerably more is known about the physical and biological dimensions of irrigation management than about the human and institutional dimensions (which encompass behavioral, organizational, and administrative issues). Also comparatively little is known about the information and financial dimensions, and the performance evaluation and rehabilitation processes. Research in these areas at the national level is constrained by the lack of appropriate methodologies. This presents a challenge to IIMI and to other organizations.

5 See the companion paper in this publication: Small, Leslie E. 1985. **Research priorities for irrigation management in Asia**

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4. Cheong Chup Lim, **Irrigation Management Research in Malaysia.**
5. Senen M. Miranda, **Status Report on Irrigation Management Research in the Philippines.**
6. Effendi Pasandaran, **The Status of Irrigation Management Research in Indonesia.**
7. Prachanda Pradhan, **Research Status Report on Irrigation: Nepal.**
8. P. S. Rao, **Status Report on Research on Irrigation Management in India.**
9. Nukool Thongthawee, **Irrigation Management Research in Thailand.**

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6. Thomas Weaver, **Problem Areas and Researchable Issues in Irrigation.**

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