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Public Intervention in Farmer-Managed Irrigation Systems

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Summary: In many countries, farmer-managed irrigation systems account for a significant portion of the irrigated area and food produced. A growing recognition of their importance has led irrigation agencies to assist these systems by increasing water supplies and improving reliability. Results have been mixed. To identify and define research issues and appropriate methodologies related to public intervention in farmer-managed irrigation systems, IIMI and WECS held an international conference in Kathmandu, Nepal. These 18 conference papers present recent and ongoing research, as well as agencies' experiences, on farmer-managed systems.

Please direct inquiries and comments to the Information Office at Headquarters:

HEADQUARTERS
International Irrigation Management Institute
Digana Village via Kandy, Sri Lanka.

Tel: (national 08; international 94-8) 23439, 32491
Tlx: 22318, 22907 IIMIHQ CE
Fax: (national 08; international 94-8) 32491

COLOMBO OFFICE
64A, Jawatte Road, Colombo 5, Sri Lanka.

Tel: (national 01; international 94-1) 586135, 502457
Fax: (national 01; international 94-1) 502457

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PREFACE

Landowners and cultivators worldwide have developed irrigation systems that are managed completely by farmers themselves. Although there are examples of large farmer-managed irrigation systems, generally they are small and numerous, accounting for a significant -- in some countries the majority -- share of irrigated area. Furthermore, a substantial portion of the population in many countries subsists on food produced in farmer-managed irrigation systems. Yet, the impact of this production on national economies often goes unrecognized. Until recently these systems were often ignored by irrigation agencies and in some cases were not included in national statistics of irrigated area.

There is now a growing recognition of the importance of farmer-managed irrigation systems, and irrigation agencies in many countries are increasing assistance to these systems. The main purpose of public assistance programs is to enhance agricultural production by increasing the water supply and improving its reliability. It is expected that such assistance will result in an expansion of the area irrigated or intensification of crop production or both.

The results of public assistance programs in farmer-managed irrigation systems have been mixed. In some cases, such as the Philippines, farmer organizations have been strengthened, and the technical inputs have resulted in more productive irrigation systems. However, there have been cases where public assistance caused the farmers to view the agency as the owner of the system and thus responsible for its operation and maintenance. In other cases, technology inappropriate to the farmers' mode of system operation has been installed, with the result that farmers have broken or by-passed the new structures. Both the approach to public assistance and the actual assistance affect the continued viability of farmer-managed irrigation systems.

Public assistance programs differ among countries and agencies. Two general trends can be observed. One is toward *increasing* agency involvement by taking over responsibility for managing systems. For example, in Himachal Pradesh, India, the Irrigation and Public Health Department provides assistance to farmer-managed irrigation systems only after the existing farmer organization turns over management of the system to the agency. The other trend is that some agencies find it difficult to manage a large number of small systems and are *decreasing* their involvement by turning over the management responsibilities to farmer organizations. When the National Irrigation Administration in the Philippines constructs or rehabilitates a small system, the whole system is turned over to a legally registered farmer organization. Documents are signed which clearly establish the organization's ownership of the system and its responsibility and authority for operation and maintenance.

Researchers in Asia and elsewhere have studied farmer-managed irrigation systems, and analyzed the process and results of assistance programs. This has helped make irrigation agencies more aware of the farmer-managed irrigation sector. National planning and irrigation agencies have begun to recognize and address the potential as well as problems of these systems.

The papers published in this volume were commissioned by the International Irrigation Management Institute (IIMI) for presentation at the "Conference on Public Intervention in Farmer-managed Irrigation Systems." The authors of the papers include officials of agencies engaged in assisting farmer-managed irrigation systems, researchers from universities and research institutes in developing and developed countries, and a representative of a donor agency. The papers are being published in full to make them available to the broader community of practitioners and researchers concerned with improving the understanding and performance of farmer-managed irrigation systems.

IIMI wishes to thank the Water and Energy Commission Secretariat (WECS) of the Ministry of Water Resources, Government of Nepal, with which it collaborated in organizing the conference, and especially Mr. B.K. Pradhan, Executive Director, WECS, for his support. Funding for the conference and for printing and disseminating this publication was provided by two grants from the United Nations Development Programme (UNDP).

Dr. Edward Martin (Agricultural Economist), on IIMI Headquarter's staff, and Dr. Robert Yoder (Agricultural Engineer), IIMI's Resident Scientist in Nepal, shared responsibility for organizing the conference. Dr. Prachanda Pradhan, also a Resident Scientist in Nepal, organized the field trip at the end of the conference.

Roberto Lenton
Director General
International Irrigation Management Institute (IIMI)

CONFERENCE OVERVIEW

Edward D. Martin and Robert Yoder

CONFERENCE OBJECTIVES AND PARTICIPANTS

Research on farmer-managed irrigation systems is one of several primary program areas of the International Irrigation Management Institute (IIMI), and is oriented around the theme of public intervention to assist these systems. In Nepal, IIMI collaborates with the Water and Energy Commission Secretariat (WECS) of the Ministry of Water Resources on an action research project to develop processes for assisting farmer-managed systems.

To provide a forum for discussing research issues related to farmer-managed irrigation systems and programs to assist them, IIMI, collaborating with WECS, organized an international conference on Public Intervention in Farmer-managed Irrigation Systems from 3-6 August 1986 in Kathmandu, Nepal. The main objectives of the conference were to identify and more clearly define research issues, and to discuss research methodology and how an international research network could best facilitate further research on the identified issues. The 18 papers published in this volume were presented and discussed. They represent recent and ongoing research on farmer-managed irrigation systems, as well as agencies' experiences in assisting these systems. The conference included a two-day field trip to several farmer-managed irrigation systems.

The 60 conference participants included researchers from universities and research institutes and representatives from irrigation agencies in Bangladesh, India, Indonesia, Morocco, Nepal, Niger, Pakistan, Philippines, Senegal, Sri Lanka, Thailand, and the United States. The interaction among irrigation agency personnel and researchers was an essential part of the process of identifying research issues that would most likely produce information useful to agencies engaged in planning and implementing intervention programs.

PRESENTATION OF THE PAPERS

Review of Past Research and an Agenda for the Future

The first paper is a keynote paper for the conference. E. Walter Coward, Jr. and Gilbert Levine review past research, emphasizing the types of studies which have so far provided information on farmer-managed irrigation systems. These include: 1) colonial compilations, 2) anthropological descriptions of irrigation systems but in which irrigation is incidental to the issues being studied, 3) irrigation ethnographies that describe how existing farmer-managed systems operate, and 4) development-oriented studies which either examine cases of intervention or study farmer-managed systems in order to make policy recommendations regarding intervention.

Coward and Levine also suggest an agenda for future research aimed at addressing

explicitly two endemic problems in many programs for assisting farmer-managed systems: 1) transforming highly autonomous farmer-managed irrigation units into systems that are overly dependent on government actions, resources, and staff; and 2) forcing a standard efficiency logic of operations, and the hardware needed to operationalize that logic, on these farmer-managed systems, many of which have multiple objectives and whose logic may or may not emphasize the efficient use of water.

Current Research

Most of the 10 papers in this section deal with situations or programs involving public intervention in farmer-managed irrigation systems. The authors are all from universities or research institutes in Asia and Africa.

A common and important theme is that, before intervening, agencies should understand how the existing farmer-managed systems are organized, the way they carry out irrigation activities, and the environment in which they operate. Authors stress that in many countries, there is little information available about the daily operation of farmer-managed systems. Collaboration among researchers and agency personnel is needed to acquire this information.

Several authors also stress that an agency should work closely with a farmers' organization to insure that, from conception to end, an assistance project develops in ways that improve the organization's management capabilities without making it dependent on continuing agency assistance.

Agency Intervention Programs

The four papers, authored by staff of assistance agencies, describe the intervention program and address some of the problems which the agencies face in providing assistance to farmer-managed irrigation systems.

Mahesh Man Shrestha describes the Farm Irrigation and Water Utilization Division's (FIWUD) program for participatory irrigation development in Nepal. For this program, farmers must deposit 5 percent of the estimated cost of the project before construction begins and contribute an additional 20 percent in cash or labor during construction. A committee, consisting of the FIWUD project engineer and farmers and chaired by a farmer, is responsible for managing construction. After completion, the system belongs to the farmers and operation and maintenance are their responsibility.

Jaliya Medagama describes the Department of Agrarian Services' Village Irrigation Rehabilitation Program in Sri Lanka. Under this program, small-scale village tank and *anicut* (diversion) systems are rehabilitated and water management programs initiated. However, among other problems, lack of information and farmer participation in planning inhibit the program. Another drawback is that rehabilitation and water management are viewed separately and are undertaken by two different departments. These problems reduce the farmer organization's capacity to manage the system and result in greater

dependence on the government.

S.B. Upadhyay presents an inventory of irrigation systems from eight districts of the Nepal's *Tarai* (plains area). The 836 farmer-managed systems identified account for 75 percent of the irrigated area in these districts.

The final paper in this section, by Maliha H. Hussein and others, evaluates the irrigation component of the Aga Khan Foundation's Rural Support Program (AKRSP) in the Gilgit District of Pakistan. AKRSP's approach is predicated on helping to build effective local institutions that can select and implement development projects. The village organization is one such institution. Members choose the kind of activity they want financed by a grant from AKRSP, are involved at all stages of the project, and are given sole responsibility for implementing and maintaining the project. The policy of paying for local labor as part of the grant and disbursing the grant in installments are important features of the AKRSP approach, which, according to the authors, has resulted in irrigation projects which are technically feasible, institutionally sustainable, and economically profitable.

Use of Research Results to Improve Agency Programs

Three papers deal with the interaction among researchers and agency personnel, and how research is used to modify and improve agency programs to assist farmer-managed systems.

Ben Bagadion, formerly in the Philippines' National Irrigation Administration (NIA), describes how academic research on farmer-managed systems influenced NIA's approach to providing assistance to farmer-managed systems. Action research was used to test and modify the intervention process.

Uraivan Tan-Kim-Yong, from Chiang Mai University in northern Thailand, describes an action research project to increase interaction, communication, and coordination among agency staff, farmer irrigators, and researchers. A series of meetings and workshops involving the three parties diagnosed problems and suggested solutions. She proposes using more farmer-to-farmer training and consulting services backed up by a mobile team of professionals.

In the final paper, Frances Korten of the Ford Foundation office in Jakarta examines why agencies have so often not utilized the results of research and discusses how researchers can be more effective in assisting agencies to develop appropriate intervention programs. The paper contrasts the macro- and micropolicy arenas, as well as two research perspectives -- policy analysis and social learning. She argues that most issues related to public intervention in farmer-managed irrigation systems fall into the micropolicy arena and that social learning research is more appropriate for addressing these issues.

CONFERENCE DISCUSSIONS

Research Issues

What are the effects of changes in the socioeconomic environment on the viability of farmer-managed irrigation systems? These systems exist in many different environments, and those which have survived and prospered have been able to adapt to environmental changes. However, systems that were once relatively isolated self-sustained communities are being integrated into regional and national economic svstems. Different rapidly changing forces are being brought to bear on the irrigation organization. Can farmer-managed systems be sustained in the face of increased government intervention in all areas of society? What happens to farmer-managed systems when labor has a much higher opportunity cost as a result of industrial development? As government authority penetrates more into rural areas, what happens when local customary water rights conflict with national water laws? What macro factors induce change in farmer-managed systems, and are systems able to adapt to the change? How do systems adapt?

Why have some farmer-managed irrigation systems failed? Most studies of these systems have looked at successful, relatively well-functioning systems. This has, perhaps, resulted in a rather idealized perception of farmer-managed irrigation systems. In order to understand better the causes of failure, studies should be made of systems which have failed. Have systems failed because of changes in the environment to which they were unable to adapt? Why haven't systems been developed in areas where there is a potential irrigation resource?

Why are farmer-managed irrigation systems asking for public intervention? Irrigation agencies are receiving more and more requests to assist in or take over the management of these systems, even from organizations whose systems are functioning well. What is inducing the organizations to give up control of their systems and request intervention? What do they expect to gain from intervention?

How do different agencies intervene in farmer-managed irrigation systems? Most past studies have described and evaluated the performance of the farmer organizations which manage these systems. New studies should examine the different types of agencies that assist farmer-managed systems. What approaches to intervention do different agencies take, and what affects their choice of approach? What are the capabilities of agencies? What improvements do agencies expect to make, and are the objectives feasible? What types of intervention seem most promising?

How should responsibilities for irrigation system management be shared between farmers and government agencies? This might entail location specific action research in a number of countries to determine the most appropriate share of responsibility for operation and maintenance between government and farmers.

What is the impact of government intervention in farmer-managed irrigation systems? This would involve doing case studies that analyze both successful and unsuccessful

interventions across a number of countries. Through such a cross-country analysis, it should be possible to arrive at some more general understandings than those gained from individual case studies.

Research Network

Conference participants expressed great interest in the concept of a research network on farmer-managed irrigation systems as a means to continue the exchange of information begun at the conference. However, underlying much of the discussion of how a network could facilitate research were different views of how research should be conducted, the type of questions to be investigated, and the methodology most appropriate for addressing the questions.

To maximize comparability, some participants felt that there should be a common core of research objectives addressed through a common methodology by researchers in a number of different countries. Others thought that researchers in each location should work closely with an implementing agency to enhance the agency's capability to assist farmer-managed systems. Viable research questions would emerge as a result of dialogue between the agency personnel and the researchers, and, like methodology, could differ considerably among the different network locations. Proponents of this view felt that skilled researchers could analyze the results of such studies and arrive at general understandings even though the individual studies did not follow a common methodology nor address the same specific questions.

After considerable discussion, there was general agreement that it was desirable to have network research that facilitated cross-country comparisons as well as supported close interaction with implementing agencies to develop situation-specific research questions. The conference ended with a decision to pursue formation of a network and involve a wide spectrum of participants. IIMI volunteered to provide administrative support for such a network.

REVIEW OF PAST RESEARCH AND AN AGENDA FOR THE FUTURE

STUDIES OF FARMER-MANAGED IRRIGATION SYSTEMS: TEN YEARS OF CUMULATIVE KNOWLEDGE AND CHANGING RESEARCH PRIORITIES

E. Walter Coward, Jr. and Gilbert Levine*

BACKGROUND

Ten years of research in farmer-managed irrigation systems have corrected the myopic notion formerly held by many that irrigation systems were facilities that governments built, and irrigation development the domain of irrigation departments and international donor agencies. There is now wide-spread recognition that very frequently the total irrigation sector of a particular country involves a substantial portion of systems that were created and persist largely, though not entirely, outside the government sector.

Governments now are giving more attention to these farmer-managed systems than ever before. But in many countries there has been a long history of some form of government aid. Not infrequently, aid to these local systems has been channelled through some department other than irrigation--Agriculture, Community Development, or Local Administration. This has also acted to isolate these farmer-managed facilities from the hydraulic works within the purview of the formal irrigation department.

But things are changing rapidly. Nearly everywhere, farmer-managed systems are being subsumed under the mandate of irrigation departments. And therein lies the problem. Worldwide, diverse policies are being fashioned, and varying procedures are being implemented with uneven results. Pressures to increase the involvement of government in farmer-managed systems arise from both government and water users. The significant increase in government involvement in farmer-managed systems has raised several important and interlocked concerns: concern for the increasing dependence of farmers on government-provided resources; concern for the imposition of inappropriate planning, design, and operational criteria; and increased concern for escalating costs of both construction and operation and maintenance (O&M).

These concerns, arising from the rapid acceleration of State[1] assistance to local systems and the increasingly central role of irrigation departments in planning and executing such assistance, have important implications for the nature of socially relevant studies of farmer-managed systems.

A major objective of this paper is to discuss these implications and suggest lines of study and inquiry appropriate for a research agenda on farmer-managed systems for the next ten years: a decade in which we expect the State will continue to be active in developing policies and implementing programs related to farmer-managed irrigation. The first part of this paper reviews past and current research, while the second suggests future research trends.

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*Irrigation Studies Group, Cornell University, Ithaca, New York 14853, USA.

REVIEWING PAST RESEARCH

Antecedents to Contemporary Work: Colonial Compilations

The historical literature of the West contains various references to farmer-managed systems that were recorded by agents of colonial governments as they went about their formal and informal inquiries. Three examples from different regions of the world, illustrate this this early material. Christie (1914), discussing the farmer-managed systems of Ilocos Norte in the northern Philippines the now well-known *zanjeras* tried "to convey a general idea of the degree of development of native irrigation in Ilocos Norte." A unique item in the article is the full text of an agreement signed by a group of individuals joined into a zanjera. In some cases, Christie hinted at important aspects of zanjera organization though he did not elaborate on them. For example, he noted that the land irrigated in the zanjeras is divided into equal shares among the majority of the members, a point that Coward (1979) and Siy (1982) later elaborated as the "atar concept."

The point on which Christie ends is important: in cases where the government takes action to assist these zanjeras, it is important that the agents of change scrutinize "the original papers organizing the local irrigation societies" in order to be fair to these members. This must be one of the earliest calls for government assistance to farmer-managed systems that is sensitive to local history and existing arrangements.

Saunders (1980), in her report on irrigated agriculture among a Hausa group in southern Niger, used the materials of colonial agents to establish a long history of the area's irrigated agriculture. She refers to the writing of Brouin (1938), who reports that in the 18th century the local ruler:

> ...allegedly recruited some one thousand workers to build a small barrage, or simple dam, and a canal some three kilometers long and fifteen meters wide, to carry water from a natural pond to a nearby depression which flooded during the rains but lacked water during the rest of the year. Brouin reports that the system could still be seen in the 1930s (Saunders 1980:6).

She also refers to quotations from a German explorer who travelled in the area in the mid-19th century and reported an extensive district irrigated by springs that "ooze forth from the sandy downs." The bits and pieces that she is able to assemble from the colonial records give historical context to the contemporary system that she describes in detail.

In the early 20th century, the British Colonial Government operated a research institution called the "Board of Economic Inquiry, Punjab." This Board conducted studies of the rural sector in the State of Punjab an administrative unit that covered the present-day states of Punjab in both India and Pakistan, as well as additional areas now assigned to other states in both countries. One such study surveyed agricultural conditions in the Haripur and Margarh Tawgas subdistricts of the District of Kangra, and describes in some detail the organization and operation of a farmer-managed irrigation system, here called a *kuhl*, reported to irrigate more than 240 hectares (ha) and serving people of 9 hamlets (*tika*).

The description is a complimentary one, emphasizing the presence of different canal leaders. It also describes a sophisticated system of water allocation and distribution, including rotation and the means of mobilizing resources to operate and maintain the works. It ends with:

> Notwithstanding all these difficulties, these kuhls are a remarkable instance of self-government and it is wonderful how well they are managed when we consider the many conflicting interests involved (Board of Economic Inquiry 1933).

Irrigation as a Means of Social Analysis: Anthropology Field Studies

A second information base on farmer-managed systems was produced by anthropological field workers whose research objectives were focused on some aspect of social organization or culture. They made observations on irrigation-related activities in the course of their field work. Thus they provide us with significant, though frequently incomplete, information about local systems of irrigation. There are numerous examples that illustrate this point.

In this genre of studies, the central nature of irrigation phenomena to the analysis varies. Sometimes, it is the major social activity that the analyst uses as a means for the study of some larger social process.[2] For example, Geertz (1967) uses the Balinese *subak* and Potter (1975) the *muang-fai* systems of northern Thailand as vehicles for understanding important principles of rural social organization; the Hunts (1974) employ irrigation to understand political power and processes in Mexico; Lewis (1971) examines irrigation groups in the northern Philippines to explore issues of habitat and social organization; Leach (1961) looks at irrigation in Sri Lanka while pursuing his basic interests in kinship and social organization; and Mitchell (1976) studies irrigation in Peru as part of his analysis of political and ritual life.

For other analysts, irrigation was a more incidental topic. For example, Moerman's (1968) study of farmer decision making in northern Thailand makes only brief mention of irrigation activities, but that short discussion coupled with other information from northern Thailand gives an idea of farmer-managed irrigation in his study area. Or take the case of von Furer-Haimendirf's (1980) study of the Apa Tani in Arunachal Pradesh (northeastern India). The prose is sparse but highly suggestive in terms of what we know about small systems elsewhere:

> Every one of the streams rising on the wooded heights that ring the Apa Tani country is utilized for irrigation purposes soon after it emerges from the forest and reaches a gully wide enough to accommodate a series of narrow terraces.... The channels have been cut deep into the soil and their dams are secured against the onrush of flood water by rows of wooden stakes sometimes reinforced by strong bamboo matting (von Furer-Haimendirf 1980).

Neither of these types of studies, in which irrigation phenomena are either incidental or central, sets out to understand irrigation systems per se. Rather, the analyst began

with some other "problem," usually one suggested by models and concepts developed within the analyst's discipline, and irrigation behavior and organization were examined because of their relevance to that disciplinary problem. These analysts examined irrigation activities not to understand how irrigation systems functioned, but to advance understanding of kinship processes, principles of social stratification, and so on. In fact, the best of these studies advances our understanding of both.

Irrigation Ethnographies

But there also were studies describing how existing farmer-managed systems operate. In these, the analysis may or may not be embedded in larger theoretical arguments. Three cases exemplify this line of research.[3] Grader's (1960) study of Balinese subaks in the region of Jembrana is the first example. It is a straightforward description of the "ideal" organization of subaks in this region, touching on such topics as membership in the subak board, subak services and levies, subak religious activities, and subak regulations. In one case, Grader describes the creation of a new subak which began with the hiring of tunnel diggers by the traditional district government official responsible for coordinating subak affairs (*sedahan agung*). Only after the tunnel diggers were able to identify precisely the lands that would be irrigated, did the owners of those lands form themselves into a subak group.

Taillard's (1972) study of traditional irrigation systems in northern Laos is a preeminent example of irrigation ethnography. The report gives details of the geographical setting, the types of apparatus used to acquire and distribute water, and important features of the social organizational arrangements in place for handling such elementary tasks as system repair and water distribution.

Wilkinson's (1977) study of irrigation systems in Oman represents a third example of a careful irrigation ethnography. Unlike the Grader and Taillard examples which have irrigation descriptions as their end, Wilkinson's research purpose is to understand irrigation systems and settlement forms in the context of larger historical processes of political control. However, his means to this end is a careful discussion of the local irrigation systems of central Oman. Focusing on these farmer-managed systems, here called *falaj*, he states his intention as follows:

> We will examine first, the layout of a falaj settlement, then the principles of water shareholding and the way in which finance and maintenance of the falaj are arranged, and finally the division of labor and responsibilities in the irrigation system (Wilkinson 1977:97).

Careful attention to detail in his field study allows him to reach important conclusions regarding the sociotechnical features of the falaj -- in particular, the means by which the architecture of the system is made congruent with the water rights of the users.

These irrigation ethnographies provide us with rich detail on the internal characteristics of the systems being studied often including information on both social organization

and the physical artifacts used to handle water. They have the characteristic that Geertz has called "thick description" allowing the reader to grasp much of the immediate context in which irrigation processes are operating. Irrigation ethnographies, based as they usually are on detailed field studies, typically uncover the considerable complexity of technical and institutional arrangements that develop in a farmer-managed system that has persisted over time. It is these complexities that are likely to remain unknown when less penetrating research procedures are employed.

Development-Oriented Irrigation Studies

Development-oriented irrigation studies are defined here as those studies in which the analyst is either examining a case of external involvement in farmer-managed systems or studying farmer-managed systems for the purpose of making development recommendations.

Some of the earliest of such studies was work done as part of the so-called Mekong Development Program. For example, Frutchey (1969) examined the activities of the people's irrigation systems in northern Thailand to better understand the institutional aspects of irrigation development that irrigation planners would face. Similarly, Coward's (1976) work in western Laos examined the implementation of a government irrigation development activity in a region where many farmer-managed systems existed. Irrigation development activities in Taiwan provided the setting for important development-oriented studies by Pasternack (1972) and VanderMeer (1968, 1971). VanderMeer's work, in particular, caught the transition from formerly independent farmer-managed systems to systems in which government was highly involved but farmers remained significant managers. Perhaps the most extensive effort by government to create new farmer-managed irrigation systems was the Thana Irrigation Program (TIP) of Bangladesh, launched in the early 1970s (Thomas 1976, Haq 1976, Hamid 1982). Much of the TIP's design was based on "experimental" work at Comilla in which the field staff designed and tested approaches for introducing tube wells and low lift pumps through village cooperative societies (Coward and Ahmed 1979, Howes 1983). The centrality of these farmer-managed pumps systems for agricultural change in Bangladesh has made them a subject for continuing study and research (Biswas and Mandal 1982, Hamid 1982, Howes 1982, Wood 1984).

One of the best examples of development-oriented studies is the work of de los Reyes and colleagues in the Philippines. This research has been done in close collaboration with the National Irrigation Administration (NIA) as that agency has endeavored to develop a more participatory style of government assistance to farmer-managed systems, called "communals" in the Philippines. Especially significant was their attempt early in the process to provide a broad-based understanding of the situation of the communal systems by conducting a nationwide study (de los Reyes 1980a and b). The study was based on a survey of a national sample of communals supplemented by detailed case studies of selected systems. Since then, other development-oriented work on farmer-managed systems has been done in the Philippines (Siy 1982; Angeles 1983, 1984; Illo et al. 1984; Illo and Volante 1984; de los Reyes 1984, 1985; Bagadion and Korten 1985).

While irrigation had been the subject of study in Indonesia for some time, an early development-oriented study of farmer-managed irrigation was made by Hafid and Hayami (1979) when they studied the outcome of the government's village subsidy program on two small systems, one in Java and one in Sulawesi. In the late 1970s, Cornell University began a series of field studies in Central Java that included farmer-managed systems. These studies were significant in that they attempted to observe both the engineering and the socioeconomic dimensions of the systems and their operations (Oad 1982, Duewel 1985). Early in the 1980s, with assistance from the Ford Foundation, teams from Universitas Udayana in Bali, Universitas Sriwijaya in South Sumatra, and Universitas Andalas in West Sumatra began irrigation studies in each of their regions that included farmer-managed systems. Their work has yielded useful ethnographic information on the organization and operation of farmer-managed systems and is beginning to produce important information on the processes by which government is providing assistance to such systems (Sutawan et al. 1983, Universitas Sriwijaya 1983, Abuasir 1985). Also, there has been a set of studies examining a small-scale irrigation program called the "Sederhana Program." This program is being implemented by the Government of Indonesia with funding support from the United States Agency for International Development (USAID). Several other studies have been completed that give special attention to the farmer participation aspect of the program (Morfit and Poffenberger 1984, Robinson 1985a and b).

In addition to research in Bangladesh mentioned above, some important and useful development-oriented research in South Asia has been reported and is currently underway. In Nepal, Martin (1986) and Yoder (1986) have completed detailed field studies of farmer-managed systems in the hill areas. That line of research is being continued through the joint activities of the International Irrigation Management Institute (IIMI) and the Government of Nepal.

In Sri Lanka, Abeyratne and Perera (1984) and Begum (1985) have recently completed field studies of village tanks and village *anicuts* (weirs), and of government assistance provided through the World Bank-financed Village Irrigation Rehabilitation Program (VIRP) (Medagama 1982).

In Pakistan, most irrigation studies have focused on the large public canal systems of Punjab and Sind. However, there has been limited work on the smaller farmer-managed systems in selected hill areas of the country. For example, Bhatty (1979) has reported on the organization and operation of a *gul* system in the North-West Frontier Province. Some work has also been done on the well-known *karez* systems of Baluchistan (Kemper et al. 1979) which are presently being rehabilitated through various government programs.

Minor irrigation systems are an important part of the irrigation sector in India. A large number of these minor systems are tube wells, some of which are individually owned and operated. Many, though not all, of the minor systems both groundwater and surface water works -- are farmer-managed. Thus far, there have been relatively few studies, development-oriented or otherwise, of these small farmer-managed facilities. Pant (1984) has written about pump groups in eastern Uttar Pradesh and made suggestions for future public intervention. Small systems are numerous in the Himalayan region, but there have been

few studies of these systems in India. As part of a project planning exercise, Shingi (1984) has reported on such systems in Himachal Pradesh. Also, Joshi and Seckler (1982) have written about an innovative project to introduce a farmer-managed irrigation system in the Sivalik hills near Chandigarh. Some development-oriented studies have also been completed in South India. For example, Patil and Kulkarni (1984) have written about the farmer-managed *phad* systems found in Maharashtra which are being affected by government assistance. But the most extensive research has been done on the tank systems of Tamil Nadu, which are now the subject of a major "modernization" program (Saktivadivel 1982) as well as the tanks of other states in South India (von Oppen and Rao 1980a and b, Doherty 1982). Palanisami and Easter (1983a and b) have written extensively on the tanks of Tamil Nadu, some of which are farmer-managed while others are jointly managed (see also Meinzen-Dick 1984). Most recently, tank studies have been undertaken by Saktivadivel et al. (1986) at the Centre for Water Resources at Anna University.

Information on farmer-managed systems in northeast Asia is conspicuously lacking -- including development-oriented studies. Nearly all of the research on irrigation in Taiwan has focused on systems that are jointly managed by government and farmers. While much has been written about irrigation in Japan, including farmer-managed systems, most of the information is available only in Japanese (Kelly 1982). Small farmer-managed systems are extensive in Korea. However, with the exception of the study by Oh (1978), little research has been done on these systems and on related issues of public intervention. Wade's (1982) report, which does have a development thrust, deals only with the larger, bureaucratically managed systems. Finally, there is a complete absence of information on this topic from China. However, the recent shift in government policies to the so-called "responsibility system" could have important implications for farmer-managed systems.

There is some literature on development-oriented research into farmer-managed systems in Africa. In Morocco, for example, several useful studies are available. Moroccan researchers have done work on "irrigation petit" and the changing policies of government toward such systems (Bourdebala et al. 1984). Government involvement in the development of farmer-managed perimeters along the Senegal River has been the subject of several recent studies (Diemer and van der Laan 1983, Patterson 1984, van der Laan 1984, Miller 1985, Horst 1986). Two very useful studies have recently been completed in Kenya. Ssennyonga (1983) has carefully analyzed traditional furrow systems in a region of the Rift Valley and discussed their relevance to regional development. Fleuret (1985) has reported on farmer-managed systems in the Taita Hills region of southern Kenya. These systems are currently experiencing high levels of disorganization as a consequence of government land titling programs. The Food and Agriculture Organization (FAO) has been especially active in promoting irrigation development strategies in Africa that favor farmer-managed systems (Underhill 1984).

Farmer-managed systems in the Andean region are also experiencing continuing government intervention and some researchers have been analyzing these processes. Recent work by Lynch (1986) has reported on government intervention in the Sierra region of Peru through the project called "Plan Meris."

Finally, we note some development-oriented research on farmer-managed systems in North and Central America. Small systems are widespread in certain regions of Mexico. The Government of Mexico, sometimes with assistance from international agencies, has been providing public assistance for "improving" these systems for some time. Government strategies toward farmer-managed systems have been studied by Lees (1974) and more recently by Goldring (1985) and Hunt (1986).

Less well studied is the process of government assistance to farmer-managed systems in the United States, especially in states such as New Mexico, Colorado, and Utah. That such assistance is still being planned and implemented is demonstrated in the following quotation describing a proposed Bureau of Reclamation Project to improve several acequia systems in northern New Mexico.

> The project is located on the Rio Grande in Rio Arriba County, New Mexico. There are presently nine diversion barriers and approximately 27 miles of diversion canals serving approximately 1,800 acres. The principal features of the project consist of improvements such as the installation of more permanent diversion structures, headgates, wasteways, arroyo siphons, and concrete lining of ditches to improve irrigation efficiency, conserve water and reduce operation and maintenance costs (US Bureau of Reclamation).

In their 1978 book, Maass and Anderson provide some details on such systems in Colorado and Utah as part of their analysis of irrigation organization and performance. Thompson (1984) is presently undertaking a research project to understand the various forms of financial assistance provided to farmer-managed systems in the western United States.

People's Irrigation in Northern Thailand

While the above discussion sets out to disaggregate and categorize the various studies of farmer-managed irrigation systems, it is also instructive to examine the mosaic of such studies that have been completed in a given region. The case of the muang-fai in northern Thailand is an interesting example of the diverse sources of information available, the changing and continuing interests of researchers over time, and the cumulative evidence that has been developed regarding these systems.

One can begin with an interesting irrigation ethnography that deals with irrigation in an area geographically outside the political borders of northern Thailand but in a proximate zone and with a culturally similar group. In 1949, Han-Seng published a report on land systems in southern China which included a description of local irrigation organizations among an ethnic Tai group[4] in a part of the ancient kingdom of Sip Song Pan Naa. From this report we learn of various rules and roles for operating and maintaining the irrigation systems. We also discover an important point regarding the function of the local nobles (*chao*) in developing rice lands by which they extracted surplus from the peasants. Various writings, categorized above as social science studies using irrigation as a means for understanding social processes, were produced in the 1960s and 70s (Wijeyewardene 1965, 1973; Potter 1975). Several irrigation ethnographies also have been written

(Bruneau 1968; Tanabe 1981; Sirivongs 1982; Lando 1983; and, as previously discussed, for related areas in Laos, Taillard 1972). Also beginning in the mid-1970s and continuing to the present, several histories of local areas have highlighted the development of people's irrigation systems (Calavan 1974, Cohen 1981, Ganjanapan 1984). Finally, more recently, several researchers have undertaken field studies with an explicit focus on change and development in people's systems (Frutchey 1969, Sektheera and Thodey 1975, Suraroek et al. 1980, Sirivongs 1982, Tan-Kim-Yong 1983).

From Wijeyewardene's 1973 paper, we first learn about the impact of government irrigation development activities on the affairs of people's irrigation systems. That theme, in its contemporary manifestations, is again repeated in the writings of Suraroek et al. (1980), and especially in the detailed field studies conducted by Sirivongs (1982) and Tan-Kim-Yong (1983). Moreover, the contemporary involvements of the state can be placed in historical perspective, since the writing of Calavan (1974), Cohen (1981), and Ganjanapan (1984) detail the manner in which earlier political figures frequently played a large role in stimulating the creation of particular people's systems or significantly modifying systems that already existed. External intervention in these systems is shown not to be a new process --though there may be unique features of the present government involvement.

Finally, we should note that in recent years, there has been growing interest on the part of the government in developing farmer-managed irrigation systems in the northeast region of Thailand. As a complement to this policy, researchers at Khon Kaen University have been involved in innovative programs for delivering external assistance to existing, and new, farmer-managed systems in that region (Mayson 1984).

Characteristics of the Completed Research

The above review of completed research on farmer-managed systems, while not exhaustive, serves to demonstrate the considerable literature that exists. Although a large portion of the research deals with Asia, significant work from other regions of the world is also available -- and perhaps is not out of proportion to the extent of existing systems in the various regions. With the above literature in mind, we suggest the following six generalizations regarding the relevance of this body of completed research for improving the policies and programs of public intervention in farmer-managed irrigation systems.

1. The completed research is very heavily social science-oriented, and is primarily concerned with the institutions and organizations by which farmers create, operate, and reproduce their systems. While many of the reports refer to various physical components of the hydraulic works and the agronomic dimensions of the irrigated crop(s), in many cases, these dimensions are presented as mere background, and the discussion fails to provide a discussion of processes through which organization and apparatus are articulated. There have been relatively few solid engineering contributions to this literature, important exceptions being von Oppen and Rao (1980a and b), Worboys (1981), Horst (1983), Angeles (1983), Wensley (1984), Engelhardt (1984), Wensley and Walter (1985), and Yoder (1986). While a number of studies have approached the field with a socio-technical orientation that has made the researcher sensitive to the interplay between the physical apparatus

and the institutional rules and organizational arrangements, the latter typically receive more attention than the former.[5]

2. Nearly all of the completed studies have been descriptive; very few have been analytical. The studies are excellent in answering the question: What is going on in this location? Such information has been absolutely critical for correcting many of the stereotypes and inaccurate assumptions that policy makers held about farmer-managed systems. The body of completed research has been essential for creating a more informed picture of the informal component of the irrigation sector in many countries, and has encouraged a rethinking of the future of such systems. But there is a need to go beyond these various descriptions to provide analytical concepts and models that help explain the systemic features of these systems and the regular patterns associated with their reactions to external assistance. One line of work in this area is the "property concept" discussed by Coward (1983, 1985a and b). Other approaches are needed.

3. Nearly all of the completed studies have focused on the internal dynamics of the systems under investigation. Most studies have not placed these systems in the larger regional contexts in which they operate, and thus have not been able to inquire about the possible impact of external environmental, social, economic, or political changes on these critical internal happenings. The exceptions to this pattern are those studies that have examined the impact of external government assistance. However, without an understanding of the other external forces that may be at work, we may fail to understand why government assistance is being requested, being provided, or resulting in the observed consequences.

4. Nearly all the studies that have been concerned with the impact of government assistance on farmer-managed systems have examined short-term effects only. The studies have been undertaken immediately following or within a year or two of completion of the intervention. Given that external interventions to any system tend to have at least short-term disorienting effects, and that new irrigation structures or procedures may always require a "shakedown" period for learning and adjustment, it may not be surprising that our studies tend to identify long lists of intervention problems. Extending the impact period may modify our findings.

5. The studies of farmer-managed systems, nearly without exception, fail to discuss the bureaucratic characteristics and processes of the assisting agency (an exception is Goldring 1985). If one assumes that the consequences of public intervention minimally result from actions of both irrigators and agency staff, this failure to discuss the bureaucracies that plan and implement programs of public intervention is devastating to any research program intended to provide suggestions for improving such interventions.

6. The completed research has not included a clearly articulated concept of the role of the State and its bureaucracies in national development. Some researchers seem to assume that the role of the government is to integrate the various competing forces of society, and to play a role in allocating society's scarce resources in some fair manner. Other analysts may assume that the function of government is to represent the interests

of the ruling classes and to direct resources in ways that protect and enhance the favored position of those with power and influence. Still others may view the State as having a large degree of autonomy; thus being relatively independent of either society as a whole or of the ruling classes. The consequence of not having a theory of the State's role is that its various actions in relation to farmer-managed systems are presented in an anecdotal and atheoretical manner. One result is that the undesirable effects of public intervention tend to be blamed on inadequately trained staff, insufficient resources, or greedy public servants.

AN ILLUSTRATIVE AGENDA FOR FUTURE RESEARCH

Over the past 10 years, studies of farmer-managed irrigation systems, and of public interventions to assist them, have multiplied vastly. During this decade, we have seen growing recognition of the importance of farmer-managed systems on the part of national governments and international donors. No longer are farmer-managed systems merely of academic interest; they are the object of many public programs in irrigation development, and are now within the purview of most mainline irrigation agencies. Moreover, it is not just a matter of irrigation departments forcing their assistance on farmer-managed systems; in many instances, the request for help from the farmer group is strong and persistent. Thus, there are both supply and demand forces at work, which has profound implications for a relevant research agenda for the next decade.

In our judgement, two of the dominant trends in present public intervention programs must be modified: 1) transforming highly autonomous farmer-managed irrigation units into systems that are overly dependent on State actions, resources, and staff; and 2) forcing a standard efficiency logic of operations, and the accompanying hardware to operationalize that logic, on these farmer-managed systems, many of which have multiple objectives and whose logic may or may not emphasize the efficient use of water.

These are endemic problems in the public intervention programs aimed at improving farmer-managed systems. A research agenda focused on these systems should address these problems explicitly. We believe that an agenda, organized to address the following four questions, but not limited to them, is a step towards that objective

* What are the forces leading to government intervention?
* What are the factors leading to dependence?
* What are appropriate planning, design, and operational criteria?
* What are the effects and implications of extended involvement of government in farmer-managed irrigation systems?

What are the Forces Leading to Government Intervention?

It can be hypothesized that these forces derive from factors internal to the particular irrigation system, the local community of which it is a part, and the context in which both operate, and other factors that are associated with the State and its environment. These factors lead to several specific research issues.

Labor dynamics and farmer-managed systems. Most studies of farmer-managed irrigation systems have shown that their O&M processes are labor-intensive and that their reproduction is highly dependent on the ability to mobilize labor supplies. There often has been the assumption that in the developing country situations in which we are working, labor is abundant rather than scarce. However, new work on labor dynamics in rural areas has shown that as rural households become integrated into wage labor and commodity markets, they often experience complex and contradictory pressures on their labor supply. Collins (1986) states the arguments as follows:

> Labor availability in contemporary communities cannot be understood apart from the processes of semiproletarization that are affecting rural households. Family members may be involved in subsistance production one month, petty commerce another, and seasonal migration to use their labor power during the dry season. The need to participate in these diverse activities is frequently related to a diminishing land base, or to declining terms of trade. This dynamic may lead to problems of labor scarcity.
>
> Labor scarcity may in turn lead to patterns of poor resource management. Thus a vicious circle of impoverishment is created (Collins 1986:26).

This perspective of labor dynamics could be highly relevant to the farmer-managed irrigation systems that we are studying. It could partially explain the interest on the part of local groups in external assistance that they hope will ameliorate labor constraints. Faced with the difficulty of mobilizing sufficient manpower for system repairs and operation, farmer groups may turn, however reluctantly, to the State to take over system operation and maintenance. Note also that many State intervention programs assume that the irrigation group will implement the necessary operation and maintenance activities following the State's intervention. Frequently this does not occur. Again, part of the explanation may lie with the changing labor dynamics of the irrigation households and not just with perverse ideas about government being responsible for what it builds.

In brief, whether or not changing labor dynamics are altering the ability of an irrigation group to mobilize needed manpower is an empirical question. Labor dynamics may be a factor in explaining key processes, such as system operation, calls for external assistance, and reaction to public interventions.

Collins (ibid.) makes several points regarding research strategies for the study of labor dynamics that have direct relevance to farmer-managed systems. First, she argues the need to determine labor availability or scarcity in specific regional and temporal contexts. We could add to that: in specific system contexts. The suggestion here is not to assume that labor scarcity is a problem in all farmer-managed systems, but rather to make labor dynamics a specific part of the inquiry regarding system management.

Second, she argues the need to "...be able to recognize communities stressed by the growing need to sell off-farm activities, and land that is poorly managed as a result of strategies to meet short-term needs" (ibid.).

Modifying this for our situation, one could propose that we need to be able to recognize farmer-managed systems that are being stressed due to changing labor dynamics with the result that system management is poor or deteriorating. Collecting information on the percentage of income derived from off-farm sources or the percentage of income derived from non-irrigated agricultural activites or both could alert the researcher to a possible labor-stress situation. Moreover, identifying such stressed systems would be a first step in developing public intervention policies that are sensitive to this condition, rather than exacerbating it. One can expect that public investments in labor-stressed systems are unlikely to result in desirable consequences unless the intervention directly confronts that labor problem.

Farmer-managed systems in a regional context. A concern with labor dynamics is one facet of a more comprehensive perspective that views individual farmer-managed systems as part of a larger regional political economy, a network of relationships by which the local system and its users are connected to the State and its bureaucratic apparatus as well as to an external economy, often a world economic system.

It is easy to overstate the historical autonomy of farmer-managed systems -- to assume that they were once unconnected to any larger economy or polity -- and thus to misunderstand the significance of present State involvements with them. Important recent scholarship has called into question, many of these prior assumptions regarding historical connections (Roberts 1967; Calavan 1974; Ludden 1978, 1979). We have learned that many, perhaps even most, locations were within the spheres of influence of some regional realm, and that patterns of trade were remarkably far-reaching. Ganjanapan's (1984) discussion of the development and change of the people's irrigation systems in a district of Chiang Mai province at the turn of the century ilustrates this point. In this period, the Bangkok-based kingdom of Siam extended political control over the Chiang Mai-based kingdom of Lan Na and, simultaneously, the construction of a railroad linked the Chiang Mai region with the world rice market. Both of these processes created significant incentives for the regional elite to invest in the development of local irrigation facilities.

The understanding of these historical connections suggests that many of the systems that we now see as indigenous and independent may in fact have origins associated either with general policies of some earlier State or with direct past actions of the State. That is, the State has been an important part of the environment in many farmer-managed systems, historically as well as in the contemporary period. The same can be said regarding trade.

This view can be important to conceptualize the research problem dealing with public intervention in farmer-managed systems. By hypothesizing an extended period of State involvement rather than merely a recent one, the researcher is led to several novel questions. What was the nature of State intervention in the earlier period? What of those earlier forms of intervention has persisted, and what has been modified? What factors have contributed to continuity and to change in State assistance to farmer-managed systems?

The simple paradigm that identifies local systems in an earlier non-intervention period in contrast to current farmer-managed systems in which intervention is occurring may apply in relatively few situations. More likely, we would be observing cases in which there is a long history of State involvement in the local system and the nature of this intervention may have changed little, or dramatically, over time. These changes may be producing sociotechnical results rather unlike the results of the prior era. Adopting a paradigm that explicitly assumes some prior form of State intervention until otherwise empirically determined, would alert the researcher to search for continuity and change in State actions. It would also prompt an analysis of the extent to which the positive or negative outcomes of the intervention might result from a misfit between the present regional situation and changes or consistencies in the form of State intervention.

Studying the irrigation bureaucracies. A large factor determining the outcome of public intervention in farmer-managed systems is the implementing bureaucracy. However, most studies focus only on the outcomes of public interventions -- a pump installed, a division box mislocated -- not on the agency processes that led to that result. Thus, to a very large extent, the processes and procedures of public intervention remain a black box. There are some exceptions. In the context of the participatory approach to communal irrigation development in the Philippines, attention was given to understanding how the technical agency and its staff were organized (Alfonso 1981). In addition, through the use of a research technique called "participant observation" (de los Reyes 1984), researchers were able to collect information on agency decisions and interactions with local groups more or less as they occurred.

However, in general, our understanding of what occurs within the farmer-managed systems (and, to some extent, why) is now superior to our understanding of what occurs within agencies planning and implementing public assistance for such systems. Without understanding the latter, we are unlikely to understand the limits to agency actions or the forms of assistance most readily supplied by the State apparatus. There seems to be little likelihood that we can make progress in improving public intervention without a significant increase in our understanding of the relevant bureaucracies.

The research strategies and techniques for studying irrigation bureaucracies will both parallel and differ from those we use to study irrigation communities. While irrigation bureaucracies that implement programs for farmer-managed systems are practically unstudied, bureaucracies in general are a focus of many social inquiries, including some work on irrigation bureaucracies concerned with administering large-scale systems (Moore 1980, Lees 1984). Work on this topic should begin with a review of current theory and research in formal organizations.

Two important parallels should be followed. First, the dominant research design should be "field studies;" that is, the study of agencies in context doing their normal tasks. Researchers should be participant observers within these contexts -- attending meetings, accompanying staff as they go about their routines, "hanging around" during tea breaks, and so forth. In effect, for the agency analyst, the office (and, by extension, the field in which the staff operate) becomes the "village."

Second, studies should be done with the interdisciplinary perspective that has informed much of our study of farmer-managed systems. An irrigation agency is not just a formal organization, it is a formal organization with specific irrigation-related functions that have high engineering content and, frequently, high economic content. Many of the processes and procedures used in the agency will be justified with regard to some engineering or economic "need." Thus studies of such organizations, and explanations of staff behavior, are likely to be unsatisfactory if based only on a single disciplinary viewpoint, such as sociology or public administration.

While the above parallels are important, a potentially important difference must be considered: the matter of access. Gaining access to farmer-managed systems, while not always simple, usually can be achieved because there are many such systems; if access is difficult in one, an alternative can be approached. Moreover, since the researcher is often seen to be in a superior social position to the villagers in a farmer-managed system, access often is tolerated. None of this is meant to minimize the important issues of establishing rapport between the researchers and local people, even in a location where access has been provided.

But irrigation agencies clearly are very different social entities. In dealing with them, the researcher may not be operating from a position of perceived social superiority. Moreover, there may not be several irrigation agencies to choose from; being turned down by one may preclude the ability to conduct the research (unless one is in a position to move between countries or perhaps between distant regions in a large country). Thus, the matter of access is not inconsequential.

One approach to this access problem is what might be called the "management consulting approach." The researchers work closely with the agency to understand its processes and procedures, consulting with the agency regarding desirable changes and improvements. Disadvantages of this approach might include the need for the analyst to make the study results confidential and not available to the general research community. Such confidentiality would severely limit the ability to draw contrasts and comparisons across agencies and thus to begin processes of generalization and model-building.

An alternative approach would be to enter the agency setting in a more traditional research role with support from and accountability to someone other than the agency staff -- perhaps to a superordinate agency, such as a planning ministry. In this case, more effort would probably be required in developing researcher-staff rapport, but the study results could be more widely available for reporting and debate.

No doubt, different irrigation agencies will be differently disposed to permit research on themselves. In some cases, it will be necessary, perhaps even desirable, to begin with the management consulting approach. In others, an agency may have enough self-confidence to allow the traditional research approach to be employed. Researchers should be prepared to proceed using whatever approach is initially acceptable to the agency, while constantly seeking opportunities to move study results into the public arena for discussion and debate, and thus contributing to our cumulative knowledge of agency processes.

What are the Factors Leading to Dependence?

Increasing dependence can be a result of persistent or extraordinary lack of fundamental resources on the part of the irrigators, of governmental policies which indirectly disadvantage these farmers, of intervention practices which reduce the effectiveness of small group action, or of deliberate governmental policies and practices designed to decrease independence for political objectives. This view of the potential causes of dependence suggests an additional set of research issues.

Studying farmer-managed systems that do not function -- the "autopsy approach." Some critics of the existing research on farmer-managed systems have noted that most studies have focused on systems that are functioning well. The result is that farmer-managed systems are all depicted as operating smoothly, while it is clear to many observers that there are numerous examples of local systems, that have fallen into disrepair and disuse. No doubt there has been a tendency for researchers to search for sites where things are operating well because in these systems there is an opportunity to see the various social processes of irrigation occurring and to obtain details on rules and roles that are functional. Research sites with these characteristics were required precisely because the research was concerned with understanding how farmer-managed systems operated and why. Thus, non- or poorly functioning systems represented unsatisfactory sites for the research purposes at hand.

Now, however, in attempting to understand public intervention strategies and outcomes, and in the light of the considerable body of available information regarding the processes occurring in functioning systems, the importance of studying farmer-managed systems that are not operating well increases.

For one thing, such systems will often be the target of public intervention. Farmers in such systems may be the ones agitating for public assistance. And the State's perception of the problems of these "poor" systems will be the basis of policy formulation and program planning. Consequently, there is a definite need for research that examines the factors related to the unsatisfactory operation of these systems. Why have systems fallen into disuse? Why are systems that once operated effectively no longer able to do so?

One might call this the "autopsy approach." We presume that a satisfactory study of these nonfunctional systems will require an interdisciplinary approach because the causes of system decline may lie in any of several different domains: changes in hydrologic conditions, changes in prices or public policies, changes in land ownership, unmanageable social conflicts, and so on. Sorting superficial from deep causes would be important. Likewise, trying to determine which causes, if any, could be ameliorated through public intervention should be given priority.

Work on nonfunctioning systems and the identification of factors related to system decline, combined with existing research on the social processes occurring in performing systems, should yield better insights regarding the most appropriate forms for public intervention in particular regions and areas. For example, some public intervention programs

are working on the premise that problems lie below the point of diversion within the command area of the farmer-managed systems, and thus their interventions are targeted at hardware and software intended to improve the management of water at that level. Other public agencies are minimizing their involvement at that level of the system and focusing their attention on improving regulation of the hydraulic flow above the point of water diversion or capture by the various farmer-managed systems. Choices between these approaches, and others to be identified, should be derived from a broader database that is built on studies of both "good" and "bad" farmer-managed systems.

Hazard research and understanding public interventions. Recent writing in ecological anthropology suggests that researchers concerned with the interplay between habitat and social organization begin by identifying the hazards that individuals face in their environments. They then proceed to examine the various responses, individual and collective, that people develop for dealing with these hazards (see Vayda and McCay 1975). Lees (1980) has extended this line of thought to the analysis of development projects. She argues that examination of development projects should include attention to the following questions:

> a) What are the hazards that exist in the pre-project situation and how are local people organized to respond to these hazards?
>
> b) What new hazards may be embedded in the project's solutions for resolving the pre-project hazards -- including the likely attrition of pre-project hazard response patterns and institutions developed locally?

This general approach could be useful in examining public intervention to assist farmer-managed irrigation systems. The analysis would begin with attention to the risks and hazards that are involved in the operation and use of the pre-project irrigation system. Answers would be sought to the broad question of who in the pre-project system responds in what ways to what hazards. The next logical question would deal with the actions taken by the State: Whose ability to respond to which hazard and by which means has been improved or reduced? Finally, the analysis would pursue the question: Will the State's actions create any new hazards and, if so, who is expected to respond in what way to these?

Examining cases of State intervention in farmer-managed systems within this inquiry frame could serve to highlight several important matters. First, it facilitates identification of the sociotechnical processes by which irrigators, individually and/or collectively, respond to threats and perturbations in their environment, in the hydraulic works, and in the derived water supplies. Second, it helps clarify the degree of conformity in perceptions of system problems as held by the irrigators, on the one hand, and the State's agents, on the other. Third, it highlights the State's actions and tests them in terms of their likelihood to constitute a novel hazard for the local group or to attenuate existing response patterns. And finally, assuming that the State's actions may introduce some new hazard(s), it allows the analyst to identify the presence or absence of expected response capability on the part of the users. Solid research and analysis and the development of improved policies and guidelines can be expected to follow from the application of this perspective.

What are Appropriate Planning, Design, and Operational Criteria?

The identification of appropriate criteria on which to base changes in farmer-managed systems is relatively difficult. This is partly due to conflicting views of the current performance of these systems and to differing perspectives regarding system objectives. This suggests the following research issues for consideration:

Improving the conceptualization and measurement of system performance. Most irrigation improvement activities are explicitly intended to increase the performance of some existing irrigation system -- yet system performance remains one of our most elusive concepts. Only two of the numerous studies of farmer-managed systems are explicit about the meaning of good system performance or incorporate empirical measures of system performance. The first is Oh's (1978) study of small tank systems in Korea in which he attempts to evaluate the "customary rules of reservoir management" being used in a sample of 64 systems from which data was collected. There are more than 15,000 small reservoirs (command area of less than 50 ha each) in Korea, operated by farmer groups coordinated by local government authorities. One important aspect of the study is Oh's explicit conceptualization of system performance. He notes, for example, that:

> The practical goal of management policy should be to provide the minimum security guarantees (of water rights) to induce cooperation of all irrigators in system maintenance and water resource conservation (ibid.: 105).

In some ways, this represents a rather straightforward conceptualization of good management: A well-managed system is one that delivers water with a degree of certainty that motivates the users to cooperate in maintaining the system and allocating water effectively. These concepts would undoubtedly be difficult to operationalize in a field setting. While Oh's research methodology is overly dependent on a questionnaire approach, his work is to be commended for the unambiguous concern with understanding management performance and the role of institutional arragements, especially the hypothesized effect of secure water rights, in contributing to good performance.

A second study that gives direct attention to conceptualizing and measuring performance is Vermillion's (1986) study of two farmer-managed systems in nothern Sulawesi, Indonesia. He tackles the difficult issue of assessing the impact of various forms of informal behavior among the irrigators (water borrowing, negotiating special deliveries of water, etc.) on the actual "efficiency and equity of water allocation" (1986:254). To achieve this goal, Vermillion required measures of water supplies across space and time. This he did by collecting field measures of concepts such as relative water supply, field water depth, and relative water adequacy. With these measures of system performance in hand, he was able to reach conclusions such as the following:

> So the observed prevalence of interpersonal water allocating in these systems had not meant disorder or a basic misallocation of water by any apparent criterion. On the contrary, such practices generally are adaptations which roughly serve to counteract the effects of the physical inequalities among irrigated plots (ibid).

If we are to make progress in analyzing the impact of public intervention on the performance of farmer-managed irrigation systems, we need to have clear procedures for assessing performance -- ideally, before and after the intervention. This area of research overlaps with research on government-managed systems in which performance is also a key concept without conceptual precision or associated operational measures.

The growing importance of water rights. Completed research has demonstrated the importance of secure water rights for the successful operation and continuity of farmer-managed irrigation systems (Martin 1986, Cruz 1986). This research is consistent with theoretical ideas from economics and sociology on the role of property rights in creating incentives for individual and group actions (Hollowell 1982, Macpherson 1978). In the past, given the low intensity of irrigated agriculture in many of the regions where farmer-managed systems are located, such systems have been able to guarantee rights to their members. Now as competition from other users increases, including competition from the irrigation department, more and more farmer-managed systems are faced with insecure conditions for their water rights (Korten 1985). The continued development of irrigated agriculture in a region, particularly when the State is one of the development agents, can have the effect of eroding or eradicating the legitimate rights of existing water users. It appears that one effect of public intervention in farmer-managed systems is to disrupt the security of water rights held by traditional users (Pradhan 1984). In effect, the State often trades "improvements" for control, but usually not guarantees, of water rights. This increase in uncertainty can have negative impacts on the legitimacy of the irrigation organization involved in operating a farmer-managed system. An ambiguous situation of water rights also can lead to undesirable policies and actions by the agency because there is no clear limit to acceptable action on their part.

What Korten (ibid.) has noted for Southeast Asia may apply more widely. Few countries now have an "operational program" for allocating and enforcing water rights to groups and individuals in society. However, it may be that this is one of the more important functions that the State can perform in support of irrigation development. Clearly, it is a State function and not one that can be performed by the local groups themselves. Second, without secure water rights, the incentives for existing farmer-managed systems to continue, or for new ones to form, will be reduced.

Cognitive studies of farmer-managed systems. Earlier, we noted the common tendency in public intervention programs to impose a logic of water efficiency on farmer-managed systems -- a logic that many analysts either carry with them from particular settings in which water is scarce or which they carry as part of their socialization in a professional discipline (especially the disciplines of engineering and economics). But not all farmer-managed systems operate either in a setting of water scarcity or in settings in which water efficiency is given primary utility. In a recent survey of literature on local irrigation systems, we concluded that a fundamental principle of the systems studied was equity, operationalized through a fair allocation and distribution of water (Levine and Coward 1986).

The argument here is not that a logic of equity characterizes all farmer-managed systems, but rather that there is a need to study systems to determine empirically the

underlying logic and fundamental values on which operational choices and decision are based. That is, there is a need to study these systems to determine the ideas that are used to give meaning and order to them. This "cultural analysis approach" to irrigation is illustrated in the work in Morocco of Geertz et al. (1979). Vermillion (1986) in his fieldwork in northern Sulawesi has also applied this approach in attempting to ascertain local concepts and meaning of crucial behavior, such as "water borrowing." A number of researchers in the Andean region have focused on ritual activities in farmer-managed irrigation systems as a means to understanding the structural principles and underlying values that energize these systems (Isbell 1978, Sherbondy 1986).

A fuller understanding of this cultural dimension of farmer-managed systems is needed for very practical reasons. First, these cultural ideas are often central to the everyday behavior we observe in system operation (water sharing, mobilizing labor for needed repairs, etc.), and give meaning to these activities beyond the material consequences. Second, they are the least visible elements of the local scene, and therefore the least likely to be understood and considered in planning and executing a program of public intervention. And finally, they are likely to be in strong contrast with the implicit cultural ideas of the technocratic irrigation department. For this reason, our understanding of the outcome of public interventions of farmer-managed systems may be enhanced if we operate from a sound cultural analysis of the farmer-managed systems (as well as of the implementing agencies) and anticipate project outcomes that reflect local cultural accommodations.

What are the Effects and Implications of Extended Involvement of Government in Farmer-Managed Irrigation Systems?

Providing answers to this broad question depends on our broadening the scope of inquiry regarding effects and implications. In particular, we suggest the following issue: Analyzing long-term public intervention in farmer-managed systems.

As noted previously, State intervention in farmer-managed irrigation systems is not a new phenomenon. In areas such as Bali (Indonesia), Ilocos Norte (Philippines), and Chiang Mai (Thailand), public programs that intervened in farmer-managed systems began early in the 20th century. However, to our knowledge, there have been no studies that examined the impact of this long-term government involvement. Such work would be compromised by the lack of pre-project data. Most studies of public intervention have focused only on very recent State activities. For example current research on public interventions in the Balinese subaks is primarily concerned with contemporary interventions, although there were significant State involvements in some subaks during the earlier Dutch colonial period (Sutawan et al. 1983).

Looking only at current State actions and only very soon after they have been completed, may distort our understanding of the processes and outcomes of public intervention. Following any public intervention, there is perhaps a period of disorganization during which learning about and adjustment to the new hardware or software will occur. If this is the case, and if most of our studies are conducted during that transition period, the result could be an overly pessimistic assessment of the impact of public intervention on these

systems. To avoid this possible bias in research findings, several research designs could be utilized:

1. research sites in which a longer time has elapsed between the period of intervention and the period of study should be included in the analysis; or

2. a longitudinal research design could be employed that would follow particular sites in which intervention has occurred for a longer post-intervention period to ensure that observations were being made beyond the initial period of confusion and disorganization; or

3. research sites in which initial public intervention occurred much earlier -- several decades or more -- could be investigated to understand long-term effects better.

Any or all of these alternatives would complement our present work and add depth to our understanding of public intervention processes and outcomes. Such studies may be more difficult to fund because they are not as directly related to immediate agency problems and concerns. However, it may be that some ingenious research project designs could incorporate a few such sites along with the more conventional sites, thus providing useful comparisons while allowing the researchers to provide immediate feedback to the sponsoring agency.

Conclusion

This agenda for future research on public intervention in farmer-managed irrigation systems is intended to be suggestive rather than definitive and illustrative rather than comprehensive. However, we think it identifies major breaches in present understanding and gaps critical to the formulation of improved public policies. Nevertheless, contributions to its refinement or perhaps to its complete reformulation are welcome.

NOTES

[1]*Editor's Note:* the authors' use of "State" and "government" has been retained.

[2]All the examples in this section deal with studies of contemporary as compared to ancient irrigation situations. However, it should be noted that there is a considerable body of archeological literature concerned with irrigation and sometimes specifically with the interaction between State and locality in irrigation matters.

[3]Three other remarkably detailed ethnographies are Gray (1963), Eldblom (1968), and Hart (1976).

[4]*Editor's note:* A group of languages spoken in southeast Asia, including Thai, Lao, and Shan.

[5]An interesting example of this point arises in the context of the Muang-Fai systems of northern Thailand. Many of these systems use a technique of constructing twin weirs at the point of water diversion from the stream. While several social scientists have noted such structures, there has not, as yet, been a careful study of their purpose and function from an engineering point of view.

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CURRENT RESEARCH

AVERTING THE BUREAUCRATIZATION OF A COMMUNITY-MANAGED RESOURCE: THE CASE OF THE ZANJERAS

Robert Y. Siy, Jr.*

INTRODUCTION

Many large-scale technically sophisticated government-managed irrigation systems throughout the world irrigate much less area than they were designed to serve, experience rapid rates of deterioration, and leave water users frustrated and dissatisfied with unreliable, unpredictable deliveries of water.[1] Yet there are also many reports of relatively high performing irrigation systems constructed, operated, and maintained by long established indigenous water users organizations.[2]

It is unfortunate that irrigation engineers have for many years dismissed such indigenous systems as primitive and inefficient, and have seldom sought to learn the lessons of their experience.[3] Few irrigation bureaucracies even include the areas served by such systems in their reports of area under irrigation. The tendency to ignore these systems becomes particularly disturbing when, as is common throughout the humid tropics, so-called modern systems are built in areas where community-operated irrigation systems already exist.[4] The problem is illustrated in the following discussion.

The province of Ilocos Norte in the northern Philippines is well-known internationally as the domain of the *zanjeras*, farmer-irrigator organizations that have been unusually effective at managing water resources.[5] Some are as large as 1,000 hectares (ha), many are centuries old, and all are recognized for their highly appropriate and systematic rules and procedures for water allocation and system maintenance.

These zanjeras managed their irrigation systems through heavy monsoons and scorching summers with only minimal external assistance or intervention -- until 1978. In that year, a 22,600 ha irrigation project was proposed for funding by the Overseas Economic Cooperation Fund (OECF) and the Japanese International Cooperation Agency (JICA), Japan's two institutions responsible for overseas aid. A "modern" irrigation system, designed by a joint Japanese-Filipino consulting team, was to cover the entire project area, an area already served by over 200 zanjeras, each with its own social organization and canal facilities. The proposed design would have almost completely obliterated the existing indigenous irrigation systems. The following discussion relates how a potential tragedy was averted by a combination of active, persuasive farmer resistance, and the wisdom of an enlightened and sympathetic agency administrator. What followed in the wake of the near tragedy was the establishment of a precedent-setting experiment of farmer-agency collaboration in the design and implementation of a large-scale irrigation project.

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*Management Specialist, Asian Institute of Management, Makati, Philippines.

THE ZANJERA IRRIGATION SYSTEMS

As of 1978, the landscape of the province of Ilocos Norte was dotted with hundreds of community-built and managed irrigation systems, many of which were constructed over 200 years ago. The groups which operated and maintained these systems were known to the local people as zanjeras, a term taken from the Spanish word *zanja*, meaning canal. In recent years, documents have been found in the possession of a few zanjeras which prove their existence as far back as the 18th century.

A number of these documents describe how some of these irrigation societies were formed. In areas where unirrigated arable land was held as private property, groups of skilled and resourceful individuals seeking land for cultivation offered to construct irrigation systems in exchange for the right to farm portions of the newly irrigated area. This novel arrangement permitted landowners to increase the productivity of their farms, while permitting even landless individuals to gain access to land. Other farmers in the province, encouraged by the experiences of these enterprising individuals, formed zanjeras to irrigate the lands they were already cultivating. By the end of the 19th century, hundreds of zanjeras were already in operation in the province and their brush dams and earthen canals were a common sight along the waterways of Ilocos Norte.[6]

Operated without government assistance, they relied on the mobilization of local labor for operation and maintenance. It was common for individual members to contribute an average of 20-30 days of labor per year. In a number of zanjeras, individual members contributed as many as 80 days of labor annually.

The activities involved in the upkeep of the facilities included construction and repair of temporary diversion dams destroyed by the annual typhoons, reinforcing canals, and cleaning out vegetation and silt accumulations. Communal labor was also required for activities such as water distribution. Over the years, systems were expanded and technical improvements were gradually introduced. Members' contributions of labor and materials were called for according to need (e.g., a particularly bad typhoon might create the need for extensive repairs) and thus contributions varied from year to year.

The success of the zanjeras in mobilizing local labor for irrigation system management was greatly facilitated by: 1) a pattern of land distribution which helped to mitigate conflicts, and 2) assessment of labor contributions in proportion to the area of land a member cultivated.

Within each zanjera, individual landholdings usually consisted of several nearly equal size parcels -- one parcel in each of the sections of the service area (i.e., at the head, middle, and tail of the canal system). This situation helped to avoid the usual "upstream-downstream" or "head-tail" distinctions among farmers and eliminated one of the most common sources of conflict among irrigation users. The fact that members farmed parcels at the head as well as in the tail end of the system served as a strong incentive for cooperating to maintain the system at maximum efficiency in order to adequately irrigate the entire area, greatly facilitating the tasks of water allocation and system maintenance.

The other factor that seemed to explain the longevity and cohesiveness of the zanjeras was their method of regulating contributions of members. In each zanjera, members were assigned "shares," called *atar*, in the organization. These represented the member's share in the water produced and delivered by the irrigation system, and were directly proportional to the area of land that he cultivated within the area irrigated. The ratio of an atar to land area was constant over time and unique to each zanjera. For instance, in one zanjera a member was assigned one atar for every one-fourth of a hectare he farmed; in another organization, members were assigned one atar for every three-fifths of a hectare.

The atar also defined each member's obligation to contribute labor and materials to operate and maintain the irrigation system. The basic rule was that each member was obligated to provide one man-day of labor during each work session for every atar assigned to him.

Over the years, these shares were passed on to the heirs of founding members; they were also transferred whenever zanjera land was sold, leased, or tenanted. Through this process, the landholdings of founding members were subdivided. Atars were fractionalized accordingly whenever the lands of founding members were transferred to new members. Thus, if a person now farmed one-half of the lands of the founding member, he would be assigned one-half atar and would have to fulfill one-half of the labor obligations of that atar.

Because work obligations continued to be assigned in proportion to the area farmed by each member, the ratio of individual benefits to labor contributions remained roughly equal for all members of a given organization, despite changes in the distribution of landholdings. This equitable sharing of benefits and costs, deeply imbedded in the norms of the local culture, contributed to a more open and unconstrained atmosphere of cooperation.

These features of the zanjera help to explain why they were able to survive for generations, successfully resolving conflicts and mobilizing local labor and materials as required.

THE PROPOSED IRRIGATION DEVELOPMENT PROJECT

In 1978, a Japanese engineering survey team contracted by the OECF and the JICA submitted a report to the Government of the Philippines recommending for the Province of Ilocos Norte, a two-phase integrated agricultural development project which would include the construction of irrigation facilities, a dam, and two hydro-electric power plants.

The Plan

The report presented a convincing case for the project. First, the province had not till then received major development project funding. Second, the proposed power generating facilities would permit the province to become self-sufficient in electrical energy. Third, the project was estimated to benefit roughly 17,500 farm families in the 22,600 ha project area through improved irrigation.

Although the survey team recognized the existence of many community-managed irrigation systems within the project area, their report noted a lack of modern facilities for water regulation; water losses resulting from seepage through the earthen canals; and the use of temporary dams made of wood, stone, and sand which had to be rebuilt after the yearly storms and floods. According to the survey team:

> No systematic water distribution facilities are provided to convey water to the terminal areas, and the so-called continuous flowing irrigation has been practiced for both the wet and dry season cultivations.... Under the circumstances, water resources development as well as the provision of systematized irrigation facilities inclusive of the on-farm facilities are the prerequisites to achieving double cropping of high yielding rice and upland crops.

The economic potential of the area, it was argued, could only be realized through the modernization of the area's agriculture. This, in turn, would mean introducing an irrigation system which would permit a more efficient and equitable distribution of water, dams which could withstand the regular typhoons and monsoon rains, and an organizational structure which would ensure coordination and cooperation among water users.

The first phase of the project was to involve an area covering 10,200 ha, and was expected to cost US$65.5 million. The engineering studies reported that this initial development site contained 136 indigenous water users' organizations (the actual number was later determined to be 186) ranging in size from 2-1,000 ha in service area, and irrigating a total of 8,041 ha. Although the consultants' report acknowledged that a large part of the project area was already under irrigation by local water users groups, it contained minimal description of these organizations. There was no mention of the skills, organizational resources, or management practices of the groups which were already bringing irrigation to roughly 80 percent of the Phase I project area. Their irrigation systems were merely regarded as being below acceptable engineering standards. This conclusion, however, was reached without conducting formal hydrological and engineering studies to determine the actual water use efficiencies of the zanjera systems.

Although the survey team made several visits to the project site and spent a total of 31.3 person-months in the area, most of their work had centered on technical aspects of the project design. Among the members of the survey team, there was only one social scientist -- an agricultural economist -- who spent two months at the project site collecting statistics on land use and crop yields in order to generate the project's cost-benefit calculations.

The plan called for the construction of five dams, 159 kilometers (km) of irrigation canals, 200 km of drainage canals, and nearly a 1,000 km of main and supplementary farm ditches. The five concrete dams would be built on the upstream sections of each of the five major rivers serving the area. From the dams, the water in each river would be diverted into the new canal system. Water would flow from each dam into a main canal from which it would be conveyed to secondary canals, flowing from these into main farm ditches each serving a 30 ha area called a "Compact Farm."

The project planners envisioned that the farmers in each Compact Farm would be organized into a Farmer Irrigators Group (FIG). The FIGs in each 500 ha area would then compose a Farmer Irrigators Association (FIA). A water management technologist, provided by the irrigation authority, would be assigned to each FIA to assist them in system operation and maintenance activities. The FIAs in each 2,500 ha area would be formed into a Farmer Irrigators Federation. The federations in the 10,200 ha (Phase I) area would then form the Farmer Irrigators Union.

The project plan entrusted the National Irrigation Administration (NIA) with the responsibility for controlling and allocating water within the new system. Farmers were to pay for the services of the irrigation authority with a standard irrigation fee equivalent to 250 kilograms (kg) of paddy rice per hctare per year.

During construction, a total of 675 ha of farmland in the Phase I area would need to be expropriated by the government for the construction of new canals and access roads.

Project Implementation

By November 1980, Phase I of the project had been approved for funding by the OECF and the JICA. Detailed plans and engineering designs had been completed by a team of Japanese and Filipino consultants, and a large contracting firm, a Filipino-Japanese joint venture, had already mobilized to begin construction on the first 1,000 ha of Phase I which was called the "Pilot Area."

This area was intended to serve as a demonstration site -- to prove to farmers in the rest of the project area the benefits of a systematically designed irrigation system, and to convince them to cooperate with the NIA. Unlike the rest of the project, which was to be financed by a low interest loan from the Japanese Government, the Pilot Area construction was considered to be a "gift" from the Japanese Government. The provision of a direct grant of US$4.3 million permitted the NIA to initiate Pilot Area construction activities ahead of the implementation schedule for the rest of Phase I.

The construction of facilities for the Pilot Area was to be completed by March 1982, including: 1) a temporary diversion dam 48 meters long and 0.8 meters wide; 2) a main canal of 9,170 meters with related structures; 3) 4,885 meters of lateral canals and structures; 4) 13,762 meters of drainage canals; and 5) 46,000 meters of farm ditches, farm roads, and drains.

Construction on the remaining Phase I area, which covered 9,200 ha, was to begin in the third quarter of 1981. The completion of Phase I construction was programmed for the end of 1984.

By December 1980, an agency project management team had assembled 276 people at the site, all eager to get the project off to a good start. Nearly all senior management positions were staffed by civil and agricultural engineers.

It did not take the team long to realize that serious difficulties were in store. The first indication of trouble came when farmers refused project staff and engineers permission to conduct surveys on their lands. In a few districts, trees were felled by farmers to block the vehicles of project staff. Project employees were viewed with suspicion and treated with hostility.

The strongest reactions came from the members of zanjeras located along the upstream sections of the rivers. One of the largest federations, composed of over a dozen upstream zanjeras, not only banned project staff from entering their irrigation service areas, but also sent a delegation of their representatives to Manila to meet with agency administrator, Dr. Florello Estuar, to demand their exclusion from the project. Various explanations were offered for their resistance. Members of zanjeras with good access to water contended that the project would not provide them with additional benefits, yet it would give the NIA authority to collect irrigation fees, thus reducing their incomes.

More surprising to the engineers was opposition from members of zanjeras which would gain by improved access to irrigation. They feared that the project, with its wide canals and access roads, would reduce their already small landholdings. In certain areas, the paths of the main canals would completely consume the farmlands of a number of farmers. Many of these farmers were share tenants and therefore the compensation for expropriated land would be given to their landlords, leaving them without any means of subsistence. In many other cases, parcels would be cut in two by the lines of the new canals making these farms more difficult to operate.

Perhaps the most compelling reason for the resistance of the local community was that the project would install a completely new and different irrigation system. It would level and erase the community-built systems and destroy along with them the local institutions and organizational structures that had been in existence for generations and which would be essential to the effective management of the proposed irrigation system.

Alarmed by the local dissent among the farmers and by the message delivered by the zanjera leaders to his own doorstep, Dr Estuar made a series of visits to the project site. In addition, he endorsed visits by a number of concerned social scientists to the area. His own observations confirmed those of the social scientists that implementing the project as designed would result in the eradication of the indigenous water users organizations, would create much dissatisfaction and resentment among farmers, and would seriously jeopardize prospects for successful operation of the new system.

In August 1981, the Japanese design consultants submitted to the administrator several bound volumes of their final design for the entire Phase I area. These three volumes provided detailed engineering drawings, construction time-tables, descriptions of specific activities and tasks, financial data, and other specifications to guide project implementation over the next seven years. The Governments of both Japan and the Philippines were anxiously awaiting the approval of the plan. Approval would initiate the inflow

of needed foreign exchange to the Government of the Philippines, and delay in project implementation would mean cost increases.

A NEW PLAN

In October 1981, after consultation with key NIA staff, Dr. Estuar took the difficult decision of setting aside the project design. When asked to explain his decision, he remarked that he "refused to go down in history as the NIA Administrator during whose term the zanjeras were eradicated." Along with this bold step, Dr. Estuar laid down guidelines for the preparation of the new design.

1. The integrity and identity of each zanjera in the project area should be preserved.

2. The existing canal lines should be utilized to the extent possible and farmers should be consulted regarding additional canal lines.

3. The farmers should be fully and actively involved in planning and implementing the project.

4. The likely operation and maintenance schemes should be disseminated to the farmers as early as possible to insure that they fully understand their roles and responsibilities in managing the system.

5. The project should be conceived as one involving the rehabilitation of many small community-managed irrigation systems rather than as the construction of a new large-scale irrigation project.

Many of the engineers and designers at the project site had extensive experience in building large-scale irrigation systems, but never had they been required to follow such guidelines. In other large projects, farmer participation had been limited to the hiring of a few skilled laborers from the community and to meetings where the agency personnel informed the farmers about the projects. The reasons for limiting farmer involvement in decision making were well understood; design and construction work had to be accomplished according to a tight schedule and there was little time to discuss issues with the farmers. Besides, what did farmers really know about the design and construction of large irrigation systems?

But it was also understood that a project of this magnitude would be seriously impeded by open and hostile farmer opposition. The farmers could easily make work difficult for the project staff, even destroying structures which would not serve their interests. Moreover, the operation of the proposed system would need to be financially sustained by collection of irrigation fees. Dissatisfied water users were not likely to pay those fees.

The rationale for a new approach and a new design was evident, but how it would be accomplished was not apparent to those implementing the project. Particularly difficult to

conceive was how participation in the project design could be realistically obtained from over 115,000 farmers belonging to nearly 200 indigenous water users' organizations of diverse sizes, circumstances, and characteristics.

The NIA, by this time, had some experience in implementing small-scale community-managed irrigation projects with an approach that directly involved farmers in planning and construction activities.[7] However, the application of similar approaches in larger, agency-managed irrigation system projects was something very new to the irrigation authority. Clearly, an approach specific to this project would need to be developed and the design itself would have to evolve over time.

The Pilot Area

By the time the decision had been made to reject the original project design, construction work as originally planned was already well underway in the 1,000 ha Pilot Area of Phase I -- with new canals, standardized rotation areas, and completely different organizational requirements. New farmer organizations with newly elected leaders were formed by NIA institutional personnel to correspond to the new canal network with the new groups commonly consisting of farmers from several former zanjera organizations. Although by October 1981 the implications of these changes had become clear to the NIA management and staff, the Pilot Area implementation was already too far along to allow for any changes.

The results were tragic. Although Pilot Area construction was scheduled for completion by March 1982, as late as June 1982, when the main season cultivation activities should have been started, major irrigation structures were still inoperative. Over a dozen turnout facilities were defective and the main canal suffered leaks in several places. Furthermore, the construction activities in the Pilot Area had disrupted planting schedules, and the right-of-way requirements of the design had forced many farmers to give up parts of their farms in order to accommodate the new canals, laterals, and access roads. Most of the new canals actually crossed over the existing zanjera canals and prevented the farmers from operating their systems during the construction period.

Facing the start of the main 1982 cropping season with inoperable irrigation facilities, the farmers took it on themselves to bring irrigation water to their fields by reviving their original zanjera systems. They rebuilt their brush dams and restored their old canals. In several sectors of the Pilot Area, farmers resorted to destroying the new farm ditches so that their old canals could bring the water to their fields. They also found ways of rerouting their canals to bypass the newly built structures. Irrigation water was soon flowing again through the "traditional" zanjera systems, while the main canal of the new system was almost totally dry.

The institutional situation was also problematic. The radical change in organizational affiliation and leadership structures generated much confusion and conflict within the community. Friction erupted between traditional zanjera leaders and the new officers of the rotational units. The situation became even more strained when the engineering defects in the new structures forced the farmers to reactivate their zanjera systems.

For a time, two different systems for delivering water co-existed within the same area, each with its own organization and leaders.

This experience was clearly a frustrating and demoralizing one for the project staff. However, the Pilot Area experience permitted the NIA managers to view first hand the serious weaknesses of the original design and its damaging consequences for the affected farmers. It also provided a constant reminder of what should not be permitted to happen in the implementation of the rest of the project, serving to convince many of the cynics at NIA of the importance of farmer participation in each of the stages of project planning and implementation. For these reasons, the Pilot Area was a valuable component of the project -- though the purpose it served was quite different from that which had been intended, and was not fully appreciated by the farmers who were its intended beneficiaries.

A PARTICIPATORY PLANNING PROCESS

The new participatory planning approach introduced outside the Pilot Area was intended to avoid just these problems. Here the project staff began by holding meetings with each of the water user organizations. These were meetings where, first, they assured the zanjera members that the identity of each zanjera would be respected and that the new design would, to the extent possible, make use of existing canals. Second, they used the meetings as opportunities for dialogue -- where the engineers tried to win trust and support rather than convey information. Following these zanjera-level meetings, the project staff organized conferences among the leaders of all the zanjeras in the area. These conferences permitted the exchange of views between different local leaders and sharing of experiences in managing local organizations. One of the most ambitious events was a field trip hosted by the project managers for 50 zanjera leaders to another large-scale irrigation project in the neighboring province. There, the zanjera leaders interacted as equals with the agency staff, and closer personal relationships were established between farmers and engineers. Never before in a project of this scale had NIA officials gone to such lengths to develop rapport with farmers.

As the two sides grew more familiar with each other, the farmers become aware of the benefits that the external assistance could bring. They came to respect the advice of the engineers and recognized their sincerity. The engineers, likewise, came to appreciate the traditions and values of the farmers, and the leadership and organizational resources that the farmers had sustained over many years. They then realized and understood the serious threat that the original project design had posed for the farmers.

In the months that followed, new plans and designs were formulated, this time in close consultation with the farmers. Canal lines were laid out, revised, and finally approved by the zanjera members. In most cases, the canal lines followed the existing zanjera canals. In others, the farmers opted for alterations in the old zanjera lay-out, approving designs that would be more efficient or durable than what were currently in place. The granting of rights-of-way was greatly facilitated by the consultations on canal locations. And since most of the project canals would follow existing zanjera canals, the need to negotiate for

additional land was minimized. In the new design, as finally approved, over 80 percent of the canal lay-out followed existing zanjera canals, in contrast to 20 percent in the original plan, and permitted each zanjera to retain its identity.

Under the new design, upstream dams would divert water from a river and channel it to specific zanjeras. Beyond the point of delivery, the zanjera was to have full control of the operation of its own distribution system, being free to adopt its own procedures for water allocation and system maintenance in accord with its time-tested rules and policies.

While the concept was acceptable to the zanjeras and was consistent with existing practices, there remained other critical issues to be resolved. For example: How would water be allocated to different zanjeras? Who or what body would make the water distribution decisions or policies at the main system level? Should the irrigation agency step in or would it be left to the zanjeras to come to an acceptable agreement?

In the past, the zanjeras operated almost independently of one another, with each zanjera simply maintaining its own temporary dam along the river. Commonly, the upstream zanjeras enjoyed more plentiful supplies while down-stream zanjeras often suffered water shortages in the dry season except in selected cases where water sharing agreements existed between neighboring zanjeras specifying how available water supplies would be allocated among them.

Management of the Main System

By establishing physical "links" between different zanjeras, the new system created the need for closer coordination on matters of water allocation among zanjeras and the distribution of responsibilities for the maintenance of common facilities. Even with the construction of the new dams and canals, the engineers estimated that available dry season water supplies would be inadequate to irrigate the entire project area. Within each zanjera, there were strong organizational capacities and skills. The question was how to build on those in order to develop cohesion and cooperation at the next level above the individual association.

One option would have been for the NIA to assume responsibility for main system operation and for making the critical water allocation decisions. But this involved hidden costs. An external institution responsible for regulating and allocating water would probably come under attack or criticism during periods of scarcity. And it is difficult for the agency to keep people on the spot 24 hours a day to enforce the allocations. There were also expenses involved in deploying system management staff at the project site after project completion. The agency therefore opted to examine alternatives which would encourage the farmers to assume a larger responsibility.

IMPLICATIONS

This case points to several features of conventional irrigation project planning and

implementation which can be very costly. The first is the assumption that the design of the physical structures is the most important determinant of an irrigation system's effectiveness and performance, and that the choice of structures and their location should be based primarily on the analysis of hydrology, topography, and crop requirements. A corollary assumption is that the required management and organizational capacities can be developed at later stages of project implementation, and that these can be shaped to suit the demands of the optimal engineering design.

These features of conventional irrigation project planning lead naturally to: 1) a failure to adequately understand prevailing social and institutional conditions in the project area; and 2) poor flow of communication between the government agency and local community, especially during the stages where the most crucial decisions are being made. Consequently opportunities are lost for securing farmer assistance in generating both social and technical information on the project area, and for strengthening local organizational capacities by involving the farmers in the decision making process. The poor flow of communication likewise invites the risk of future resistance and opposition from the local community. More important, there is the danger that alterations, or so-called improvements in existing physical facilities may undermine existing and sometimes quite effective, local organizational arrangements, while imposing demands for new arrangements alien to the experience of the local people.

The case presented here is not intended to focus criticism or blame on one country, agency, or set of advisors. Rather, its purpose is to reveal serious inadequacies in conventional approaches to planning and implementing rural development programs. The case at the same time directs attention to alternative planning approaches which appear to hold promise of more positive results. These alternatives are founded on the premise that existing community organizations -- as exemplified by the zanjeras -- are a stategic resource in rural development and have much to contribute to the extent that their identity and essential autonomy are maintained.

A tragedy was averted in this case as a result of the willingness of the key actors -- the agency officials, the team of consultants, and the donor agency -- to abandon an unrealistic and undesirable plan in favor of a fresh start based on a more appropriate approach. Considerable personal courage and conviction were necessary in order to redirect efforts and to reorient established agency procedures and policies. There are many other situations in the developing world similar to the one described in this case. The opportunities for corrective action and change in those situations are likewise present. The relevant question is not whether existing procedures and project covenants in other projects are more rigid or more flexible, but whether the key actors in those situations possess sufficient courage and conviction to take the less expedient, but more productive path.

Yet even with decisive action by NIA management in redesigning the project, as of March 1986, with Phase I construction as yet incomplete, the project engineers were concerned that the project might not produce sufficient improvements in area irrigated to show an economic return on investment. At that point they expected some expansion in the area irrigated during the primary cropping season, but an expansion of the area able

to support second cropping was not anticipated. Hope was expressed that improvements in agricultural technology planned for introduction following the construction phase, though unrelated to water management, might increase production sufficiently to allow the project to show some improvements in economic performance. Thus, in the final analysis, a less ambitious project tailored from the beginning to actual needs and existing capacities would likely have been considerably more cost-effective.

NOTES

[1]See Takase and Wickham (1976) and IRRI (1980).

[2]See Coward, Jr. (1980).

[3]This situation was one of the major concerns discussed in Coward et al. (1983).

[4]Ibid.

[5]Studies of the culture, organization, and practices of the zanjeras include: Lewis (1971), Coward (1979), and Siy (1982).

[6]See Christie (1914).

[7]See Korten (1982) and Alfonso (1983).

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FARMER-MANAGED IRRIGATION SYSTEMS AND THE IMPACT OF GOVERNMENT ASSISTANCE: A NOTE FROM BALI, INDONESIA

Nyoman Sutawan*

INTRODUCTION

For over nine centuries, wet-rice producers in Bali have been organizing themselves into socio-religious communal irrigation associations known as *subaks*. Throughout this period, subaks have remained autonomous and operated as self-contained water users' organizations. Construction, repairs, and maintenance of irrigation facilities were all carried out by the members of the association as self-help projects. Today, subaks number more than 12,000 and cover about 100,000 hectares (ha) of *sawah* (irrigated rice field).

The government became actively involved in irrigation development only around 1925. Before 1969, government assistance was limited to constructing and rehabilitating headworks and primary canals, leaving the rest of the irrigation networks as before. After 1970, headworks, primary canals, and secondary canals were all built by the government.

Beginning in 1979, the government initiated a development project to upgrade the tertiary irrigation network of subaks which had received main system development assistance. By 1983, about 60 percent of the total sawah area in Bali was already irrigated by government-built dams and the remainder by upgraded tertiary networks (Dinas Pekerjaan Umum Propinsi Bali 1982).

The responsibility of operation and maintenance (O&M) of the main system, which contains the permanent government-built dam, has been taken over by the bureaucracy. The management of tertiary systems, however, remains in the hands of subak members. Thus, an irrigation system in which the dam was government-built is jointly-managed. (i.e., the main system is managed by an irrigation agency and the terminal system is farmer-managed.) At present, about 60 percent of the total sawah area in Bali receives water from jointly-managed irrigation systems. In other words, almost 40 percent of the total sawah area falls under farmer-managed irrigation systems.

There is concern that government intervention in subak affairs, particularly in taking over the responsibility for main system O&M, may have adverse effects on subak organization. This paper first introduces the structures and functions of the subak to provide the necessary background information about irrigation systems in Bali. The paper then discusses the socio-institutional implications of government assistance extended to subaks. Parts of this paper were derived from a current research report by a research team from Udayana University (Sutawan et al. 1984a, and Sutawan et al. 1986), while the rest was based on the author's personal observations and interviews with several subak leaders.

*Department of Socio-economics, Faculty of Agriculture, Udayana University, Denpasar, Bali.

STRUCTURES AND FUNCTIONS OF SUBAKS

Subak Structures

The subak water users' organization is characterized by: 1) a common source of irrigation water; 2) availability of one or more rice field temples (*bedugul*); and 3) autonomy in handling its own affairs -- such as managing its own budget, with its own written or unwritten rules and regulations (*awig-awig*) -- and in making contact with other institutions. Subaks having a weir (*empelan*) as their source of water usually have a common weir temple (*ulun empelan*) near the dam.

A large subak is usually sub-divided into smaller units called *tempeks* (or in some places *banjaran*, *munduk*, *lanyahan*, or *pamunduk*). A tempek has no external autonomy, though in many cases it has internal autonomy as signified by a common bedugul shared by the members of the tempek or its own budget or both, which is managed without intervention by the subak. In some cases, several subaks for coordination purposes unite into a single body called a *subakgede*.

Recently, some traditional weirs have been replaced by a single permanent dam built by the government to become a single unit irrigation system with a larger service area. The government encouraged the former independent subaks to unite themselves into a subakgede. In that case, a new water temple was erected near the new dam and the previous water temple of each subak was abandoned.

Due to the lack of historical data and the varying terminologies used by local farmers, it is difficult to identify without careful investigation whether an irrigation system which has been long in existence is really a subakgede or only a subak. Although it is not yet precisely known in what ways subakgedes were originally formed, and data on the number of subakgedes are not available, the following possibilities (Sutawan et al. 1986) can be considered:

1. The union of several subaks each of which formerly had its own water temple and its own common source of water but which finally agreed to share a new common water source and water temple, signifying a single unit irrigation system from the viewpoint of a physical and social system;

2. the union of several subaks into a single coordinating body, but with each maintaining its own water source and its own water temple without sharing a new water temple; and

3. a single subak which developed into a larger subak due to the expansion of irrigated rice fields and an increasing number of subak members so that the former tempek gained full autonomy in handling its own affairs, and thus, in this sense, each tempek changed into a subak.

Note that each subak does not necessarily have its own water temple as it can share with other subaks within a subakgede. Similarly, each subakgede does not necessarily

have a common water temple shared by member subaks (in case each subak still maintains its own weir). Also, a subak does not necessarily have to be divided into several tempeks.

Lack of historical information makes it hard to ascertain whether the many existing subakgedes with only one dam originated from a single subak or from a union of several subaks each of which had its own weir.

In a few cases, farmers within a subakgede were grouped into a number of coordinating units. The local farmers improperly called such units "subaks." To avoid confusion, such groups shall be called here *pekasehan*. The manner of grouping has nothing to do with water allocation and distribution, but was mainly to improve coordination of ritual performances and system maintenance. The pekasehan was formed by grouping subaks or by grouping farmers based on their domiciles irrespective of the subak to which they belonged.

The administrative personnel or administrator (*prajuru*) of an irrigation association varies from subak to subak. In general, the prajuru comprise the head of a subak (*pekaseh* or *kelihan subak*), a deputy (*wakil pekaseh*), a secretary (*penyarikan*), a treasurer (*juru raksa* or *bendahara*), and several messengers (*juru arah*, *saya*, or *kasinoman*). In a small irrigation association or subak having no subdivision into tempeks, its prajuru usually comprises a subak head and a messenger. The latter changes every 35 days or every crop season. For subaks having tempek subdivisions, the subak head delegates part of his daily duty to the tempek heads (*kelihan tempek*) within their respective jurisdictions. In semi-autonomous tempeks, a tempek head is usually assisted by a deputy, a secretary, a treasurer, and a number of messengers -- similar to the prajuru at the subak level. In many cases, however, the tempek heads all are given the position of prajuru at the subak level which means that, in practice, the former functions as a messenger of the subak for his own tempek. However, since he has a messenger at his own tempek, the task of extending information to the tempek members is performed by the messenger at the tempek level.

The prajuru at the subakgede level also varies. A subakgede is headed by a so-called *pekaseh gede*. Like the subak head, the pekaseh gede also has his own staff comprising a deputy, a secretary, a treasurer, and one or more general assistants who are responsible for extending information and instructions to the subak heads. In some cases, such as observed in Tabanan District, all of the subak heads are assigned as prajuru at subakgede level, in the same way that the tempek heads of a subak are appointed as prajuru at subak level. In other cases, such as found in Karangasem District, the pekaseh gede has no staff because his function is merely to extend information and government instructions to subak heads and to process the subaks' requests for assistance to the government.[1]

The highest authority of the irrigation organization is the *sedahan agung*. He is a government official responsible for collecting land taxes; for approving new subak formation or sawah expansion; for handling water disputes; for supervising and coordinating subaks and subakgedes within a district (*kabupaten*); and supervising water management throughout the kabupaten in consultation with the Department of Public Works, Agri-

culture, and Local Government. The sedahan agung is assisted by a number of government officials (*sedahan*), whose area of jurisdiction is called *kasedahan* or *pasedahan*, and which covers several subaks within a watershed area. It does not necessarily overlap with the *kecamatan* or subdistrict (administrative unit below a kabupaten).[2]

The status of subak members can be distinguished into: 1) the members (*pengayah* or *sekehe yeh*) who are actively involved in the routine activities of the subak; 2) the passive members (*pengoot* or *pengampel*) who do not participate in daily activities of the subak but who must contribute a certain amount either in cash or in-kind; and 3) the members (*leluputan*) who are exempted from daily activities and other subak contributions due to their position in the community, such as the priest (*pemangku*) and the head (*bendesa*) of a village community (*desa adat*). In most of the cases, the size of holdings is used as the criterion to determine whether a member is allowed to be a passive member or not. In a few cases the decision is made according to the supply and demand of the amount of pengoot (Sutawan 1985).

Some subaks in Bangli District distinguish the role and status of their members on whether or not they have *sawah catu*. Those having sawah catu are responsible for maintaining the main system and the tertiary system, in addition to preparing and executing rituals at Bukitjati Temple. The sawah catu owners are called *krama pekaseh*. The members who have non-catu rice fields are responsible only for maintaining the tertiary system. All the members, the catu owners, as well as non-catu owners, are called *krama subak*. Unlike the non-catu owners, the catu owners are not allowed to be passive members. Their tasks are heavier. Catu owners from several subaks, obtaining water from a common weir, but living at the same desa adat, come under a pekasehan, headed by a so-called *kelihan pekasehan*.

Functions of a Subak

A subak as a social system has five main functions: 1) water allocation and distribution, 2) conflict management, 3) operation and maintenance of the irrigation system, 4) religious rituals, and 5) fund raising. A brief description of each follows.

Water allocation and distribution. Within a jointly-managed irrigation system with many subaks, water allocation and distribution among subaks is based on the size of the subak to be irrigated. Allocation and distribution within a farmer-managed irrigation system and also among tempeks (subsubaks), as well as among farmers within a jointly-managed irrigation system is, however, based on the water share received by each member of the subak (*tektek*). If, for instance, farmer "A" has 1.0 tektek and "B" has 2.5 tektek, the water should be distributed through a division structure in such a way that the proportion between the width of water inlet for A and B are in a ratio of 1.0 to 2.5. Whether the debit of water is large or small, the volume of water flowing through the inlet for A would be 1.0 tektek and that for B, 2.5 tektek.

The size of a sawah receiving one tektek of water varies from place to place. For example, in Subak Celuk, Gianyar District, rice fields of about 0.20-0.70 ha were allocated one

tektek (Sutawan et al. 1984). In Subak Kerobokan, Tabanan District, rice fields of about 0.30-0.80 ha received one tektek; below 0.30 ha received only 0.5 tektek; and above 0.80 ha received 2.0 tektek (Sutawan 1985). At present many farmers consider this method unjust, because, in practice, larger rice fields have been taxed higher than smaller ones, whereas the water share has not been exactly proportional to their sizes. In response, for example, the farmers of Subak Umabali in Tabanan District recently changed the water allocation system based on tektek to one based on the size of the rice field being irrigated.

The farmers having two tektek of water share should contribute twice as much labor and other services, whereas those having half a tektek should contribute only half as much.[3]

Water distribution among subaks as well as among tempeks within a subak is generally done by a continuous flow method. An individual farmer who does not need water could close the water inlet by putting mud and rubbish in it.

In some cases, the *nyorog* system of water distribution is employed. This is done by dividing the subakgede or subak, for instance, into two or three groups such as head, middle, and tail. The group receiving water first is called *ngulu*, the second, *maongin*; and the last, *ngasep*. For example, in one case, upstream subaks are ngulu, and the middle subaks get their turn (maongin) after the head finishes land preparation, and finally the tail has its turn (ngasep) after the middle finishes land preparation. In Buleleng District, the sequence is reversed: here the subaks located at the tail are ngulu and get water first, followed by those upstream (ngasep).

In areas where water is scarce, water distribution is done by rotation (*giliran*). In this case, the subak area is also divided into two or three groups. During the rainy season, all groups are allowed to grow rice at the same time (*kertamasa*). After the harvest of the kertamasa crops, the first group must grow rice while the other must grow non-rice crops such as peanuts or beans (*palawija*). For the next crop season, the first group must grow palawija while the other, rice. Water is given to the group whose turn it is to grow rice.

In case the nyorog and giliran systems cannot be adopted at the subak level, water scarcity may be overcome by employing such arrangements at the tempek or even at a special group level called *kanca* or *penasan* (an informal group consisting of 4-10 farmers whose sawah are located close to one another).

To avoid water stealing, the subak receiving water distribution usually appoints a special team of water guards (*petelik* or *pecelang*) to safeguard the water at important and strategic division structures.

Water borrowing among subaks within an irrigation system and among irrigation systems along a river course varies: in some cases it is allowed, in others it is not. A permit issued by the sedahan agung should be secured in case of water borrowing among different irrigation systems along a river course. For water borrowing among subaks within a subakgede or irrigation system and among tempeks within a subak, the decision is made by the head of the subakgede or subak concerned without the need for approval from the sedahan agung.

Conflict management. Water disputes usually occur where water is scarce. But it seldom develops into fights and generally can be settled at the subak level. Only in a few cases is the issue brought to higher authority.[4]

Recent conflicts that required the involvement of the provincial government for resolution have been observed in Subakgede Pama-Palean, located in the neighboring districts of Badung and Tabanan, and were due to the unification of several subaks in 1977. A dam, which had previously served only three subaks, was required to serve nine (Tim Fakultas Pertanian Universitas Udayana 1981).

In general, water disputes occurred mainly because of the incidence of water stealing from the downstream farmers by upstream farmers within an irrigation system, or from the downstream irrigation system by the system upstream.[5] Because the dam and the structures of main systems have been made permanent by the government, the incidence of water stealing has been drastically reduced. One probable reason is the difficulty of manipulating the permanent structures.

Water stealing is strictly forbidden and is liable to a fine. The amount depends on the location of the theft and varies from subak to subak. The nearer the subak is to the dam, the higher the fine. All matters dealing with subak organization, including sanctions for infractions against rules such as water stealing, are set up in the subak's by-laws. Each subak has its own written or unwritten by-laws.

Operation and maintenance of the irrigation system. For jointly-managed irrigation systems, the main system O&M has become the responsibility of the government whereas that of the tertiary system remains in the hands of the subak. For farmer-managed irrigation systems, the main system and the tertiary system O&M are completely in the hands of farmers on a self-help basis.

In jointly-managed irrigation systems, the government usually assigns and pays a dam keeper and his assistants. The dam keeper is given a house near the dam.[6]

Before a permanent dam was built by the government, each active member had to go down to the river 30-70 times a year to repair the weir which was often damaged by floods. Subak Kesiut in the District of Tabanan, for example, had to mobilize about 25,000 man-hours per year to repair the weir on a self-help basis. However, after the dam was built, the burden of the farmers of the jointly-managed irrigation system had been reduced to a minimum because O&M had been taken over by the government. Only on particular occasions, such as when the main canal was closed by landslides, were the farmers requested to help the government clean the canal without any payment.

Little difficulty has been encountered so far in mobilizing the farmers to participate in such communal work. Some explanations may be offered: a) the water opening ceremony (*magpag toya*), which must be performed by all the farmers at the ulun empelan near the

dam, and the inauguration ceremony of the water temple apparently bring the farmers together, reaffirming their solidarity and attachment to the irrigation system as a whole; b) the authority for water allocation and distribution is still with the head of the irrigation association; c) the old canals of subaks are almost fully utilized; d) there is flexibility in implementing system lay-out; e) there is farmer involvement through labor, either paid or unpaid, and of local materials during the construction stage; and f) irrigation water has a social function.

In mobilizing communal labor for system maintenance, the head of the subakgede or subak may assign the work among the member subaks or tempeks on either a concurrent or rotational basis, depending on the work.

Religious rituals. Religious rituals carried out by the subak are closely related to stages of rice cultivation. Religious rituals seem to be a strong unifying element for the life of the subak. More than 60 percent of the annual expenditure of the irrigation association has been for rituals (Sutawan et al. 1984b, Sutawan et al. 1986).[7] In subaks where irrigation networks are permanent structures, almost all annual expenses are for rituals.

The main objective of the rituals is to pray to God for His blessing. The ritual may be performed by the subak as a whole in the subak temple or individually by the farmer at his own altar in the rice field.

The preparation and execution of rituals at the subak or subakgede level is coordinated by the pekaseh or pekaseh gede. For labor efficiency, the pekaseh or pekaseh gede may rotate the work assignments among tempeks or subaks. The rituals at the tempek level are supervised by the head of the tempek whereas those at the subak level, within a subakgede, are supervised by the head of the subak concerned.

The description of religious rituals by the irrigation association may go into many pages and is not of interest here. Suffice it to say that the kind of ritual performed individually by the farmer as well as by the tempek, subak, or subakgede as a whole varies from place to place. However, some important rituals usually performed by all subak members together are: a) *magpag toya*, a water opening ceremony held at the beginning of the wet season at the ulun empelan or at the water temple built near the dam (*ulun suwi*); b) *ngusaba*, a kind of thanksgiving ceremony held prior to harvest at a bedugul; c) *nangluk merana*, a ritual to avoid widespread attack of pests and diseases; d) *piodalan*, a ceremony for inauguration of a subak temple, such as the *ulun danu* (temple of the lake).

Each of these rituals is also conducted by the individual member at his own rice field altar called *sanggah catu* or *ulun carik*. Each member of the association also usually conducts individual rituals based on the stage of rice growth, such as a) *ngawit nambah*, before starting land preparation; b) *ngurit* or *pangewiwit*, an offering before spraying the seed bed; c) *nandur*, an offering made just before transplanting; d) *miseh*, an offering when the rice starts blooming; e) *biukukung*, an offering when the plant is in the milk stage; f) *dewa nini*, a ritual held immediately before harvest; g) *manyi*, a thanksgiving ceremony at harvest; and h) *mantenin*, a ceremony performed after stocking the rice

bundles or threshed rice at the granary.

Fund raising. Each subak has its own ways of raising funds necessary for rituals, and for repairing irrigation structures and subak temples. The sources of subak revenues are, among others: payment by passive members as substitute for labor (pengoot or pengampel); contribution in-kind paid by all the subak members (*suwinih* or *sarih tahun*); fines collected from offenders of by-laws; cash contribution collected whenever needed from all subak members (*peturunan*); rent from the subak's rice fields used for duck raising, and interest on loans (if any) to an individual member. The contribution by individual members depends on the size of landholding or the tektek received by the member.

IMPACT OF GOVERNMENT ASSISTANCE

Study of the impact of government assistance to farmer-managed irrigation systems in Bali is limited. The available research documents on irrigation development projects in Bali focus only on the production and economic impact of the project. Moreover, no effort has been made to probe the socio-institutional implications of irrigation development projects. Windia (1985), for example, in his study on the impact of tertiary development projects, concluded that projects apparently did not bring about any significant increase in cropping intensity, production per hectare, or family income of sample farmers.[8]

On the other hand, the University of Udayana (1985, 1986) reported that, in some cases, the main system development projects have brought about considerable increases in cropping intensity, rice yield, and farm income.

This chapter raises issues related to government assistance to subaks. The discussion is based on observations and in-depth interviews with the heads of several irrigation associations which had obtained irrigation development assistance from the government. Although these are not the only cases, they may provide valuable lessons to irrigation policy makers enabling future government assistance to become more effective and efficient.

Cases Illustrating Less-successful Projects

The following irrigation development projects could be regarded as less successful in that the respective subaks were dissatisfied with project implementation which resulted in inequitable water distribution, a decline in water supply, and a need for coordination among formerly independent irrigation systems.

Betiting Irrigation Project. This project, located at Betiting River in Bangli District, was completed around the end of November 1985. It combined two traditional weirs, which belonged to Subak Umadesa (upper stream) and Subak Denan (lower stream), respectively, into a single permanent dam called Betiting Dam. The dam was built on the former upper stream weir. The Denan system then received its water supply from a new division structure located at the main canal of the Umadesa system through a new canal connected to

the old main canal of Denan. However, where the two canals met, the level of Denan's canal toward the upper stream was lower than that toward the lower stream so that the water flowed to the Denan weir instead of to the Denan rice fields.

The Denan farmers complained of the reduced water supply compared to conditions before the project, and charged the Umadesa farmers with frequent water stealing at the diversion structure located at Umadesa's main canal. The Denan leaders complained that they did not know of the project before its implementation. They only heard that the government would give assistance and were instructed not to grow rice during construction.

The Denan farmers still regard the water supply as reduced in spite of the fact that the irrigation agency has built a special structure functioning as a "buffer" to avoid water flowing back toward the Denan weir. The head of Subak Denan wants its own traditional weir upgraded and a direct water supply from the new dam through the stream and not from the newly built division structure located at the main canal of Umadesa.

Pau-Manduang Irrigation Project. Pau-Manduang Irrigation Project combined two irrigation systems, each of which previously had its own weir located on the Jinah River, Klungkung District. Pau irrigation system (72.8 ha) was upstream, whereas Manduang irrigation system (116.45 ha) was downstream. The newly built government dam combining the two weirs is about one kilometer downstream from Pau weir and located between the two former weirs. The new primary canal is joined to the former primary canal of the Manduang system.

The Pau and Manduang farmers were not adequately informed about the project, or involved in its planning and implementation. Learning that Subak Pau was to receive water from a new division structure, the subak head requested that his weir should be upgraded and kept separate from the Manduang irrigation system. The request was not accepted because the service area was less than 150 ha (a minimum requirement for irrigation development projects). Therefore, the two systems were combined into a single system covering a total area of more than 150 ha, and the project was completed in March 1986. The Pau farmers are now drawing water from a new division structure located at the former main canal of Manduang system and channelled through a flume that crosses over the road separating the two subaks.

The interviews with the head of Subak Pau were conducted in the first week of May 1986. Although the new system had been in operation for less than three months, the Pau farmers felt that without the additional water supply from their former weir, the available water supply was less than preproject levels due to the small size of the flume (the head of Subak Manduang agreed). The head of Subak Pau felt disadvantaged by the project. He therefore suggested the following alternatives: a) his subak's former weir be kept functioning in addition to the present flume; b) the farmers be allowed to take water directly from the dam instead of using the present flume; c) his subak's weir be upgraded and completely separated from the Manduang irrigation system; and d) the present flume be replaced with a bigger one.

Either socio-institutional problems remain as a consequence of the unification of the two irrigation systems, such as how the two subaks are to be organized and coordinated, whether or not a new water temple is to be built near the new dam, and who will be responsible for allocating and distributing water between the two subaks.

Government assistance to Subak Bedugul and Subak Bumbung. The weir of Subak Bedugul is on the upper stream and that of Subak Bumbung is on the lower stream of a small river in Karangasem District. The distance between the two weirs is about one Klometer.

In 1985, the government assisted both subaks to rehabilitate their main canals. The total length of the main canals of the two subaks is about 2,500 meters (about 1,000 meters belonging to Subak Bedugul and 1,500 meters to Subak Bumbung). Additionally, Subak Bedugul had its intake upgraded.

Lining the main canals and upgrading the intake of the Bedugul weir were, in fact, only a kind of expansion of a bigger project called the Ababi Irrigation Scheme which covered a command area of more than 1,600 ha under the Bali Irrigation Sector Project. The farmers of both subaks were not informed beforehand about the project, except during the construction phase when they were instructed not to grow rice.

It is unfortunate that such an expensive project was poorly accepted by the farmers. Many of the new permanently built structures were left idle because division structures along the canal were not properly located. During the construction stage, the head of Subak Bumbung had protested about the improper location of division structures but the contractor had to follow the project blueprint. After completion, many farmers could not obtain water because their previously operated canals and division structures were closed. As a result, they had to make holes along the newly built canal, otherwise no water would flow to their rice fields.

The farmers in Subak Bumbung wanted government assistance to upgrade their temporary weir and its intake into a more permanent structure. Their weir had been frequently destroyed by flood and its intake covered with sand, requiring about 350-600 hours of communal labor annually for repairs and maintenance. Surprisingly, they received government assistance for the canal lining, which was not as urgently needed as improvements to their weir and its intake (Sutawan et al. 1986).

Tertiary development projects. Tertiary development projects were extended to the jointly-managed irrigation systems. Government assistance for improving tertiary networks was given therefore only to irrigation systems having already received main system development assistance.

Under the tertiary development projects, the government introduced a new perpendicular branching type of division structure, known as a *ngerirun* system, which replaced the subak-built straight line type structure, known as a *numbak* system. Compared to the numbak system, the inflow sections for the ngerirun were much narrower. In addition,

between the inflow sections, a stilling pool was made with a depth of 15-20 centimeters (cm). The stilling pool was designed to enable the water to circulate prior to entering each inflow section so as to permit more equitable distribution of water. However, for the proper functioning of this new structure, constant cleaning was necessary due to the fact that the narrow openings were easily clogged by debris and the stilling pool easily filled with sand and mud.

The case study of Subak Celuk in Gianyar District (Sutawan et al. 1984a) reveals some interesting findings. The farmers in Subak Celuk were not informed by the head of the subak about the government assistance for tertiary development. They only came to know about it after the contractor had dismantled the old permanent structures which had been built by the subak on a self-help basis. Although the subak members expressed their objections, the contractor insisted on following the design provided by the irrigation agency and replaced the old structures with the ngerirun type. The farmers seemed dissatisfied with the ngerirun system because: a) it failed to provide equitable water distribution to farmers getting water from the left or right of the boxes because the narrow openings were easily clogged with grass and leaves and the stilling pool filled easily with sand and mud; b) rotational water distribution, used in cases of water scarcity, could not be practiced anymore because the water overtopped the canal; and c) the quality of the new structures was inferior to those previously built by the subak.

Similar findings were noted in other irrigation systems receiving tertiary development assistance. In Subakgede Tamanbali, for instance, although the irrigation agency provided information, subak leaders had difficulty in comprehending detailed blueprints and remained unaware of the real form of the new structures. After a number of new structures were completed, they realized that the ngerirun structures were different from the earlier ones built on a self-help basis and tried to stop further dismantling of the remaining old structures. However, the contractor continued to work according to the blueprint provided by the irrigation agency. After completion of the project in 1983, the subak could not use one of the newly built structures because, when plentiful, water overtopped the canal and damaged the embankment. The farmers were compelled to replace this structure by the numbak system. Furthermore, some of the ngerirun boxes were of inferior quality and were damaged by frequent overflowing of the water. The subak-built structures which were not replaced by the new boxes are still functioning well (Sutawan et al. 1986).

Similar complaints were also expressed by farmers of Subak Sidayu in Buleleng District about the replacement of their numbak structures, which had been permanently built on a self-help basis, by ngerirun boxes.

In other cases, however, particularly in subaks where the previous division structures had not yet been permanently built, as at Subak Mandi and at Subak Aya in Bangli District, no complaints were made by farmers with regard to government assistance for tertiary network improvement. Farmers were satisfied with the new structures. And yet, the leader of Subak Aya himself seemed to prefer the numbak structure. This was evident from his proposal (mentioned during the interviews) that the remaining numbak structures should be upgraded into permanent ones without changing the old design.

Cases Illustrating Rather Successful Projects

The government has carried out an increasing number of main system development projects in which several traditional weirs were combined into a single permanent dam serving water to all the former irrigation systems. Because the subak as an irrigation system is not merely a physical system but a social system as well, it is likely that irrigation projects combining several subaks would create problems such as those illustrated in the previous section. Although main system construction has long been completed for some irrigation projects that combined previously independent systems (as observed along the Ho River in Tabanan District), the problem of coordination among these systems is not being considered and the problem of how to manage the new system has not yet been formulated. This indicates that the socio-institutional aspects of such projects frequently seem to be neglected.

Irrigation development projects dealing with only one subak or irrigation system seem to be more acceptable to farmers than projects combining several irrigation systems into one because, with a single subak or irrigation system, the problem of coordination does not arise.

Prior to the Bali Irrigation Sector Project in 1979/80, the government fund was limited. Sushila (1984) notes that the basic policy of the government in providing assistance to the subak has been: 1) to preserve the old canals as much as possible; 2) to request the involvement of farmers in the project, particularly during the construction phase, through contribution of labor and local material such as stones and sand; and 3) to adopt the subak's suggestions in laying-out the irrigation structures.

The adoption of such a policy, which no doubt secured the farmers' sense of belonging and sense of responsibility toward the irrigation system, might explain the willingness of farmers to participate in main system maintenance whenever needed, although main system O&M usually remains in the hands of the government.

Due to the increasing number of projects since the Bali Irrigation Sector Project, and the inadequacy of irrigation agency personnel in handling the increasing scope of projects, the above policy has been practically neglected, although still used as a reference. Thus, in practice, there have been many shortcomings in project implementation with various implications, as shown by the previously discussed cases illustrating less-successful projects.

One development project which combined several irrigation systems that could be regarded as a success is the case of Caguh Irrigation Project located near the Ho River in Tabanan District (Sutawan et al. 1986). The project combined nine subaks. Of these, Sambian, Samsam, Caguh, Kesiut, and Penatih subaks had their own weirs, whereas Anyarkumpi, Dukuhancak, Mumbu, and Batuaji subaks depended on water through seepage. Under the Caguh Irrigation Project, all nine subaks are now served by one permanent dam covering a total area of more than a 1,000 ha.

Before the construction of the dam, the irrigation agency and local government officials, particularly the sedahan agung, held lengthy discussions with leaders of the respective subaks concerning the project and the need for an intersubak coordinating body (subakgede). Two subaks, Sambian (an upper stream subak) and Mumbu (a seepage subak) refused to join the project. However, after discussion at a meeting on 29 December 1978 (which is considered the birth date of Subakgede Caguh), they agreed to join under the following conditions: 1) during construction of the dam, the existing weirs would be kept functioning as much as possible and the water shared with all subaks; 2) a single division box would be built for Subak Sambian and the canal diverting water from this box would only deliver water to its area (i.e., no other subaks would be allowed to draw water from this canal); and 3) Subak Mumbu would join the project and become a member of the subakgede if and only if it really depended on the dam for its irrigation water. If the Mumbu farmers could not grow rice without water from the five subaks with weirs, that would be proof that they really depended on the dam for irrigation.

During dam construction, the subaks were able to grow rice by building a temporary division structure on a self-help basis among the five subaks concerned. This temporary structure was built using coconut trunks at the location where the primary canals of the respective subaks were close to each other. (The project utilized this location later to build the permanent division structure.) Subak Samsam was allowed to draw water from the weir belonging to Subak Sambian by building a temporary canal, whereas the other four subaks obtained water from the temporary division structure. The construction of the common temporary structure could be regarded as a "test case" for the new subakgede. The farmers were convinced that the project could really benefit them.

During construction, the project employed the farmers as hired labor. The subakgede sold stones and sand collected by the farmers under the supervision of the leader of the new association, who was appointed through consensus. The proceeds went into the association's fund.

During construction of main canals and division structures, water was not available for almost two crop seasons and, as a consequence, the farmers in Subak Mumbu and neighboring subaks, were unable to grow rice. This proved the dependency of Subak Mumbu and other seepage subaks on the dam located on the Ho River. Therefore, Subak Mumbu finally agreed to join the subakgede.

At the project's completion in September 1980, the keys of sluice-gates at the division structures (which in a jointly-managed irrigation system are usually kept by the *tukang empelan*) were handed over to the leader of the subakgede, signifying that the authority for water allocation was in the hands of the farmers. Near the dam, a new water temple was erected for use by the member subaks and all the previous water temples were abandoned.

The Caguh project has run smoothly. Farmers have been satisfied with the project and grateful to the government because they no longer had to go down to the river to repair their weirs, which were frequently destroyed by floods. There has been no difficulty in

mobilizing self-help labor among farmers for repair and maintenance of the main canal when requested to do so by the government. In particular, farmers have so far been willing to participate in cleaning an area of the main canal about 1,200 meters from the intake which is filled by landslides almost every year.

CONCLUDING REMARKS

A subak, as an irrigation association, is location-specific in nature. Although subaks have been in existence for more than a thousand years, relatively little is known about their present performance or about the existing irrigation systems in Bali, particularly those receiving government assistance. To enrich the knowledge of irrigation systems in Bali, more in-depth studies are required.

Religious rituals seem to play an important role in the life of the subaks and provide a strong social basis for unifying subak members. This is evident from the high percentage of annual expenditure allocated to rituals by the subaks.

Many small (below 50 ha) traditional irrigation systems greatly need government assistance to upgrade their temporary weirs, but without combining them into a single system. Although combining might be technically and economically efficient, it may not be effective. It seems that, to some extent, efficiency must be sacrificed for effectiveness.

Farmers' active involvement in repair and maintenance of the main system for jointly-managed irrigation systems, despite main system O&M being the responsibility of the government, may be due to the following reasons: 1) the existence of a water temple near the dam no doubt draws the farmers together and reaffirms their membership in the irrigation community; 2) the involvement of the association leader in making decisions about water allocation and distribution; 3) the almost total utilization of the old canals of subaks; 4) the government's flexibility in implementing physical lay-out; 5) the involvement of the farmers during construction; and 6) the continuing use of irrigation water for domestic and household purposes.

However, concern has been raised that management of main systems by the government may reduce the farmers' sense of belonging and their feelings of responsibility toward their irrigation system, particularly when the supply of water for daily household needs can be provided from other sources, such as water pipes or pumps. Therefore, action research to determine proper division of management tasks between the farmers and the irrigation agency in various sizes of irrigation systems is necessary.

Tertiary development projects were initiated in 1979 in an effort to upgrade tertiary networks of jointly-managed irrigation systems. In many cases, the subak leaders as well as the farmers did not know about the project but came to know about it only after the contractor had dismantled the old structures. The tertiary development assistance has been criticized and found less acceptable to many farmers because of three major shortcomings: 1) the ngerirun boxes introduced by the government as a substitute for the

numbak division structures failed to secure equitable water distribution; 2) under conditions of plentiful supply, water frequently overtopped the canal and damaged the embankment, especially where the inflow sections were narrower than the subak-made division structures; and 3) the new structures were of inferior quality compared with the old ones built by farmers on a self-help basis.

The cases illustrated earlier regarding the impact of government assistance for irrigation development clearly support the view that the "blueprint approach" has been less successful than the "participatory approach" to irrigation development. Therefore the participatory approach should be employed in future irrigation development strategies.

GLOSSARY

The words below are Balinese except for those indicated by *.

Adat	Customary law, Hindu in character.
Awig-awig	rules and regulations or by-laws of the association.
Banjar	subdivision of *desa adat,* basically an implementing organ of the desa adat and the main organization responsible for activities related to customary law.
Banjaran	subdivision of a *subak* (subsubak); see *tempek* (most popular term), *lanyahan, munduk,* and *pamunduk.*
Bedugul	rice field temple dedicated to *Dewi Sri.*
Bendahara*	Indonesian word for treasurer; see *juru raksa.*
Bendesa	head of *desa adat.*
Biukukung	an offering by a farmer when the rice is in the milk stage.
Desa adat	an autonomous (i.e., completely independent from the hierarchical structure of government administration) self-contained, traditional community based on *adat.* Desa adat usually comprises one or more *desa dinas* (in Bali there are 1,456 desa adat but only 575 desa dinas). Within a desa adat there are a number of *banjar* (3,508 in Bali). The most important characteristic of desa adat is the *kahyangan tiga.*
Desa dinas	an integral part of the hierarchical structure of the government administration unit below the *kecamatan*

Dewa nini	a subak ritual held by farmers immediately before harvest by making a symbol of *Dewi Sri* (i.e., 162 rice panicles are divided into 2 parts consisting of 108 and 54, signifying male and female, respectively).
Dewi Sri	god of fertility.
Empelan	a traditional weir built and maintained by the farmers on a self-help basis.
Giliran*	rotational method of water allocation.
Juru arah	messenger; see *saya* and *kasinoman*.
Juru raksa	treasurer; see *bendahara*.
Kabupaten*	district; administrative unit within a province.
Kahyangan tiga	three important temples found in each *desa adat* namely: *Pura Puseh* (temple of origin) dedicated to Vishnu, the Preserver; *Pura Desa* or *Pura Bale Agung* (village temple) dedicated to Brahma, the Creator; and *Pura Dalem* (Temple of Death) dedicated to Shiva, the Destroyer.
Kanca	an informal group consisting of 4-10 farmers whose *sawah* are located very close to one another; see *penasan*.
Kasedahan	a cluster of *subaks* or *subakgedes* within a watershed; see *pasedahan*.
Kasinoman	messenger; see *juru arah* and *saya*.
Kecamatan	subdistrict; administrative unit under the *Kabupaten*.
Kelihan	elder, head, leader; also *kelihan pekasehan*, head of a *pekasehan*; *kelihan subak*, head of a *subak*; and *kelihan tempek*, head of a *tempek*.
Kertamasa	system where rice is grown on all fields simultaneously.
Krama	member of an organization; also *krama pekaseh*, the owner of *sawah catu*; *krama pekasehan*, member of a *pekasehan*; *krama subak*, member of a *subak*; and *krama tempek*, member of a *tempek*.
Lanyahan	subsubak; see *tempek*.

Leluputan	*subak* members who are exempted from its daily activities and from other contributions.
Magpag toya	a water opening ceremony held by all *subak* members at the beginning of the wet season at the *ulun suwi* or *ulun empelan*.
Mantenin	a ceremony performed after stocking the rice bundles or threshed paddy rice at a farmer's granary.
Manyi	a thanksgiving ceremony performed by a farmer at harvest.
Maongin	part of the *subak*/irrigation system, gets water at the second turn.
Mùnduk	subsubak; see *tempek*.
Miseh	an offering made by a farmer when the rice starts blooming.
Nandur	an offering made by a farmer before transplanting rice.
Nangluk merana	a ritual by the whole *subak* to avoid the attack of pests and diseases.
Ngasep	part of the *subak*/irrigation system, gets water at the last turn.
Ngawit nambah	a ceremony by a farmer before beginning land preparation.
Ngerirun	perpendicular branching type of water division structure.
Ngulu	part of the *subak*/irrigation system, gets water at the first turn.
Ngurit	an offering made by a farmer before spraying the seed bed; see *pangewiwit*.
Ngusaba	a kind of thanksgiving ceremony performed by the *subak* as a whole prior to harvest.
Numbak	straight line type of water division structure.
Nyorog	method of water distribution by dividing the *subak* or irrigation system into 2-3 groups, such as head, middle, and tail. The head gets water at the first turn, followed by the middle and finally the tail.
Palawija	non-rice crops such as corn, bean, and onion.

Pamunduk	subsubak; see *tempek*.
Pangewiwit	an offering; see *ngurit*.
Pasedahan	cluster of *subaks*; see *kasedahan*.
Pecelang	water guards; see *petelik*.
Pekaseh	head of a *subak*.
Pekaseh gede	head of a *subakgede*.
Pekasehan	a number of coordinating units within a *subakgede*.
Pemangku	priest.
Penasan	informal group of farmers; see *kanca*.
Pengampel	passive member (i.e., farmers who do not participate in daily activities of the *subak* but must pay a cash or in-kind contribution. Such contributions are also called *pengampel* or *pengoot*).
Pengayah	active member (i.e., farmers who are actively involved in the daily activities of the *subak*); see *sekehe yeh*.
Pengoot	payment by passive members of a *subak* as a substitute for labor; see *pengampel*.
Penyarikan	secretary.
Petelik	water guards; see *pecelang*.
Peturunan	cash contribution collected whenever needed from all *subak* members.
Piodalan	a ceremony for the inauguration of a subak temple, held every 210 days. Each temple has its own *piodalan*.
Prajuru	*subak* administrators.
Sanggah catu	small altar; see *ulun carik*.
Sarin tahun	in-kind contribution paid by all members of the subak, usually at the end of the harvest; see *suwinih*.

Sawah	irrigated rice field; *sawah catu*, rice field given to the farmers by the king in former days in Bangli District and in exchange the owner has been responsible for the performance of rituals at the Bukitjati Temple.
Saya	messenger; see *juru arah* and *kasinoman*.
Sedahan	government official, assistant to *sedahan agung* (the area of jurisdiction of a *sedahan* is the *kasedahan or pasedahan*).
Sedahan agung	the highest authority of *subak* organization; he is a government official mainly responsible for land tax collection for *subaks* or *subakgedes* within a district.
Sekehe yeh	active members; see *pengayah*.
Subak	water-users' organization in Bali.
Subakgede	intersubak coordinating body.
Suwinih	contribution; see *sarin tahun*.
Tektek	a measure of water share.
Tempek	most popular term for a subsubak.
Tenah	a bundle of unhusked rice around 25-30 kg; since one *tenah* of rice seed is required for a rice field of 0.35-0.50 ha, which also receives one *tektek* of water, then quite often *tenah* is used interchangeably for *tektek*, size of *sawah*, and the amount of rice harvest.
Tukang empelan	dam or weir keeper.
Ulun	temple. *Ulun carik*, a small altar belonging to a farmer erected at the rice field nearest his own water inlet (see *sanggah catu*); also *ulun suwi*, water temple; *ulun danu*, lake temple; and *ulun empelan*, weir temple.
Wakil pekaseh	deputy to head of a subak.

NOTES

[1]In Karangasem District, it was found that several irrigation systems were put under one coordinating authority. It was probably introduced by the government during the Dutch era for tax collection. This coordinating authority had nothing to do with irrigation per se and each member subak remained completely independent of the others.

[2]In Bali there are 8 *sedahan agung* because there are 8 *kabupaten* (districts) and 80 *kesedahan*, but only 51 *kecamatan* (subdistricts). Below the kecamatan there are 575 *desa dinas* (Dinas Pekerjaan Umum Propinsi Bali, 1982).

[3]At the beginning of *subak* formation, it was highly probable that irrigation water was allocated equally to each member based on participation in the construction works of weir and irrigation networks irrespective of the size of *sawah* owned (except for the leader who might be given extra shares as reward for his service to the association). Later on, due to such reasons as inheritance and transactions through buying and selling of water rights, the water share has apparently become unequal among individual farmers. Depending on the consensus, the members having sawah located a long distance from the main canal may be given an extra share of water.

[4]Water conflicts among members of the same subak are tackled by the head of the subak concerned. In case he is unable to solve it, the case is forwarded to the *sedahan*. And if the sedahan cannot overcome the problem, he can take it to the *sedahan agung*.

[5]In former days, serious conflict frequently occurred between subaks located at the border of neighboring kingdoms. The king whose area of jurisdiction was located upstream instructed his people to close his enemy's weir and divert water for the benefit of his own people. As a result, the enemy's sawah dried so that no crop could be grown, or the weir of the enemy was destroyed so that the enemy's territory was flooded (Liefrinck 1969).

[6]Prior to the construction of a permanent dam by the government in place of a temporary structure in some subaks, such as in Subakgede Tamanbali in Bangli District, the *subakgede* had assigned a dam keeper (*tukang empelan*) and a number of water guards (*petelik*). They were paid in-kind by the association and their tasks were in fact more or less similar to the present tasks of the dam keeper and his assistants paid by the government. In Subak Tinjak Kayu in Gianyar District, members, and not the government, pay the dam keeper although the dam was built by the government.

[7]In 1985, for example, the total annual expenditure of Subakgede Caguh (1,057 ha) amounted to almost Rupiah (Rp) 10 million (US$8,991). Of this, almost 80 percent was for rituals and the remainder was for other purposes, such as repairs and maintenance of irrigation facilities. Meanwhile, in Subakgede Tamanbali (351 ha), total annual expenditure was about Rp 6 million (US$5,395), with almost 92 percent for rituals; in Subakgede Saren (84.6 ha) more than 95 percent of a total annual expenditure of about Rp 2 million (US$1,798) was for rituals. The annual expenditures of individual member subaks ranged from Rp 0.2-2.6 million (US$193-2,333) within Subakgede Caugh; Rp 0.05-0.38 million (US$40-340) within Subakgede Tamanbali, and Rp 0.09-0.36 million (US$81-323) within Subakgede Saren (exchange rate used was Rp 1,112 - US$1.00).

[8]The study only compared two neighboring irrigation systems, one with and the other without a tertiary development project.

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INSTITUTIONAL INNOVATIONS IN IRRIGATION MANAGEMENT: A CASE STUDY FROM NORTHERN PAKISTAN

Anis A. Dani* and Najma Siddiqi**

> ...a number of the organizational arrangements and processes observed in Fai Muang Mai [and other irrigation systems] are expositions of an underlying *property grid*. That property grid, formed during the initial period of constructing the hydraulic works and continually reproduced, provides the logic both for the persistence of certain old practices and the creation of new procedures as circumstances require (Coward 1985:7; emphasis added).

INTRODUCTION

Irrigation analysts and development agencies now recognize irrigation management as a socio-technical process (Uphoff 1985b) consisting of a technical infrastructure and an institutional framework which determines the use of that infrastructure. Both are equally important in the success of the irrigation system.

Irrigation systems require considerable labor investments for system development and maintenance. Those who invest labor in the hydraulic system thereby enter into property relations with each other and have a vested interest in the common property represented by their hydraulic works (Coward 1983). These relationships are based on past and continuing labor investments in the irrigation system leading to "terre-capital" formation (Tamaki 1977). The underlying property grid formed by these relationships determines the entitlements of individuals within the irrigation system.

The notion of hydraulic property defined by property relationships is a useful beginning for an understanding of the institutional complexities in farmer-managed irrigation systems. These relationships are not constant. Changes may occur due to historical evolution or due to the availability of new inputs, such as markets or new technology, which change the nature and value of the resource.

To permit a more dynamic analysis, Bromley (1986) feels a concept of property as a secure claim or entitlement to a resource which offers "a stream of benefits to humans over time" may be useful. Mirroring the notion of the socio-technical process, harnessing the stream of benefits requires both physical ability and effective institutional arrangements which define its management and control, and hence its nature and allocation.

Enduring irrigation systems, like other resource management systems, need organizational structures for system management. These organizational structures and the institutional rules and conventions regulating the system constitute the Common Property

*Social Scientist, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal; and **Coordinator, Women in Development, Aga Khan Rural Support Programme (AKRSP), Gilgit, Pakistan.

Regime (ibid.) which ensures continuity and sustainability of the system. It is the non-perception of these regimes which has misled some into believing that the commons[1] will inevitably be overexploited (Hardin 1968).

In addition to a basic skepticism about the effectiveness of their technical capabilities, governments and intervening agencies often consider existing "social arrangements" obsolete, thus legitimizing modifications (Coward 1985:14). In order to refute these assumptions, the capacity and nature of institutional innovations found in Common Property Regimes with viable irrigation systems need to be documented and analyzed.

Four hypotheses are suggested as characteristic of this process:

Hypothesis 1: Historical growth and changing externalities may stimulate institutional innovations in the rules or organizational structures of Common Property Regimes.

Hypothesis 2: Barring complete breakdown or replacement of the irrigation system, these institutional innovations will adhere to the logic of the underlying property grid (i.e., existing property relationships).

Hypothesis 3: Although some of its functions may become redundant, and some of the institutional rules accordingly modified, the modified Common Property Regime will tend to replicate pre-existing organizational structures as far as possible.

Hypothesis 4: Where the irrigation system is managed by existing organizational structures, intervention will succeed to the extent it builds on the existing Common Property Regime.

Testing these hypotheses requires microlevel data to understand the dynamics of irrigation systems and to disaggregate the contributions made by the intervening agency and local groups to irrigation development. This paper analyzes a farmer-managed irrigation system in the Hunza Valley in northern Pakistan to test the hypotheses. Local farmers there have been tapping glacial melt from the Ultor Glacier to irrigate fields since the 1880s. Two major changes in the irrigation management system are documented and examined.

A private development agency, the Aga Khan Rural Support Programme (AKRSP), entered the arena in 1983 and has been supporting construction of a new irrigation canal to supplement existing water resources. This intervention sheds light on the directions in which similar agency-sponsored institutional changes may occur.

The historical evolution of the irrigation system, and the villagers' response to AKRSP's post-1983 intervention, provide useful case study material which will be used to test the above hypotheses. Toward the end of this paper, an attempt will be made to derive implications for development theory.

THE CASE OF ALIABAD

Aliabad is located in the Hunza Valley, 100 kilometers (km) beyond Gilgit and slightly more than 700 km from Islamabad along the Karakorum Highway. It is one of the three new settlements -- Hyderabad and Dorkhand are the other two -- which have developed out of the expansion of the fabled capital of Hunza: Baltit (now renamed Karimabad) and its satellite, Ganish. These villages are contiguous and share the same water resources emanating from the Ultor Glacier.

Aliabad was established during the last two decades of the 19th century when the then Mir of Hunza authorized selected households from the four lineages living in Baltit -- Biratating, Brong, Diramiting, and Khurkutz -- to construct an irrigation channel from the Ultor Glacier beyond Baltit in order to settle the relatively flat land further down the valley. Since then, Aliabad has expanded to 337 households. Although Aliabad shares the irrigation system with Baltit and Hyderabad, this paper will focus primarily on the three Aliabad subsystems. These subsystems act as a second level of organization.[2]

Two smaller settlements -- Aga Khanabad and Dorkhand -- also come within the subsystem management level of Aliabad. Residents of these two settlements are from the same four lineages as those of Aliabad but they migrated here from Ganish, a village in the foothills of Baltit. The relatively small number of households within Dorkhand and Aga Khanabad makes the settlement a more significant unit than the lineages within it. Having been two separate villages in the past they now operate virtually as neighborhoods of Aliabad. In the Hunza context, neighborhoods can also operate as corporate units which may override lineage considerations.

> Segments of disparate lineages, and even of disparate clans, compose the neighborhood. Although the neighborhood does not have the sharply defined collective identity of the village nor the village's many functional attributes, it is nonetheless corporate. It is a durable, named group with recruitment based on residence within marked sections of the village. It has explicit sanctions and commitments overseen by an executive committee, and regularized arrangements for the safeguarding of women and property and for joint ritual and economic activities (Ali 1984:236).

As shall be seen later in this paper, the operational units chosen by the villagers to form village organizations under AKRSP's auspices were precisely these six units -- four lineage-based units from Aliabad and two neighborhood-based units from Dorkhand and Aga Khanabad -- which agreed to cooperate at one level in the irrigation system. For the purposes of this paper, these six units which form part of the Aliabad irrigation subsystem will be discussed as one unit of organization.

The Agrarian Setting

Karimabad is located at an altitude of 2,405 meters. Aliabad proper being approximately 200 meters lower. Annual precipitation at Karimabad averages 145.1 millimeters (mm, Whiteman 1985). There are no records for Aliabad but any variation will be on the lower

side because of its physiographic location. Not only agricultural crops but even fruit and fuel-wood trees are entirely dependent on irrigation. This is evident from the sharp contrast in vegetation between the irrigated areas and the desert-like terrain adjacent to it.

With very few exceptions, landholdings are equitable. Almost all farmers in the northern areas enjoy ownership rights to the lands they cultivate (Saunders 1983). Traditionally, these lands are not alienable beyond the lineage (Ali 1984:236).

Aliabad lies in the transition zone between the double-cropped and single-cropped zone. Were it not for the acute shortage of land, single-cropping would have been practiced (Whiteman 1985) as is evident in comparative locations in neighboring valleys.

Wheat is the most important crop in Aliabad. An early variety of maize is sometimes planted but the low grain yield means it is used largely as fodder. Some buckwheat and barley are also planted. Alfalfa is cultivated on the steeper slopes as winter fodder.

The residents of Aliabad and, in fact, of all Hunzukutz[3], practice an intensive form of agroforestry, combining fodder production with extensive horticulture and silviculture. But traditional rules prohibit tree planting within 24 *gash* (literally "forearm," meaning the distance from fingers to elbow or about 0.46 meters), or 11 meters of a neighbor's wheat field. Apricots are the most abundant fruit and, along with apples, almonds, and grapes, provide a critical nutritional supplement. The significance of fruit trees can be illustrated from the fact that, of a sample of 24 households, the number of fruit trees owned ranged from 10-500 with an average of about 96 trees per household. This is not an unusual number for the Hunza Valley. Apples and other exotic fruit such as cherries and pomegranates are now preferred because of the higher market value after the opening of the Karakorum Highway in 1978. Poplars are the most common trees and are preferred because of their rapid growth, straight pole-like trunks, and value as fodder. Other trees include willows and Russian olives (*elegenus*).

There is potential for further land development in areas where the communities of Aliabad have hereditary rights (Table 1). The total population of these 501 households is 3,887, an average of 7.76 people per household.

The major constraint for land development is water scarcity (Table 2). Understanding the irrigation system is necessary before the discussion can proceed further.

THE IRRIGATION SYSTEM

Due to the extremely low rainfall, irrigation plays a critical role in the entire Hunza Valley. Glacial melt is tapped and carried up to 10 km through indigenous channels (*kuhl*) across precarious slopes to alluvial fans and river terraces which constitute most of the arable land. These kuhls often have to cross almost vertical rock faces and a passage is then carved out or blasted along the rock wall. As in the case of landslide-prone areas in Nepal (Martin and Yoder 1983), kuhls may take the form of tunnels. In Hunza, this is more

often the case when the kuhl is traversing across scree. The kuhl is constructed on the scree slope and covered with slabs of rock. The scree soon covers the slabs forming a sort of tunnel. Actual tunnels and aqueducts are also found but are relatively rare.

Table 1. Extent of irrigable land in hectares.

Village organization	Number of members	Land development potential	
		Developed	Undeveloped
Birataling	83	253.0	41.5
Brong	85	121.5	253.0
Diramiting	85	253.0	43.0
Khurkutz	84	253.0	43.0
Aga Khanabad	86	108.5	40.5
Dorkhand	78	273.0	43.3
Total	501	1262.0	464.3

Source: AKRSP (1986).

Table 2. Constraints inhibiting land use changes identified by 24 respondents during field data collection.

Major constraint identified	Percent in favor of change[a]
Scarcity of water	52.0
Rules against tree planting	24.0
Lack of agricultural inputs	14.0
Other	9.5

[a]N = 21; percentages are rounded and do not necessarily total 100%.

Physical Infrastructure

Aliabad is irrigated by three kuhls: Samarkand, Barbar, and Harchi. Samarkand is the major kuhl and is divided into four secondary channels: Dalah, Makuchim, Chooshihar, and Peer. Of these, Dalah and Makuchim are reported to date back to the 1880s, the time of the original settlement in Aliabad. They service the main wheat fields of Aliabad. The other two secondary channels were added subsequently for sloping alfalfa fields and orchards. Water is released into them only when there is surplus. For example, Peer is provided with water only after June 15.

A number of attempts have been made to improve and extend the irrigation infrastructure. Notable are two attempts to construct a kuhl from another source, Hassanabad Nala, in the direction of the tail of the existing system. The first major attempt was by the British around 1940. This kuhl had a very small command area and was not much use to the farmers. It fell into disrepair and disuse after the first few years. The second was by the Northern Areas Works Organization (NAWO) in 1975. Construction of this kuhl was aborted because it was considered technically too difficult. With AKRSP's support, farmers are now attempting to construct a major kuhl from the same source which other agencies had declared unfeasible.

Allocation of Water

During the summer season a peak discharge of 5 cusecs reaches Aliabad through Dalah alone. The other secondary channels have less capacity and a combined discharge of 3 cusecs, providing a maximum total discharge of 8 cusecs for Samarkand kuhl.[4]

Like Samarkand kuhl, Barbar kuhl is also shared by Baltit, Hyderabad, and Aliabad. In fact, they share a common intake from the glacial stream. Water is released in Barbar only when it is in excess of the capacity of Samarkand, usually in June or July. At that point, the wooden gates regulating allocation of water between the villages are removed and surplus water diverted to Barbar kuhl.

Harchi has a different intake and is shared by Aliabad with two other villages -- Ganish and Altit -- each of which is entitled to one share of the water to Aliabad's two. A proportional weir (*chaukhat*), similar to the Sumatran *penaro* (Coward 1985) and Nepalese *saacho* (Martin and Yoder 1983), with four proportionate inlets, is installed at the source (*sarband*). These openings have been adjusted to compensate for the differential rate of flow within the kuhl. The openings in the center are slightly smaller than the two openings on the sides to ensure an equal discharge from the four openings.

Samarkand also has regulatory gates but because the major share of its discharge is earmarked for Aliabad, its role is less crucial. Water has been allocated to Hyderabad every eighth day, the intervening seven being Aliabad's share. Baltit's rights are limited to the allocation of one water inlet the size of a fist, controlled by installing a stone gate with a hole (*tori*[5]), a structure usually used for tertiary channels.

However, Baltit has a 50 percent share in the discharge of Barbar kuhl. The entire discharge during the day is allocated to Baltit while the night discharges are shared between Hyderabad and Aliabad in the ratio of 9 to 4. Normally, the water in Barbar is enough to irrigate individual fields in Aliabad two to three times a year.

The difference in timing between Baltit and the other villages is significant. Perhaps to avoid possible misappropriation of water, fields are not irrigated at night. Most tertiary channels have storage reservoirs where water is diverted, to be appropriately distributed in the morning. Because there is always loss of water through seepage from the reservoirs, a night's share amounts to junior rights (Bromley 1986) as compared to Baltit's

senior rights during the daytime when water can be directly applied to the fields. The proportion of discharge from Barbar which is actually distributed to Baltit's fields thus amounts to more than the proportion of their time share.

Three full-time watchmen (*yatkuin* or *dargha*) look after the interests of Aliabad at the intake. They live in a shed at the intake site from February through November each year and are compensated both in cash and in-kind *(gharbal)*. Each yatkuin is reported to have been paid Rupees (Rs) 200[6] (US$14.29) per lineage and provided a small amount of essential commodities in-kind by each household. Additional yatkuin are appointed to supervise the flow through the other regulatory gates and, in the past, to patrol the entire length of the kuhls. One such yatkuin at Peer was paid Rs 10 (US$0.71) per household in 1985.

A large number of tori have been installed at the tertiary level within the Aliabad subsystem. At the lowest level, that of individual farmers, water is shared on a rotational basis by the *warabundi* system (see Renfro and Sparling 1983) which determines the time share of the farmers.

A cross section of 24 respondents from Aliabad reported irrigating their wheat fields 5-8 times in 1985, with a median of 6.7 irrigations. Of these, 23 respondents felt that water availability was insufficient even for wheat, the crop which gets priority for all inputs.

Water Rights and Land Use

The relationship of water rights to land tenure varies within Gilgit District, even within the Hunza Valley. In some villages the two go together but in areas of acute water shortage, water rights are distinct from land rights (Hussein et al. 1986). Transactions of water shares also take place in some villages.

In Aliabad, water rights are directly linked to land rights. However, the allocation of water rights varies with land use. Wheat has top priority with alfalfa, vital as winter fodder for livestock, a close second. Fruit orchards come next, with plantations of multipurpose trees interplanted with grasses coming last. If alfalfa is planted on cropland, it is given priority. If, however, it is interplanted with trees, it loses its priority.

Trees have junior rights to water, while wheat and alfalfa have senior rights when planted on cropland. If regular cropland is converted to orchards, it retains senior rights. However, the 11 meter mandatory spacing from neighbors' fields acts as a constraint on horticulture development even though cash returns from orchards are at least five times that from wheat.

Some expressed resentment at what they considered to be anachronistic rules, but older farmers, who have had to be self-sufficient in the past, stressed the imperatives of food security. They explained the apparent discrimination against trees by pointing out the shading effect on other crops, but also expressed concern that the long roots of trees could reach far into the neighbor's fields in search of vital moisture. The severe scarcity of water does not permit this "luxury."

In spite of traditional logic, the availability of sufficient wheat imported from Punjab and the lure of lucrative incomes through the opening of distant markets for fruit (results of the completion of the Karakorum Highway) are generating a lobby seeking amendments to the institutional constraints against tree planting. Table 2 (above) shows that more respondents chose these junior rights than chose lack of agricultural inputs as the major constraint on positive land use changes.

If hypothesis 1 is correct, we can expect reassignment of water rights in favor of fruit trees in the near future.

Maintenance of the Irrigation Infrastructure

Each year, the kuhl is cleaned and repaired at the end of May. Every household in the villages is required to participate in this annual maintenance. The kuhl is divided into portions which are alloted to subsections of the irrigation community for repair. For example, Samarkand kuhl has been divided into five portions and alloted to five settlements from among its users nearest to those portions. Minor repairs during the course of the season are done by those responsible for patrolling the length of the kuhl but any significant breach results in the mobilization of the entire user-group. However, in such cases, the subsystem groups mobilized for emergency repairs will always be those downstream. For instance, farmers of Hyderabad and Aliabad are required to go to Baltit's assistance to repair any major breach, and Aliabad farmers are required to assist in repairing breaches in Hyderabad. Once the water reaches the tail of Aliabad, those at the head cannot be mobilized for repairs.

Households which cannot or do not wish to contribute labor may compensate in cash. The rate of compensation was Rs 300 (US$21.43) during the 1985 season. This included compensation for annual repair as well as maintenance during the course of the season. Of the sample of 24 farmers, 15 provided maintenance labor in 1985, while 8 paid cash. One was exempted as he was an office-bearer of the village organization. On an average, villagers provided 8.2 days of maintenance labor besides the annual spring repair. This low figure may be less than the average invested in annual maintenance over a longer time period as there were no major disasters in 1985.

Nevertheless, this is a considerably lower rate than that reported for hill irrigation in Nepal (Martin and Yoder 1983) and may be a function of low rainfall, which reduces the incidence of landslides. The investment of past labor to form hydraulic property (Coward 1983) and terre-capital (Tamaki 1977) is proportionately much greater in Aliabad than in the Nepal cases, in comparison with the amount of maintenance labor required to benefit from that property.

Innovations in the Irrigation Management Structure

The earliest reported management structure was lineage based. Because at the time Aliabad village was initially established, the settlers were alloted blocks of arable land on a lineage basis to be internally allocated within houeholds of the lineage, water shares

were similarly allocated. Each lineage was allocated water for a day on a rotational basis. Internal distribution was the responsibility of the lineage. There were thus two levels of organization: a decision-making unit at the level of the kuhl, and an operational one at the level of the lineage.

The irrigation system was gradually expanded to meet the needs of the growing population. As additional tracts of land were brought into the command area of the primary and secondary channels, these tracts were also distributed among all participating lineages, and further among households within each lineage. The result was that over a period of time, fragments of arable land owned by lineages and by households were scattered over the entire farmland of Aliabad.

The preexisting irrigation management system necessitated irrigating lands of a lineage on a single day. This was rendered impractical by the scattered nature of landholdings. A contradiction thus developed between the institutional system and the technical system. In 1953 this was resolved by the formation of a *jirga* (council) for irrigation management. Historical necessity thus stimulated institutional innovation (Hypothesis 1) which operated at the intermediary level between the kuhl and the lineages.

The jirga consisted of 16 members representing all segments of water users from the Aliabad subsystem. It acted as the sanctioning body, and had a supervisory role. It was also the forum for conflict resolution. Operationally, the jirga still relied on the lineages for distribution of water and maintenance of the irrigation infrastructure but the distribution system was altered. Components of the previous organizational structure were thus retained (Hypothesis 3).

Aliabad's share of water was now allocated to fields on a rotational basis. Starting with land at the head, distribution would take place towards the tail, each farmer getting his share. On reaching the tail, distribution would again commence from the head. To ensure equity, distribution the following year would commence from the tail and move towards the head. This pattern of distribution was implemented on a rotational basis by the lineages, each lineage being responsible for water distribution for one year. Although this distribution system is apparently quite different from the previous one, it seeks, in fact, to remove the contradiction between the accepted relationships of landed property and hydrological possibilities. It is thus an attempt to rationalize the distribution system in accordance with the demands of the underlying property grid (Hypothesis 2).

The jirga system was more complex than the lineage-based system and was composed of three operational levels of organization: it articulated with the kuhl organization at the top, Aliabad Jirga itself formed the second level, and the lineage within Aliabad constituted the third level. It functioned with an acceptable degree of efficiency for 32 years.

During the past decade, the efficiency of the jirga system seems to have declined. This may be attributed to an increase in the incidence of migration resulting in an increase in the numbers of absentees from communal maintenance tasks. It is also a function of monetization and other rapid changes taking place with the incorporation of the Hunza

Valley into mainstream Pakistani society (Dani 1986). If Hypothesis 1 is correct, institutional change could be anticipated.

In fact, as of 1986, the jirga has been replaced by the Volunteer Corps of the Ismaili community (all residents of Aliabad are Ismaili). The Volunteer Corps is a local militia whose practical role, in the past, was confined to participation in village welfare schemes. The Volunteer Corps has now been assigned the task of irrigation management. It supervises and manages the distribution of water from the source to the farmgate, and also patrols the length of the kuhls to guard against possible misappropriation or natural damage to the irrigation structures. Minor maintenance jobs are done by the Volunteers, but they mobilize all farmers for emergency repairs as well as for the annual repairs in May (Hypothesis 3).

The Volunteer Corps consists of 76 members. As 36 of these are too old to work, the management is carried out by 40 members. In lieu of these services, every household pays the Volunteer Corps Rs 100 (US$7.14) annually. The total amount thus generated was Rs 50,100 (US$3,578) in 1986, which went into the Volunteer Corps Fund.

One tier of the organizational structure has thus been replaced, but the Volunteer Corps will continue to distribute water using the warabundi system. The change is thus a change in form only; it does not affect the underlying property relationships (Hypothesis 2).

The history of Aliabad's irrigation management is one of an amazingly responsive and adaptive Common Property Regime, which clearly belies Hardin's (1968) notion of the commons as a situation where individuals always seek to maximize their interest at the cost of public interest, and which are thereby viable only in low population densities with abundant common resources.

Bromley (1986) classifies positive reciprocity as the most preferred form of interdependence in Common Property Regimes. The nature of relationships between Aliabad farmers and their hydraulic property continues to be one of modified positive reciprocity. Even with the latest change in the management structure, positive reciprocity is ensured by retention of the responsibility for annual maintenance and emergency repairs within the domain of the water users (lineages). The Common Property Regime is thus not only alive, but thriving.

One further organizational innovation is the formation of a federation of potential water users for the construction of the AKRSP-sponsored kuhl. This innovation will be discussed in greater detail in the next section.

INTERVENTION BY THE AGA KHAN RURAL SUPPORT PROGRAMME (AKRSP)

AKRSP is a private, non-profit organization, seeking to induce community-based agrarian development in the northern areas of Pakistan. The basic principles followed by AKRSP[7] are:

1. Establishing Village Organizations (VOs),

2. providing assistance for Productive Physical Infrastructures (PPIs), and

3. developing extension-and-supplies infrastructure for continuously providing services to the VO.

The basic tools of implementation are: the Diagnostic Survey, a series of diagnostic dialogues carried out with villagers, to form a VO and to identify and plan the PPI as an entry point; and Village Planning to develop a sequence of profitable projects for the village. Planning is thus made "location-specific" (Coward 1985:14) and is "inductive" (Uphoff 1982) in nature.

For extension, AKRSP relies on Social Organizers. Their functions are analogous to those of Group Organizers in the Small Farmers Development Programme in Nepal (Ghai and Rahman 1979), Community Organizers of the National Irrigation Administration in the Philippines (Korten 1982), and Institutional Organizers in the Gal Oya Project in Sri Lanka (Uphoff 1985a). AKRSP's Social Organizers are provided technical backup by a full-time sub-engineer who stays with them in the field.

After a PPI is identified, it and the villagers are surveyed, and cost estimates are prepared by the AKRSP sub-engineer. These estimates are further negotiated downward through dialogues with the VO. AKRSP does not adhere to the policy of mobilizing free labor in lieu of participation. The cost estimate includes a reduced wage rate as compensation for the loss of income to villagers who work on the PPI.

It is here that room for negotiation exists. The negotiated cost thus includes cost of material and a reduced amount in lieu of labor costs which is a function of the opportunity cost of labor and the eagerness of villagers to initiate the scheme to receive benefit from it sooner. Because construction is carried out entirely by villagers, costs are one-fifth of what they would be under the contractual system followed by government agencies.[8]

AKRSP then holds a final dialogue with the VO regarding the basis of its terms of partnership. In brief, these amount to forming a VO which assembles regularly, undertakes collective responsibility for implementation and maintenance of the PPI scheme, encourages members to save a small amount at each meeting,[9] and pledges to participate in other development projects of AKRSP. If the VO fulfills these conditions, AKRSP concudes what they call the "third dialogue" by handing over the first installment of the PPI grant. Technical guidance during the implementation phase is provided when necessary but, by and large, villagers manage on their own.

AKRSP in Aliabad

During AKRSP's dialogues with the villagers of Aliabad, scarcity of water was identified as the main constraint for agricultural development. Members of six VOs expressed the

need for a kuhl from Hassanabad Nala, the source of the kuhls aborted earlier. Four of these VOs were based on the four lineages of Aliabad village, while the other two were based on residence in the neighboring settlements of Dorkhand and Aga Khanabad.

Initial surveys revealed a cost estimate of Rs 1 million (US$71,429) for the construction of the kuhl. This was well above the usual amount of PPI grants -- Rs 100,000 (US$7,143) to a VO. The six VOs, considering themselves part of the same irrigation community, decided to pool their PPI grants. AKRSP had not encountered this situation before but decided to go along with the villagers' wishes. A hypothetical channel was designed and divided into six segments for budget purposes. These segments were allocated to individual VOs and the third dialogue was carried out on 15 January 1984. The total negotiated cost for all six VOs was Rs 784,980 (US$56,070).

The total length of the kuhl to the boundary of Aliabad's agricultural land is 4,674 meters[10]. The kuhl is designed to have a top width of 1.2 meters, bed width of 1.2 meters, and depth of 1.0 meter. The kuhl is expeced to have a discharge of 5 cusecs when completed. The water discharge at the intake is estimated to range from 15-100 cusecs. Because of the substantial amount of water at the source, if completed, this kuhl will provide a more reliable discharge for Aliabad than the existing ones. However, the abandoned Northern Areas Works Organization (NAWO) kuhl 10 meters above the AKRSP kuhl being constructed is mute evidence of the extreme difficulty of the terrain. Fifty-seven percent of the total grant was designated for labor costs. The remainder was earmarked for tools and explosives, without which the work would be impossible.

Institutional Innovation for Implementation

Although the PPI grant for the construction of the kuhl was limited to six VOs within the Aliabad subsystem, these VOs negotiated with the four VOs of Hyderabad and four of Baltit who would also stand to benefit from completion of the kuhl. Even if those villages did not obtain much water directly from Aliabad kuhl, the new kuhl would reduce pressure on the existing irrigation system by increasing the total amount of water available to the higher level system shared by Aliabad with Hyderabad and Baltit. In accordance with the principle that labor investments create hydraulic property (Coward 1983), those eight VOs realized that assisting with the construction of the kuhl would secure their claim to the new resource. They therefore voluntarily decided to assist Aliabad in the construction of the new kuhl.

One of AKRSP's admonishments to the VOs has been to avoid reliance on representative committees for resource management. All matters are to be discussed and decided upon at regular VO meetings which all members are supposed to attend. In spite of AKRSP's exhortations against formation of management committees, the ingenuity of Aliabad's villagers could not be restrained. Being fully aware that day-to-day matters could not be referred to the full assembly, they formed a Federation of the 14 VOs, each represented by the VO President or Manager, to deal with the management of Aliabad kuhl during construction.

Although this, in itself, does not explicitly prove Hypothesis 4, it can be suggested that one of the reasons why AKRSP's intervention in Aliabad has succeeded in galvanizing locals into action is, that the program had the capacity to absorb local modification which structured the construction of Aliabad kuhl along the lines of the existing hydraulic regime.

The organization of construction thus resembles the three-tiered structure of the existing irrigation system. At the top is the Federation of all potential water users, a total strength of more than 900 households. The second level contains the three subsystems: Aliabad, Hyderabad, and Baltit, which also exhibit a corporate identity in terms of major decision making. The third level is that of the VOs, the level which AKRSP usually deals within its development work.

The VOs thus act as the "building blocks" (Coward 1980) of the higher levels of organization. Aliabad seems to support the results of the analysis of rural local organizations that "the best structure is a combination of an assembly of all members, meeting periodically, supplemented by some committee system, possibly an executive committee" (Esman and Uphoff 1984:144-146).

Current Status of Aliabad Kuhl

The work proceeded rapidly during the first year but even the combined grants of the six VOs proved insufficient. The estimate of required materials and labor proved to be an underestimate. Actually, the villagers say, and the Field Engineer verifies, that the VOs decided to enlarge the size of the kuhl beyond that of the original design to increase the discharge. This resulted in a higher rate of utilization of materials and labor per unit length than originally anticipated.

To compensate for this, the Federation solicited contributions from the VO members. When work was slowed down by the extremely hard rock face, Rs 150,000 (US$10,714) was collected from all the households for procuring a compressor/drill machine. When their cash ran out, another collection of Rs 21,000 (US$1,500) was made for explosives. In spite of these efforts, an estimated 20 percent of the channel still remained unfinished by the end of 1985.

Unwilling to give up, Aliabad's VOs decided to renegotiate with AKRSP. Fortunately, at this time, the Northern Areas Council had granted substantial sums of money from the government's regular development budget to each of its members for local development. Lacking the organization to implement these schemes on their own, several members offered to collaborate with AKRSP. One such member was the former Mir of Hunza. He agreed to contribute another Rs 150,000 towards completion of the Aliabad kuhl and AKRSP offered the use of one of its compressors in addition to the one owned by Aliabad.

A combined meeting of all six VOs with representation from the other eight participating VOs was held in February 1986. At this meeting, the VOs pledged to make a final effort towards completing the kuhl with the help of the additional resources provided.

The eagerness of elected representatives to contribute resources towards AKRSP's projects rather than adopt usual channels of development, which are more amenable to misappropriation, is important. It is indicative of a growing recognition of institutional development and participation as prerequisites for local resource management. It is also an indicator of the success of the program and, as such, serves as a reaffirmation of the inductive planning approach adopted by AKRSP.

In Aliabad, as in many other villages in the northern areas, AKRSP's strategy of relying on local knowledge for planning and design, and collective management for implementation and maintenance has been markedly successful (Hypothesis 4). Aliabad kuhl is now closer to completion than ever before, and at far lower costs.

Nonetheless, AKRSP should be wary of getting carried away by the initial successes achieved lest they fall by the wayside as another "hothouse" success. Aliabad's case clearly demonstrates the need for a "learning process" approach (Korten 1980) with scope within the program for redefining problems and redirecting efforts as warranted by data and experience.

Aliabad's irrigation system illustrates the value of existing organizational structures for rural resource management, particularly where these resources are managed by Common Property Regimes. AKRSP's strategy of a single level of organization seems to work fine in smaller villages of less than 100 households. Larger villages, with a much wider resource management area, may require multiple levels of organization. At least for Aliabad's irrigation system, this seems to be the case.

SUMMARY AND CONCLUSIONS

This paper started with a discussion of certain terms and concepts from the literature on irrigation management and Common Property Regimes. The irrigation system at Aliabad was then described in considerable detail. The irrigation system illustrates the creation of hydraulic property and terre-capital formation through the accumulation of past labor, reinforced by regular maintenance of the irrigation system.

For all practical purposes, the irrigation system functions as a Common Property Regime. The irrigation regime is characterized by positive reciprocity among all its members, manifested in the periodic renewal of their relationships through participation in maintenance tasks.

Junior water rights for tree planting were recognized as one of the major constraints to land use changes. The increasing demand for fruit trees suggests that these junior rights will be carefully considered and, most probably, revised. This change will symbolize formal recognition of the transformation of Aliabad from a subsistence economy to one that is more market-oriented.

The evolution of the irrigation management structure from a simple lineage-based one, through a three-tiered structure with the addition of the jirga, to management by the

Volunteer Corps is the history of continuous adaptation to changing constraints and opportunities. These institutional innovations lie at the core of this discussion.

In the first instance, institutional innovation (formation of the jirga) was a response to historical growth. The more recent innovation (mobilization of the Volunteer Corps) was stimulated by changing externalities which completes the logic of Hypothesis 1. In both cases, compliance with the fundamental property grid is observed and property relationships stay unaltered. Furthermore, elements from the existing organizational structure are retained. Hypotheses 2 and 3 thus appear to be supported by the Aliabad case.

AKRSP's role as an indirect investor in the irrigation system was accepted positively by the villagers of Aliabad because the program has no axe to grind and does not, in any way, affect the claims of villagers to water and subsequent land use rights. AKRSP has proved effective in mobilizing local skills, knowledge, and organizational strength. In fact, the latter has sometimes gone far beyond what AKRSP had envisaged by progressing beyond the homogeneous village organization structure to multiple levels within a larger irrigation system. Aliabad is a prime example of this outgrowth. The three-tier structure is a direct descendant of irrigation systems predating the arrival of AKRSP and is a success precisely because of that heredity. This not only supports Hypothesis 4 but also links back to Hypotheses 2 and 3 which also seem to follow as corollaries of Hypothesis 4.

Intervening agencies would do well to learn from AKRSP's experience in Aliabad which clearly demonstrates the benefits of working with existing organizations. These are neatly summed up in a recent state-of-the-art review conducted for the Water Management Synthesis II Project:

> What is most valuable about existing organizations is that they already have procedures for decision making, patterns of communication, and means for building consensus and resolving conflicts; capabilities that invariably take some time to develop under the best of conditions. (Uphoff 1985b:8.10-8.11).

Agency interventions which ignore this and annex existing irrigation systems within an external management structure tend to alienate local groups from the hydraulic property they have created or acquired (Coward 1985, Dani 1986).

The alienation is, however, not limited to material alienation of farmers from their resources. It also extends to cognitive alienation caused by the realization that an external entity now has more authority over their resources than they have. This results in the alienation of responsibility for maintaining the resource base (see Dani 1985 and 1986), as is happening with the NAWO irrigation channels which local farmers refuse to maintain. Such alienation has been the bane of many development programs.

The obvious lesson is that public interventions which search for and attempt to build upon existing organizations will ensure continuity with the past and, therefore, may be easier to sustain in the long run.

We conclude with seven implications emerging from this examination of Aliabad's irrigation system:

1. Villagers are aware that labor investments in the hydraulic system imply rights in the hydraulic property so created and are, therefore, willing to invest maintenance labor in the hydraulic system subsequently when, and only when, these rights are guaranteed. Governments and development agencies would do well to recognize this and not insist on provision of local labor in the absence of clear tenurial and user rights.

2. Farmers are capable of mobilizing substantial resources for the development of their hydraulic works. Recognition of their claims and removal of major obstacles through indirect investments (technical and capital assistance) can catalyze this process.

3. Even in existing common property situations, organizational structures are not static; they adapt and innovate over time, although farmers tend to adhere to structures they are most familiar with.

4. Existing organizations may operate at more than one level. The number of levels depends on the complexity and size of the irrigation system and 100 households seem to be the limit for one-level structures. Farmers are capable of managing at least three levels on their own.

5. It follows from numbers 3 and 4 above, that an analysis of existing institutional arrangements and organizational structures in specific locations should precede any externally supported interventions aimed at institutional development.

6. Smaller units, such as the village organizations, can be the building blocks of larger organizational structures.

7. Development programs could gain by being more receptive to institutional innovations proposed by farmers, particularly when the proposals affect relationships among the farmers.

NOTES

[1]*Editor's note*: "Commons" is usually defined as a "tract of land owned or used jointly by members of a community."

[2]See Uphoff 1985b: Chapter 4, on levels of organization.

[3]The term *Hunzukutz* is being used as a generic label for all natives of Hunza. The term may also be used in a more restrictive sense to refer to the descendants of those who resided in the capital of old Hunza (i.e., Baltit).

[4]Personal communication (1986) with Sher Ghazi, AKRSP sub-engineer, Hunza Social Organization Unit.

[5]*Tori* literally means plugging a water outlet. Since only the stone outlets can be easily plugged, tori is commonly used to refer to the outlet.

[6]Rupees 14.00 - US$ 1.00 (1984).

[7]See Khan and Husain (1983) for an introduction to AKRSP's approach.

[8]For a detailed comparison between AKRSP's irrigation projects and similar government projects, see Hussein et al. (1986:24).

[9]The amount is kept as collective VO savings for use as emergency and/or maintenance funds or as collateral for credit purposes.

[10]The engineering data in this paragraph has been provided through the courtesy of AKRSP.

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AN EVALUATION OF NIA'S PARTICIPATORY COMMUNAL PROGRAM

Romana P. de los Reyes and Sylvia Ma. G. Jopillo*

INTRODUCTION

The program of the National Irrigation Administration (NIA) of the Philippines for assisting communal irrigation systems employs what is now widely known as a participatory approach. NIA experimented with this intervention method in one project in 1976, and developed and improved it in 16 other projects between 1979 and 1980. In 1981, NIA began to implement this method nationwide. A key feature of NIA's participatory approach is the fielding of full-time organizers to a project area months before NIA begins construction of the irrigation project. The organizers help prepare the farmers to work with the engineers to plan the layout and design and construct the system, and they use the various planning and construction activities to develop and strengthen the irrigators' association. The organizers continue to work intensively with the association until the end of the second crop season following the completion of construction. During this period, they focus on encouraging the association to develop and implement improved processes and procedures for managing the system.

This paper discusses an evaluation of the impact of NIA's participatory communal program.[1] The Institute of Philippine Culture (IPC) undertook this study with financial support from NIA and the Ford Foundation.

RESEARCH DESIGN AND METHODOLOGY

The evaluation of the effects of NIA's participatory intervention method was done through a comparison of two types of NIA-assisted communal projects: those which NIA developed using the participatory intervention method, referred to here as "participatory projects," and those which NIA assisted using its traditional approach, referred to here as "nonparticipatory projects."

Sampling Methodology

The study gathered and analyzed data on three types of populations: NIA-assisted communal irrigation projects, key informants, and farmer-users of the projects. The procedures used to select the sample from each population are discussed below.

Sample communal projects. Three considerations guided the selection of the sample communal projects. First, because NIA began construction of participatory projects throughout the country only in 1981, it was decided that the study would cover projects

*Both are research associates of the Institute of Philippine Culture of the Ateneo de Manila University, Quezon City, Philippines.

which were constructed between 1981 and 1983 and which had become at least partially operational by June 1984.

Second, consideration of costs prevented including all 12 regions of the country in the study. Consequently, five regions were designated as research sites taking into account the geographical spread, ethnolinguistic diversity, climatic variations, and the presence of a sufficient number of participatory and nonparticipatory projects in the region. The research sites were Regions 1 and 2 in northern Luzon, Region 4 in southern Luzon, Region 6 in western Visayas, and Region 11 in central Mindanao.

Third, an objective of the study was to compare the procedures adopted by associations in participatory and nonparticipatory projects to perform irrigation tasks. Because larger systems were more likely than smaller systems to develop systematic procedures for accomplishing irrigation tasks, it was decided to include only the projects that NIA reported to have actual irrigated areas of 50 hectares (ha) or more.

Taking into account these three considerations and the analytical requirements of the study, it was decided that the research would cover a total of 48 projects -- 24 participatory and 24 nonparticipatory. However, owing to the small number of nonparticipatory projects in the sample regions, only 22 nonparticipatory projects were studied [See Table 1 (below) and Figure 1 (page 111) for the distribution of the sample projects]. The systems studied represented about 29 percent of the partipatory and nonparticipatory projects which NIA constructed throughout the country between 1981 and 1983 (Table 2).

Table 1. Distribution of sample communal projects.

Project type and location	Population		Sample	
	number	percent	number	percent
Participatory				
Region 1	11	34	8	33
2	4	12	3	12
4	5	16	4	17
6	7	22	5	21
11	5	16	4	17
Total	32	100	24	100
Nonparticipatory				
Region 1	9	39	8	36
2	5	22	5	23
4	4	17	4	18
6	3	13	3	14
11	2	9	2	9
Total	23	100	22	100

Table 2. Participatory and nonparticipatory communal projects which were constructed between 1981 and 1983, and which were either fully or partially operational as of June 1984.

Project type and location	Number of projects		
	Less than 50 ha	More than 50 ha	Total
Participatory			
Region 1	0	11	11
2	5	4	9
3	2	9	11
4	1	5	6
5	2	5	7
6	0	7	7
7	1	4	5
8	1	0	1
9	2	4	6
10	0	1	1
11	4	5	9
12	4	5	9
Total	22	60	82
Nonparticipatory			
Region 1	10	9	19
2	5	5	10
3	5	4	9
4	7	4	11
5	2	3	5
6	3	3	6
7	0	0	0
8	0	1	1
9	0	0	0
10	3	7	10
11	1	2	3
12	2	2	4
Total	38	40	78

Key informants. Two instruments were used in collecting and organizing data from the key informants. These were the "Key Informant Interview Guide," which directed the conduct of interviews, and the "Key Informant Schedule," which was used in collating and organizing the interview data.

For each sample project, a minimum of 29 key informants were expected to be interviewed. They were to include the officials and personnel of the irrigators' association, non-leaders and farmer-users of the system, and personnel of local NIA offices. As it

turned out, between 17-56 informants were interviewed in each sample project, or an average of 33 persons per project. The informants represented about 95 percent of the association officials and personnel in the sample projects and about 15 percent of the farmer-users of the projects.

Sample farmers. Interviews were also conducted with a sample of farmers who tilled fields in the system. Another instrument, the "Sample Farmer Schedule," was used in these interviews. Of the 920 farmers expected to be interviewed, 914 were contacted. The sample represented 16 percent of the farmer population in the sample projects.

Data Gathering Procedure

Eleven field researchers and a senior researcher undertook the field data collection; two senior researchers supervised the data gathering activities. The field researchers underwent a five-week training prior to their visits to the sample projects.

Background data on the sample projects were obtained before field visits to the projects were undertaken. Between September and November 1984, the senior researchers visited the sample regions and examined NIA records on the projects. They also interviewed NIA regional and provincial personnel involved in the projects.

Actual visits to the sample projects were conducted from February to September 1985. As it turned out, half of the sample systems were visited during the dry season (February to May), and the other half during the wet season (June to September). Two field researchers spent a total of three weeks in each sample project.

The researchers began field work in a sample project by undertaking a walk-through of the irrigation system, together with one or two association leaders or members. They used two tools to guide the walk-through: the system layout map, and either the "parcellary" map or paddy map of the system's service area.[2] These maps were all prepared by and obtained from NIA. When they had completed the system walk-through, the researchers had developed sketch maps of sections of the system, made notations on the NIA-provided maps, and obtained data through their interviews with farmers who accompanied them or those they had met. All these sources equipped them with an overview of the irrigation system. In consultation with the association leaders, the researchers delineated the upstream, midstream, and downstream sections of the system, and drew up a list of prospective informants, making sure that they included representatives from different parts of the system.

The researchers jointly conducted the initial interviews. These were often broad, covering all topics in the Guide/Schedule. From the start, however, in-depth interviews were also done with specific informants on particular topics. Detailed interviews were immediately conducted with the association leaders regarding their tasks. Throughout the initial interviews and in the subsequent topic-specific interviews, the researchers' discussions with the informants included frequent references to the maps of the system.

Research data were also collected from the association's records. Data on the association's finances were obtained by examining the association's books of accounts, receipts, and invoices. The researchers spent from three to five days sorting out the association's financial records and validating these with the association leaders. In systems where the associations maintained other kinds of records, the researchers used them to validate the data they had obtained from interviews.

Data were further collected when the researchers' attended and observed system maintenance activities and association meetings that were held while they were in the area. They used their presence in these activities to augment their interviews and observations as well as to validate the data they had gathered.

The senior researchers visited 25 of the 46 sample projects and each visit lasted from 4-6 days. During their stay, the senior researchers first reviewed the data on the systems recently completed by the field researchers so that a call-back could be immediately conducted if there were gaps and discrepancies in the data. They later joined the field researchers in conducting walk-throughs in parts of the system where fieldwork was going on, and also assisted the field researchers in conducting interviews.

IMPACT OF NIA's PARTICIPATORY COMMUNAL PROGRAM

The effects of NIA's participatory program were examined in the context of three dimensions of irrigation: the physical irrigation system, the irrigators' association, and farmer-government relationships.

Physical Irrigation System

NIA's construction assistance to the sample systems may be classified into three types of development schemes. The first type involved the improvement of an existing system so that it would irrigate an expanded area. This improvement could include tapping a new water source and constructing a new diversion structure in order to deliver water to unirrigated areas. The second type entailed a merger of areas irrigated by two or more temporary dams (and in a few instances by pump) into one communal project. In addition, the project was often expected to reach rain-fed fields. The third type involved the construction of a new irrigation system in an area that had no irrigation previously. This also included constructing a system in an area where farmers earlier had an irrigation system which was destroyed by a flood or typhoon and had long been nonfunctional; in effect a new system was installed.

About 46 percent of participatory systems involved mergers of small separate systems into one communal system, while 82 percent of nonparticipatory systems were improvements and expansions of existing systems. About 42 percent of the participatory systems were situated in distant sites where the terrain was often hilly or rolling, while 82 percent of nonparticipatory systems were found in the plains areas.[3] These differences implied that participatory systems were more likely to encounter technical difficulties in developing the system.

The study, however, revealed contrary results (Table 3). Participatory systems turned out to have more functional canals and structures than nonparticipatory systems. In the former, farmers abandoned or rerouted only 9 percent of the NIA-built canals (about 190 meters), whereas farmers in nonparticipatory systems disused 18 percent (around 730 meters) of the NIA-built canals. NIA also installed in the sample systems a total of 776 diversion and canal structures. Of these structures, 15 percent were assessed by farmers as faulty, defective, or nonfunctional. However, farmers in participatory systems found defective a smaller proportion of the NIA-built structures than those in nonparticipatory systems (13% versus 19%).

Table 3. Functionality of irrigation canals and structures in the sample systems.

Activities	Participatory (n = 24)	Nonparticipatory (n = 22)
Mean length (in meters) of major canals constructed or improved by NIA or both	2210	4150
Mean length (in meters) of NIA-built canals abandoned or rerouted by farmers[a]	190	730
Percentage of NIA-built canals abandoned or rerouted by farmers[b]	8.6	17.6
Mean length (in meters) of operational major canals in crop year 1984/85	6110	9170
Mean length (in meters) of operational canals constructed or improved by NIA or both	2020	3420
Percentage of operational canals constructed or improved by NIA or both	33.06	37.30
Total number of NIA-built structures (diversion and canal structures)	514	262
Percentage of NIA-built structures which farmers assessed as defective[c]	13.03	19.46

[a] $t = 1.87$ ($p < 0.05$); [b] $z = 0.91$ ($p < 0.18$); [c] $z = 2.24$ ($p < 0.01$).

One important factor which appears to account for the more functional NIA-built canals and structures in participatory systems is the farmers' involvement in planning and construction. More participatory than nonparticipatory systems (83% versus 27%) incorporated farmers' suggestions in the system layout and design. This was also true in terms of

the route of the canals (58% versus 18%), location and type of the main diversion structures (21% versus 18%), and location and type of canal structures (62% versus 14%).

Apart from the functionality of the system canals and structures, three other indicators were used to assess the impact of NIA intervention on the physical systems. One was the proportion of the project's estimated potential irrigable area that was actually irrigated. NIA estimated the irrigable area of a communal project at two stages: when the initial surveys to design the project were finished and when construction was completed. The first estimate is called "the design area;" the second, "the service area."

Participatory systems were expected to serve a relatively smaller area than nonparticipatory systems. This was true in terms of both the design area (205 ha versus 246 ha) and the service area (150 ha versus 198 ha). In crop year 1984/85, both types of systems had not yet served their entire irrigable areas. However, by then, participatory systems irrigated a larger proportion of their design and service area than the nonparticipatory systems (58% versus 50%, and 74% versus 64%; Table 4).

Table 4. Mean potential and actual irrigated areas (in hectares) of the sample communal systems, and percentages of design and service areas actually irrigated; 1984/85 wet season.

Area and crop season	Participatory (n = 24)	Nonparticipatory (n = 22[a])
Potential wet season service area		
Design area	205.36	246.13
Service area	149.97	197.69
Actual irrigated area		
Wet season	104.07	148.64
Dry season	76.57	123.21
Third crop	6.83	29.66
% design area actually irrigated (z = 0.54; ns)	58	50
% service area actually irrigated (z = 0.72; p < 0.23)	74	64

[a]NIA's estimate of the design and service area of one nonparticipatory sample system could not be ascertained.

One reason for the smaller discrepancy in the potential and actual irrigated area of participatory systems appears to be the improved management of water in these systems (see section on "irrigators' associations" below). The other reason lies in NIA's new feasibility assessment methodology under the participatory program. This methodology has helped NIA engineers make more realistic estimates of a project's irrigable area, thus reducing the gap between the estimated irrigable area and the actual area.[4]

Another indicator that was used to assess the performance of the systems studied was the increase in the actual irrigated areas. The study showed that NIA's construction assistance resulted in increases in the actual irrigated areas of the two types of systems. However, participatory systems experienced a significant increase in all three cropping seasons while the expansion in nonparticipatory systems was not statistically significant (Table 5).

Table 5. Mean actual irrigated areas (in ha) of the sample systems before and after NIA assistance (1984/85 crop season).

Crop season and time period	Participatory (n = 24)	Nonparticipatory (n = 22)
Wet season		
Before	88.00	126.61
After	104.07	148.64
Difference	16.07	22.03
% expansion ($z = 0.08$; $p < 0.21$)	18.26	17.39
Dry season		
Before	56.52	104.47
After	76.57	123.21
Difference	20.05	18.74
% expansion ($z = 1.38$; $p < 0.08$)	35.45	17.94
Third crop		
Before	0.00	21.19
After	6.83	29.66
Difference	6.83	8.47

A comparison of the two types of systems also revealed that they experienced the same expansion in their irrigated areas during the wet season (18% versus 17%). However, participatory systems obtained a significantly larger expansion than the nonparticipatory systems (35% versus 18%) in their dry season irrigated areas.

Further proof of the better performance of participatory systems compared to the nonparticipatory systems is the higher percentage increase in the proportion of wet season area that was irrigated in the dry season (9.36% versus 0.39%; Table 6).

The per ha production of rice farms served by the project was also used to assess the performance of the sample systems.[5] The data showed that in Crop Year 1984/85 participatory systems produced higher yields than the nonparticipatory systems in wet season (3.04 tons/ha versus 2.55 tons/ha) and dry season (2.90 tons/ha versus 2.53 tons/ha). A key factor accounting for these differences appears to be the higher use of fertilizer and chemicals by farms in participatory systems.

Table 6. Changes in mean actual irrigated areas (in ha) of the sample communal systems.

Time period and crop season	Participatory (n = 24)	Nonparticipatory (n = 22)
Before the project		
Wet	88.00	126.61
Dry	56.52	104.47
% of wet season area irrigated in the dry season[a]	64.22	82.51
After the project		
Wet	104.07	148.64
Dry	76.57	123.21
% of wet season area irrigated in the dry season[b]	73.58	82.90
Changes in % wet season area irrigated in the dry season		
Difference between before and after the project[c]	9.36	0.39

[a] $z = 1.02$ ($p < 0.15$); [b] $z = 0.55$ (ns); [c] $z = 1.23$ ($p < 0.10$).

In order to determine differences in farm yields during the crop year prior to NIA's construction assistance and of yields during crop year 1984/85, a comparison was made of the output of sample farms for the two time periods. The results showed that, during the wet season, farms in participatory systems obtained a higher yield increase than those in nonparticipatory systems (0.21 ton/ha versus 0.06 ton/ha; Table 7). In the dry season, the yields of farms in participatory systems increased by 0.55 ton/ha, but that of nonparticipatory systems decreased by 0.03 ton/ha.

Table 7. Comparison of mean rice yields (in metric tons per hectare) of sample irrigated farms during the crop year just before the project began and during crop year 1984/85.

Crop season	Participatory	Nonparticipatory
Wet season		
Number	350	295
Yield before the project	2.84	2.59
Yield during crop year 1984/85	3.05	2.65
Dry season		
Number	230	178
Yield before the project	2.56	2.57
Yield during crop year 1984/85	3.11	2.54

Irrigators' Associations

To determine the impact of NIA's intervention on the irrigators' associations, the study examined three aspects of the associations: the organizational structure, leadership, and system management practices.

Organizational structure. Studies of successfully-managed irrigation systems (e.g., Siy 1982, Veneracion 1985) indicated that the associations in these systems developed decentralized management structures to ensure that irrigation tasks were properly attended to in dispersed sections of the system. For this purpose, the associations divided the system's service area into small units or sectors. Farmers in the sectors undertook the operation and maintenance of their respective areas; the association provided coordination across sectors.

The structure of the associations in the two types of systems differed significantly. Fifty percent of participatory systems had association boards made up of sectoral representatives compared to 14 percent for nonparticipatory systems. More important most participatory systems used sectoring as an approach to involve farmer groups in different parts of the system in system management. Only 59 percent of the nonparticipatory systems did so.

In order to summarize the degree to which the sectors were actually used in system management, six indicators of sector functionality were combined into an index.[6] The results showed that participatory systems had a significantly higher mean score than nonparticipatory systems (3.42 versus 1.93; Table 8). Participatory systems also scored significantly higher than the nonparticipatory systems in the use of sectors to prepare the

Table 8. Mean sector scores of participatory and nonparticipatory systems in the sample communal systems. (Scores indicate percentage of systems doing activity on sectoral basis.)

Indicator	[a]Part	[b]Nonpart	T-test & significance
Listing association members	0.88	0.31	4.20; p <0.0005
Conducting maintenance activities	0.54	0.46	0.45; ns
Fee collecting	0.65	0.23	2.35; p <0.01
Recording fee collections	0.56	0.31	1.53; p <0.06
Assigning water distributors	0.33	0.31	0.16; ns
Scheduling water distribution	0.46	0.31	0.89; ns
Total mean score	3.42	1.93	2.24; p <0.01

[a]Participatory; [b]Nonparticipatory.

association membership lists, and collect and record fees. They also obtained higher scores than nonparticipatory systems in using sectors in water distribution, but the differences were not statistically significant.

A more decentralized management conforms with the organizational structure that NIA's participatory program encourages. Under the program, NIA urges associations to develop decentralized management structures right from the preconstruction phase of communal projects. NIA organizers advise farmers to divide the project's expected service area into small units, and then help these units develop into action-taking groups. They also encourage farmers to form the association leadership from representatives of these small units.

Association leadership. Studies of communal associations revealed several important characteristics of the leadership. For example, associations that adopted a sectoral setup had a more intensive leadership structure, which enabled the association to mobilize farmers easily to undertake irrigation tasks (Coward 1979, Siy 1982).

In the systems studied, the association leaders could be divided into three groups: central level officials (association officers and the members of the association board); sector officials, some of whom concurrently serve as association officers or board members; and the group of individuals who attend to specific tasks such as water distribution or fee collection but who may also hold a position at the central or sectoral level. Considering all three groups, there were 16 association leaders in participatory and 12 in nonparticipatory systems. The leader-farmer ratio was 1:9 in participatory and 1:14 in nonparticipatory systems (Table 9).

Table 9. Characteristics of the leadership of the irrigators' associations in the sample systems, crop year 1984/85.

Characteristic	Part[a]	Nonpart[b]	T-test & significance
Mean number of central level officials	10.88	8.77	1.59; p <0.06
Mean number of sector officials	6.75	3.54	2.07; p <0.02
Mean number of central level and sector officials	14.04	10.41	1.95; p <0.03
Mean number of personnel	2.71	1.77	1.09; p <0.14
Mean total number of leaders	15.58	12.00	1.87; p <0.03
Ratio of association leaders to system users	1:9	1:14	1.64; p <0.05

[a]Participatory; [b]Nonparticipatory.

A second aspect of irrigation leadership pertains to the distribution of the leaders. Studies indicate the importance of leadership dispersion to all parts of the system (de los Reyes 1982, Veneracion 1985). Leadership in the upstream area is needed to control farmers' diversion of excessive amounts of irrigation and to mobilize farmers to maintain the upstream facilities so that water flows continuously to the lower end of the system. But leadership is also important in the downstream area where farmers want the water to reach their fields. Yet when the government assists an existing system and works with the existing organization, farmers in the expansion area who often represent the tail enders are easily left out.

Research results showed that participatory and nonparticipatory systems had similar dispersions of central level leadership in various parts of the system. Both types of system had about the same proportion of central level officials who owned farms located in the upstream, midstream, and downstream sectors. However, the sector leaders of participatory systems were widely dispersed, while those in nonparticipatory systems were concentrated in the upstream area.

Participatory also differed from non-participatory systems regarding the integration into the association leadership of farmers from the system's expansion areas. Significantly more central level officials in participatory than non-participatory systems came from the expansion area (28% versus 14%).

A third characteristic of irrigation leadership is the socio-economic status of association leaders. Economically well-off individuals were often found to dominate the leadership of irrigators' associations. These persons serve an important role in linking the irrigation system to outside groups and institutions, particularly to obtain financial support for system improvement (Svendsen and Lopez 1979). However, when they use their irrigation positions to enhance their general community status and power, the management of the irrigation system suffers (de los Reyes 1982).

Significant differences were found in the composition of the association leadership of the two types of system. Farmers representative of the association membership composed the leadership in participatory systems. The association central level leaders of participatory systems often were tenants or small farm owners (48% versus 33%) who tilled one hectare or less. The central level leaders of nonparticipatory systems, in contrast, tended to cultivate or own larger farms.

In summary, participatory systems had a more intensive leadership structure than nonparticipatory systems, and the leadership in participatory systems was dispersed in all parts of the system, including the expansion area, and was made up of individuals typical of the association membership. These characteristics of the association leadership represent the kind of leadership that NIA's participatory program aims to develop. Under the program, NIA organizers develop leaders in various parts of the system by involving them in the actual activities of system planning and construction. This process is intended to identify and develop task-oriented leaders. It appears that this process has dissuaded individuals who have other motivations from taking on the leadership positions; consequently, farmers who are representative of the association membership dominate the leadership of participatory systems.

System management practices. The two types of system also differed in terms of the capabilities of the associations for undertaking irrigation tasks. One indicator used to assess the association's capability for system management was the amount of labor that the association mobilized for maintaining the system facilities.[7]

The systems studied, however, included a few of the long-existing communal systems, called *zanjeras*, which have well-developed maintenance practices.[8] Because the maintenance labor inputs of the zanjera averaged five times more than the non-zanjera, a separate analysis of their labor inputs was made. The results showed that among the zanjeras, participatory systems mobilized greater amounts of labor for system maintenance than the nonparticipatory systems (59 versus 25 person hours per irrigated ha). Among the non-zanjera, farmers in the two types of system spent the same amount of labor for maintenance (7 person hours per irrigated ha).

Distribution of water was another area in which the association's capability for system management was compared. Two variables were used to compare the two types of system: the presence of water distributors, and the method of water distribution observed.[9] The study found that 67 percent of participatory and 41 percent of nonparticipatory systems had at least one person specifically designated to oversee the distribution of water. Also, 61 percent of participatory and 38 percent of nonparticipatory systems observed a rotational distribution of water during the dry season (Table 10).[10]

Table 10. Frequencies of water distribution methods observed in the sample communal systems.[a]

Water distribution method	Participatory		Nonparticipatory	
	Number	Percent	Number	Percent
Wet season				
Continuous irrigation	18	75	18	82
Rotational distribution	6	25	4	18
Dry season				
Continuous irrigation	9	39	13	62
Rotational distribution	14	61	8	38

[a]One participatory and one nonparticipatory system had very small dry season crop areas. The few farmers who planted in the dry season had fields in the upstream section of the system.

The two types of system were also compared in the management of the association funds.[11] For this purpose, 10 financial management practices were utilized as indicators of the association's financial management capability.[12] The results showed that participatory systems had better capabilities for financial administration than the nonparticipatory

systems (Table 11). However, the data also indicated a number of remaining weaknesses in the financial management of associations in participatory systems. Several associations were particularly weak in requiring supporting documents (e.g., a voucher) in the disbursement of the association funds, using a water service invoice or bill in collecting irrigation fees, auditing the association books of accounts, using the NIA-developed simplified bookkeeping forms (which were intended for recording the association's financial transactions), and using membership index cards (which were designed to enable the association to monitor the payments made and collectibles received from each member).

Table 11. Mean scores of the financial management practices of the irrigators' associations of the sample systems.

Financial Management Practice	Part[a]	Nonpart[b]	T-test & significance
Issue receipts for collections	0.88	0.68	1.59; p <0.06
Use voucher for disbursements	0.38	0.09	2.31; p <0.01
Use treasurer's cash book	0.75	0.23	4.06; p <0.0001
Use simple bookkeeping forms	0.25	0.14	0.96; ns
Use list of association members/ system tillers to collect fees	0.92	0.68	2.04; p <0.02
Use water service invoice in collecting fees	0.38	0.04	2.89; p <0.0005
Use membership index cards	0.21	0.04	1.65; p <0.05
Annually audit account books	0.38	0.13	1.87; p <0.03
Annually prepare financial statement for general assembly	0.42	0.09	2.64; p <0.0005
Banking the association funds	0.54	0.32	1.53; p <0.06
Total mean score	5.11	2.45	4.42; p <0.0005

[a]Participatory; [b]Nonparticipatory.

Farmer-Government Relationship

Philippine Government policy on assistance to communal systems, issued in 1975, provides construction assistance to communal associations in the form of a subsidized loan.

The associations are expected to pay back their loans within a period not exceeding 50 years. In addition, the associations have to provide a contribution, or equity, to system construction costs. Earlier, this equity could either be 10 percent of construction costs or Pesos 300 per ha (US$14.72)[13] to be irrigated by the system, whichever was lower. However, beginning in 1985, the associations have been required to provide a minimum of 10 percent of construction costs. The policy further requires that upon completion of NIA's construction assistance, the system is to be turned over to the association. This is consistent with the government policy that communal systems are owned by farmers who, therefore, should be responsible for system operation and maintenance.

NIA earlier encountered difficulties in implementing these policy conditions. However, when the association would not provide the required equity, NIA could not simply suspend the construction. Nor could NIA simply shut down the irrigation system when the association failed to remit their amortization payments. Implementing the policy conditions of the construction assistance to communal associations therefore rests largely on the basic relationship between the association and NIA.

Three indicators were used to assess whether an improved farmer-government relationship occurred under NIA's participatory program. The first indicator was the extent to which associations complied with the equity requirement. In this regard, the study showed that participatory systems provided significantly higher contributions to construction costs than the nonparticipatory systems. On the basis of the systems' actual irrigated area in crop year 1984/85, the mean per hectare contribution of participatory systems was Pesos 357 (US$17.52) which was more than the government requirement of Pesos 300 per ha. In contrast, the contribution of nonparticipatory systems was Pesos 54 per ha (US$2.65).

Table 12. Farmers' mean per hectare contribution (in Philippine pesos) to system construction costs in 42 sample systems, 1984/85 wet season.

Category	Part[a]	Nonpart[b]
Service area		
Number	21	21
Farmers' contribution (t = 4.66; p <0.0005)	267	45
Actual irrigated area		
Number	21	22
Farmers' contribution (t = 5.31; p <0.0005)	357	54
Mean contribution per association member	351	44
Mean contribution per wet season system user	348	44

[a]Data on the farmers' contribution to system construction costs was not available for three systems which had not been turned over; [b]NIA's estimate of the potential service area of one nonparticipatory system could not be ascertained.

The second indicator was the rate of system turnover and the manner in which the turnover was accomplished. For all 20 participatory systems in which construction was completed, the associations accepted the turnover. For the 22 nonparticipatory systems with construction completed, the associations also accepted the turnover in all but two (Table 13). While this was not a significant difference, there were important differences between the two types of systems in the manner in which they were turned over. The turnover of 90 percent of participatory systems was done during festive events attended by a majority of the association members as well as by key NIA regional and provincial personnel. Similar ceremonies were observed in 65 percent of the nonparticipatory systems, but in the other 35 percent the turnover was a strictly procedural affair with the association president, sometimes accompanied by other association officers, signing the turnover papers provided by representatives of the NIA provincial office.

Table 13. Association members' choice regarding turnover.

Category	Participatory		Nonparticipatory	
	Number*	Percent	Number	Percent
Accepted by the association	20	100	20	91
Not accepted by the association	0	0	2	9
Of those who accepted turnover:				
A majority of the members	18	90	13	65
Association president	0	0	4	20
Several association officials	2	10	3	15

[a]Of the 24 sample participatory systems, four were under construction during research. One of these had accepted partial turnover of the system.

The third indicator was the associations' repayment of their construction loans. Communal associations are expected to amortize their loans beginning the second crop year following the completion of system construction and turnover of the system to the association. Research data showed that both types of systems had been paying back their construction loans. About 82 percent of participatory systems and 50 percent of nonparticipatory systems made their amortization payments (Table 14). However, nonparticipatory systems had larger amortization payments due than the participatory systems because construction had been completed earlier in 1981, while most sample participatory systems were constructed in 1983. Of the 24 participatory systems sampled, 4 were still under construction, 1 had no loan because the association raised a 30 percent equity, and 2 were not yet due to begin paying their amortization. The associations in 2 of the 22 sample nonparticipatory systems did not accept the final turnover of the system while 1 association raised a 30 percent equity.

Table 14. Amortization payments owed and payments remitted (in Philippine Pesos) to NIA by the irrigators' associations.

Category	Participatory (n = 17)	Nonparticipatory (n = 19)
Mean amortization payment due	15,088	41,667
Mean payment remitted to NIA	12,429	21,005
Mean percentage of amortization due actually paid ($z = 2.17$; $p < 0.05$)	82	50

Summary: Impact of NIA's Participatory Communal Program

The data show that communal systems which NIA developed through the participatory approach performed better than the systems which the agency assisted through its traditional nonparticipatory approach. This was evident in the more functional facilities, larger expansion areas, and higher per hectare rice yields of the former type of system as compared to the latter. The farmers' involvement in the physical development of participatory systems apparently resulted in the construction of irrigation systems more suited to the farmers' local environments.

Systems that NIA assisted under the participatory program also had better-structured irrigators' associations than those developed outside the program. The sectoral management approach of participatory systems addressed the development of action-taking capacities in dispersed areas of the systems; however, the sectors were weakly utilized in water distribution. Consistent with the sectoral management approach, the leadership of participatory systems was dispersed in all parts of the system including the new areas brought under irrigation. In addition, this leadership was composed of farmers typical of the association membership.

Associations under the participatory program also had more improved procedures of system management. They often designated individuals to attend to the distribution of water in the system, used water distribution methods that responded to the fluctuating water supplies of their system (particularly during the dry season), adopted procedures for ensuring the regular upkeep of their irrigation facilities, and improved the administration of their funds. They remained weak, though, in several financial management procedures.

Finally, under the participatory program a more cordial and open relationship between the farmers and NIA appeared to develop. The majority of participatory systems were turned over to the associations in festive ceremonies, in the presence of the majority of association members and key NIA regional and provincial personnel. This contrasts with the strictly procedural turnover rites in more than one-third of the nonparticipatory systems. The improved farmer-NIA relationship under the participatory program is also indicated by the higher equity contributions and more up-to-date remittance of amortization

payments by participatory systems as compared to those of nonparticipatory systems.

NIA'S RESPONSE TO THE EVALUATION RESEARCH

When IPC undertook the evaluation study, IPC and NIA already had about 10 years of cooperative research and action experience. IPC and NIA maintained this collaborative relationship in undertaking the evaluation study. As has been practiced, the IPC researchers discussed the research plan with NIA management to give both organizations a clear understanding of the kinds of data the study would provide and the relevance of the data to NIA. During the fieldwork period, the IPC researchers made it a point to inform NIA's local and central management staff of the research progress and the emerging research findings.

So that NIA could fully utilize the research results, both organizations convened a workshop to discuss the research data three months after the fieldwork was completed. The workshop participants included the NIA Administrator, two assistant administrators, central office and field office staff, and the IPC researchers. In this workshop, the IPC researchers discussed the research methodology but did not make a formal report on the findings or draw conclusions. Instead, they provided tables which summarized the data by three topics: irrigation systems, irrigators' associations, and system management. The workshop participants were divided into three groups and assigned discussion topics, and each group analyzed the tables and derived conclusions on the variables included in their discussion topic. Afterwards, the participants convened in a plenary session for the group presentation and open discussion of the groups' conclusions. The participants later were divided into three NIA domain groups (field office managers, central office managers, and policy makers), and each group discussed the implications of the research findings for field-level action, internal management, and NIA's policies. The groups' recommendations for action were then presented and discussed in another plenary session.

The results of the workshop were discussed in several NIA administrative and planning meetings at the central and local offices. The IPC research data were grouped into two fields (engineering and institutional) and plans of action were outlined in both for improving NIA's communal assistance program. As regards the engineering field, one issue addressed was the gap between the service area and actual irrigated area of communal projects. Because this gap was seen as partly the result of an overestimate of the project's service area, improved estimates were planned based on parcellary maps. Another issue discussed was the functionality of canals and structures in communal systems. To ascertain the extent of the problem with NIA-built canals and structures, NIA decided to undertake a nationwide inventory of the physical condition of NIA-assisted communal systems. NIA also decided to strengthen the existing procedures for constructing communal projects through closer supervision of the provincial offices which directly implement communal projects. This supervision, provided by the regional offices, would require the regional design engineers to conduct site inspections for the design process and to join the construction engineers in supervising the construction process.

In terms of the institutional aspects of the communal program, NIA identified the need to strengthen the postconstruction assistance to the associations particularly in the areas of water distribution and financial management. The assistance in improving water distribution would continue to focus on the association level, but assistance to improve the association's capability for financial management would concentrate on key association officials who would be taught on a tutorial basis to handle specific financial management tasks.

NOTES

[1]Full discussion of the methodology and findings of this study are found in de los Reyes and Jopillo (1986)

[2]The duration of the walk-through depended on the size of the system's actual and potential irrigated area, complexity of the canal network, topography of the area, and the weather. In general, it took twice as long during the wet as during the dry season. In systems covering 50-100 ha on flat terrain and which had only 2-3 major canals, the walk-through usually took 3 days. In systems with similar canal networks but with a rolling or mountainous terrain, it lasted 5 days. In systems with the same irrigated area but with complex canal networks (i.e., 6-13 major canals), the walk-through stretched to 7 days, while in systems that served more than 200 ha, it required 8-10 days.

[3]The following may account for the locations of participatory and nonparticipatory systems. Until the early 1980s, NIA's communal assistance program concentrated on accessible areas on plains where irrigation systems were easier to construct. Under the participatory program, however, NIA adopted a new site selection methodology which included an assessment of previous NIA assistance to a candidate communal project and the added benefit that further assistance might achieve. Including these variables in the feasibility assessment resulted in lower priority to accessible sites; and consequently, under the participatory program, NIA assisted more projects in remote, hilly terrain.

[4]For a detailed discussion of NIA's feasibility assessment methodology and its impact on NIA's communal assistance program, see de los Reyes (1984).

[5]In both participatory and nonparticipatory systems the predominant crop cultivated during both seasons was rice. In the wet season the irrigated lands of both types of systems were almost entirely planted to rice. In the dry season, 85-88% of the irrigated lands were cultivated to rice, while the remaining areas were planted to crops such as vegetables, corn, sugarcane, tobacco, and cotton.

[6]This index has face value validity (i.e., it has not been tested for internal or external validity). Nevertheless, it serves as a good summary measure. For each indicator, a sample system was given a score of 1, if the indicator was present in the system, or 0, if it was absent. The scores for each indicator were then added and the total mean score of each type of system (participatory and nonparticipatory) was obtained.

[7]Mobilizing labor for system maintenance has special importance in the Philippines as elsewhere in the humid tropics because of the rapid growth of vegetation along the canals. More important, the heavy rains during the monsoon season frequently cause damage to irrigation canals and structures. Repair of these damages must be undertaken immediately if irrigation water is to be continuously delivered to all parts of the system.

[8]See Siy (1982) for a full discussion of the system management practices of the zanjeras in northern Philippines.

[9]These variables are used because, in the wet season, communal systems generally serve to supplement rainfall. Yet, there are still extended periods with no rain and the availability of water becomes critical for the standing rice crop. In the dry season, communal systems enable farmers to cultivate a second crop. Such irrigation decreases the systems' water supplies, requiring communal associations to develop methods of water distribution responsive to the level of water scarcity that they may experience. This often means that the associations have to observe rotational distribution, and, to enforce this method, they need to designate water distributors.

[10]The association's adoption of a rotational distribution method was often the result of NIA intervention. Among the 14 participatory systems that practiced rotational distribution in the dry season, 71 percent adopted the method as a result of NIA's encouragement while the other 29 percent adopted it prior to NIA's construction assistance. Among the eight nonparticipatory systems that observed rotational distribution in the dry season, four developed the method themselves and four learned it from NIA.

[11]Communal associations need to generate and manage funds for two reasons: they have full responsibility for funding the operation and maintenance of their systems, and communal associations that have received assistance to improve their system must raise funds to repay their construction loan. Communal associations often raise the needed resources for system operations costs through contributions of labor, materials, and cash, or through fee collections. The amounts involved are small, however. To meet the amortization payments for their construction loan, communal associations have to collect substantial amounts from the members.

[12]Like the index on sector functionality, this index on the financial management capability of the associations has not been tested for internal or external validity. The same scoring method was used in both indices.

[13]Pesos 20.37 = US$1.00 (November 1987).

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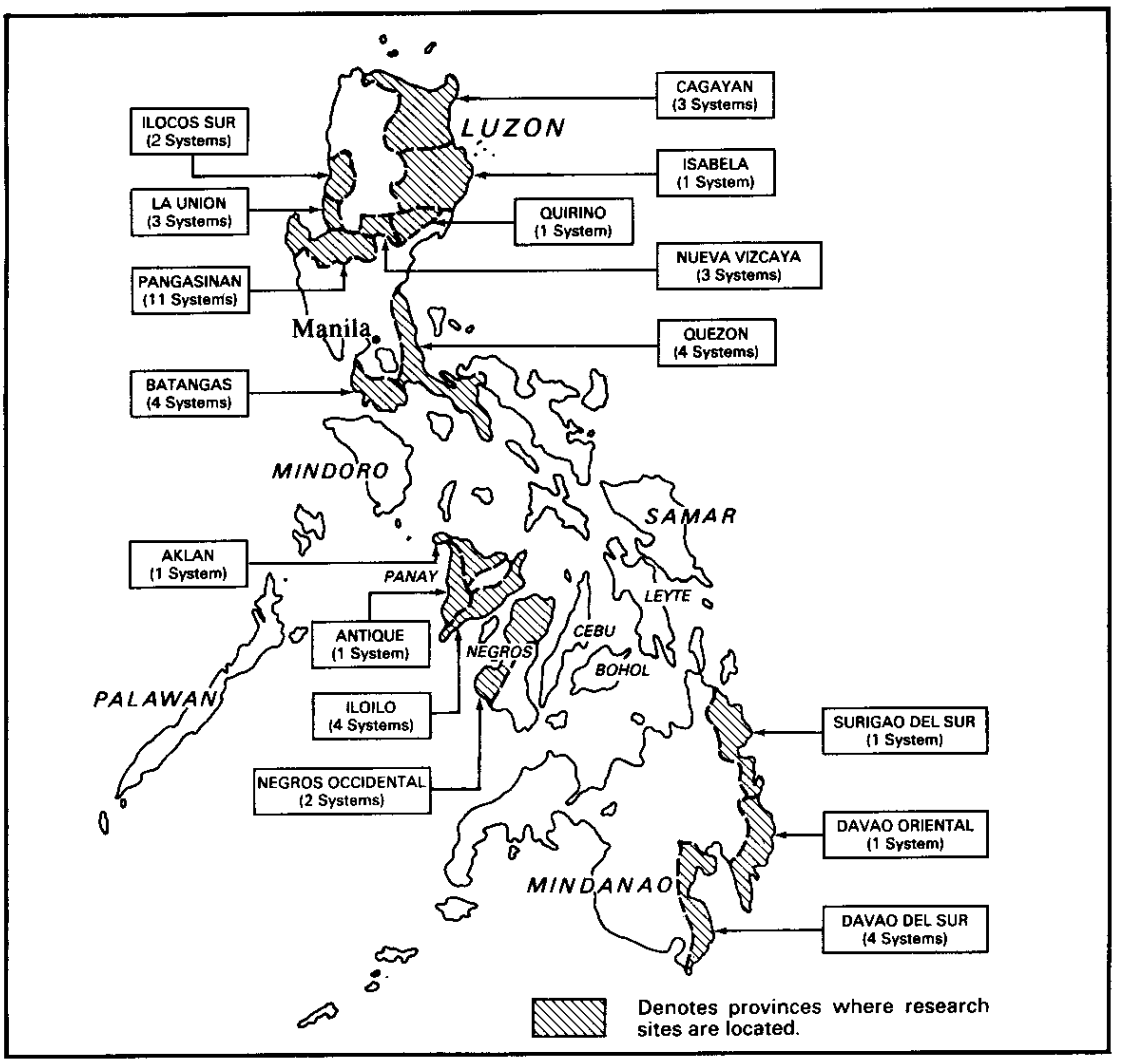
Figure 1. Map of the Philippines showing the research sites.



ISSUES RELATED TO INTERVENTIONS IN FARMER-MANAGED IRRIGATION: REHABILITATION OF A TANK IRRIGATION SYSTEM

R. Sakthivadivel* and C.R. Shanmugham**

BACKGROUND

The four southern states of India -- Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu -- have more than 125,000 tanks. These serve the irrigation, domestic, and livestock water requirements of a large percentage of the rural population, and recharge the groundwater reservoirs. The tanks in these states account for 60 percent of the tank irrigated area in India. About 30 percent of the irrigated area in the four states is served by tanks, most of which are farmer-managed. Some of these tanks are constructed in series so that the surplus flow from one tank falls into the next tank downstream, an efficient method of water harvesting and conservation. But the utilization of tank water has not been as efficient as its acquisition. The tanks are shallow, and a substantial part of the stored water is lost by evaporation, seepage through unlined channels, leakage through defective control structures, and wastage through improper water distribution and management, resulting in inefficient irrigation.

Improving tank irrigation systems through rehabilitation, better management, and the conjunctive use of ground and surface water is necessary to utilize the already developed irrigation potential for higher cropping intensity and greater agricultural productivity or to extend the irrigation facilities to new areas or both. It is in this context that a study funded by the Ford Foundation, New Delhi office, was undertaken by the Center for Water Resources, Anna University, in a selected farmer-managed tank irrigation system at Padianallur Village in Tamil Nadu.

The study objectives were:

1. to examine the present status of the tank system and to design measures to remedy deficiencies;

2. to have necessary physical improvements carried out by collaborating organizations and farmer beneficiaries, and to suggest measures for improving water distribution and management; and

3. to monitor postrehabilitation irrigation practices adopted by farmers, and to evaluate the effectiveness of the various measures.

In order to undertake rehabilitation measures and interventions, an interdisciplinary approach was established with the state government departments of Public Works

*Director and **Special Officer, Center for Water Resources, Anna University, Madras, India.

(Irrigation, PWD), Agricultural Engineering (AED), Agriculture (AD), Forest (FD), and Revenue (RD), as well as farmer beneficiaries responsible for the upkeep and improvement of tank structures, on-farm development, crop production, watershed improvement, water "cess" and land revenue, and water management.

Padianallur tank in Chengalpattu District was chosen for this study due to its proximity to the university, accessibility, representativeness of the tanks encountered in Tamil Nadu, and location in a district where 75 percent of the net irrigated area is covered by tanks. This is a nonsystem tank receiving water from its own catchment area without any extraneous source of supply.

PREREHABILITATION STUDIES

In order to gain an insight into the status of selected tank irrigation systems, a bench mark study was undertaken to collect data about: 1) the watershed, including the feeder channels, tank bed, and storage capacity of the tank and the verification of its adequacy to meet the needs of the command area, and water yield and anticipated flood discharge; 2) tank structures, comprising the tank bund, surplussing arrangements, sluices and their capacity to discharge the required quantity of water, and irrigation and drainage channels; 3) supplemental sources of irrigation available from wells and other water sources; 4) command area, including size of land holdings, land development done, soil type and depth, and other physical features of command area; 5) quality of irrigation and drainage water; 6) water distribution and control; 7) cropping pattern and agricultural practices; and 8) socio-economic conditions of the landowners of the command area and their aspirations and attitudes that affect the system.

The following additional surveys, observations, measurements, and studies were made: 1) engineering and topographic surveys of the catchment area, tank waterspread, command area, and preparation of maps; 2) measurements of water storage in the tank using depth gauges and of water flowing through each sluice using V-notches and Parshall flumes installed in the main channels; 3) water table measurements in selected open wells in the head, middle, and tail reaches of the command area; 4) drum culture studies to measure evapotranspiration and deep percolation losses; 5) measurements of transit water losses through main channels; 6) analysis of the soils in the command area for their suitability for irrigation and nutrient status; 7) testing the water quality; and 8) measurement and collection of hydrometeorological data.

Preliminary analysis of the data collected permitted the following proposals to be framed: 1) treatment of the watershed, improvements to watercourses, and strengthening of tank bunds to prescribed standards; 2) improvements and repairs to the surplus escape; 3) construction of additional sluices and improvements to the existing leaky sluices; 4) realignment and sectioning of main channels and provision of distributaries and field channels; 5) provision of additional control structures; 6) land levelling and shaping; 7) provision of drainage facilities; 8) development of an irrigation schedule and operational policies for water distribution; 9) improvements to cropping patterns and agricultural

practices; and 10) organization of farmers' committees and supporting services for regulation of water.

THE REHABILITATION PROJECT

Padianallur tank has a free catchment of 375 hectares (ha) and an intercepted catchment of 310 ha. While the entire runoff from the free catchment flows to the tank, only part of the intercepted catchment, limited to 2.38 cubic meters per second (m^3/sec), is allowed to flow into the tank through an inverted sypnon; the excess runoff flows out into a feeder channel leading from Sholavaram Lake to Red Hills Lake below it, and supplies drinking water to Madras. This syphon was found choked with rock, debris, and silt and was therefore not functioning as a water carrier to the tank.

The present waterspread area of the tank is 97.3 ha with a storage capacity of 721 thousand m^3 as against the designed waterspread of 97.7 ha with a storage capacity of 817 thousand m^3. The loss in storage capacity over the years due to siltation is 11.8 percent. Besides, thick vegetative growth of weeds like nut grass (Cyperus spp.) occupies a considerable storage space and depletes the tank water by evapotranspiration. An extent of 37 ha of private agricultural lands bordering the tank on the foreshore, which is under cultivation, contributes to soil erosion and silt accumulation in the tank bed. The salient features of Padianallur tank are shown in Table 1.

Table 1. Salient features of Padianallur tank.

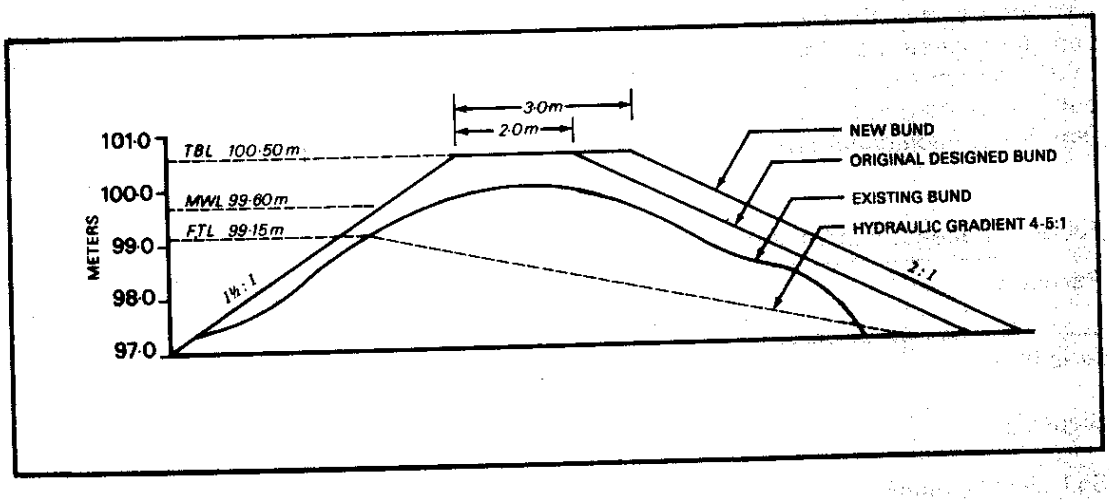
Particulars	Watershed area		Waterspread area	Command area
	Intercepted	Free		
Area (ha)	310	375	97	260[a]
Slope (%)	3.0	1.5	0.5	0.05
Soil classification[b]	RL	RL	SL	SLFS
Erosion	Mod	Slight-mod	-	-
Fertility	-		-	Low[c]
Vegetation (%)				
Agricultural crops	15	90	30	90[d]
Weeds	-	-	40[e]	-
Tree plantation	20[f]	-	-	-
Ragi & vegetables	-	-	-	10
Barren	65	10	30	-

[a]Gross (240 ha net); [b]RL - red loam, SL - sandy loam, SLFS - sandy loam & loamy fine sand; [c]poor in available N & P_2O_4, well-supplied with K, free of salinity & alkalinity; [d]mainly rice; [e]nut grass; [f]eucalyptus.

The storage capacity of the tank was originally designed for two fillings per year, with a total storage of 1.634 million m^3 to supply water for a single crop of 260 ha at the rate of 158.5 ha per million m^3 of water stored. The quantity of water received, the extent of cultivation, and the crops raised from 1982-86 are presented in Table 2.

The tank bund is a 1,845 meters long earthen embankment, trapezoidal in shape. A cross section of the tank bund along with its original formation level is furnished in Figure 1. The top level and side slopes have been obliterated over the years due to rains and erosion, encroachment by adjacent land owners, and willful cutting by the farmers. The bund needs to be strengthened and brought up to the design standard. By widening the tank bund, it can be used as a cart track which will improve the communication system between different villages situated near the north and east sides of the tank.

Figure 1. Typical cross-section of Padianallur tank bund.



A 38-meter long broad-crested masonry weir at the southern end of the tank and an earthen by-wash at the northern end of the tank bund dispose of an estimated flood discharge of 21.75 m^3/sec from the free catchment, and 2.38 m^3/sec from intercepted catchment received through the syphon, with a maximum discharge head of 0.45 meters over the crest of the weir. The surplus weir needs repair to its body wall, revetment, and apron.

There are four irrigation sluices. Sluice 4, a rectangular notch 0.5 meters wide with a sliding shutter, is located in the body wall of the surplus weir, while the other three, having plug and rod type controls, are located at different points along the tank bund. The location of each sluice in the tank bund, its sill levels, size of sluice openings, and area commanded are furnished in Table 3. About 6 ha of land north of sluice 1 is at a higher elevation and needs a very high heading up to draw water from the channel served by sluice 1. The owners of these lands cut open the tank bund and take water through the

Table 2. Particulars of water received in Padianallur tank and crops grown in the tank command area from 1981-86.

Year	1981-82			1982-83			1983-84			1984-85			1985-86	
Crop season*	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd
Max storage (million m³)	0.50	0.22	-	0.51	-	-	0.71	0.68	-	0.73	0.66	-	0.73	0.70
Date measured	Nov 81	Feb 82	-	Nov 82	-	-	Oct 83	Feb 83	-	Nov 84	Feb 84	-	Nov 85	Feb 85
Crops raised (ha)														
Rice, direct sown	159.59	-	-	160.77	-	-	156.24	-	-	164.32	-	-	117.43	-
Rice, transplanted	76.60	43.97	10.78	78.94	48.09	9.31	83.47	152.93	16.58	70.82	82.50	12.44	85.24	132.73
Rice, total	236.19	43.97	10.78	239.71	48.09	9.31	239.71	152.93	16.58	235.14	82.50	12.44	202.67	132.73
Green gram	-	68.13	-	-	72.48	-	-	-	-	-	16.34	-	-	
Groundnut	-	14.35	1.59	-	14.19	2.22	-	2.03	-	-	17.34	0.51	-	7.15
Ragi	-	0.42	22.45	-	0.42	23.82	-	0.17	3.36	-	2.50	12.29	-	0.29
Chilli	-	0.13	0.92	-	0.13	-	-	0.19	-	-	0.57	-	-	-
Cumbu (Bajra)	-	2.88	4.16	-	-	4.16	-	-	-	-	-	1.31	-	-
Gingelly (Sesamum)	-	-	1.95	-	-	2.50	-	-	-	-	-	-	-	-
Tapioca	-	0.75	1.71	-	0.62	1.36	-	-	-	-	-	-	-	-
Vegetables (Brinjal)	-	-	-	-	-	0.65	-	-	-	-	-	-	-	-
Sugarcane	-	-	-	-	-	-	-	-	-	-	4.35	1.50	-	4.21
Total (non-rice crops)	-	86.66	32.78	-	87.84	34.71	-	2.39	3.36	-	41.10	15.61	-	11.65
Total (all crops)	236.19	130.63	43.56	239.71	135.93	44.02	239.71	155.32	19.94	235.14	123.60	28.05	202.67	144.38

Year	1981-82	1982-83	1983-84	1984-85	1985-86
Rainfall received (mm)					
Southwest monsoon (Jun-Sep)	487.80	373.90	800.60	490.20	352.20
Northeast monsoon (Oct-Dec)	542.00	426.40	809.60	702.00	933.20
Dry weather & summer (Jan-May)	-	2.00	377.20	115.20	289.60
Total annual rainfall**	1029.80	802.30	1987.40	1307.40	1575.00

*1st crop - direct sown, Sep to Jan, and transplanted, Oct to Jan; 2nd crop - transplanted, Feb to May; 3rd crop -transplanted, June to Aug.
**Average annual rainfall - 1340.18 mm.

earthen cuts. This is an annual feature resulting in breaches to the tank bund during the subsequent floods. Sluices 3 and 4 are leaky. The leakage from sluice 3 was as much as 18 percent of its designed discharge. These sluices have to be repaired and made water-tight to facilitate conservation, and improve control of water regulation.

Table 3. Location of sluices (with circular tops and rectangular bottoms at sill level), specifications (in meters) of tank structures, and command area (in hectares) at Padianallur tank.

Sluice	Location	Sill level		Size of opening		Area
		Top	Bottom	Top	Bottom	
New	LS 358	98.74	98.14	0.100 dia	0.10 x 0.125	6
1	LS 680	97.84	97.24	0.146 dia	0.30 x 0.175	82
2	LS 1166	97.63	96.93	0.150 dia	0.15 x 0.175	137
3	LS 1443	97.70	97.08	0.200 dia	0.30 x 0.175	33
4	LS 1771	98.29	98.14	0.40 x 0.86	0.10 x 0.15	8

Note: LS = longitudinal section; length of tank bund, 1845 meters; top width, 2 meters (proposed increase to 3 meters); side slopes: front = 1.5:1, rear 2.0:1; Full Tank Level (FTL) = 99.15, Maximum Water Level (MWL) = 99.6 Tank Bund Level (TBL) = 100.5.

Main irrigation channels are aligned mostly in cutting to minimize seepage losses. As their bed levels are lower than the adjoining field levels, water is diverted from these channels to the field by heading it up with temporary earthen blocks. As the water level in the tank goes down toward the end of the irrigation season, the farmers remove the silt and deepen the channels to make full use of tank storage.

The command area is gently sloping eastward (0.05 percent); the soils are sandy loam and loamy fine sand, low in organic matter, nitrogen, and potash and well supplied with phosphorus. Both soil and water from the tank and the wells are suitable for irrigation and do not pose any problem of salinity. The extent of land holdings in the command area varies from 0.1- 5.1 ha. The command area totals 260 ha in the 3 revenue villages of Padianallur (157 ha), Theerthakarayampattu (28 ha), and Palavoyal (75 ha). But, in many years, the farmers cultivated only 163-239 ha (63-92%) for want of an adequate supply of water to the tank. The distribution of wells under each sluice command and the area irrigated by them are furnished in Table 4.

The water table in the command area during the post-monsoon period is 0.35, 0.54, 1.40 meters below ground level in the head, middle, and tail end reaches, respectively. There are 30 open wells and 20 tube wells in the area, of which 22 and 16, respectively, are presently in use. Irrigation from wells is resorted to when the tank is dry. Most of these wells have electric or diesel powered pumps and the area under their command is 94.50 ha (36%). After meeting their needs, the farmers sell water to neighboring landowners at a cost of Indian Rupees (Rs) 7.00 (US$0.70) per hour of pumping. It takes about 15-20 hours of pumping to irrigate 1.0 ha of land to a depth of 5 centimeters (cm).

Table 4. Wells under each sluice and area irrigated (in hectares), using electric motors (EM) or oil engines (OE) for pumping, during 2nd crop season, 1985-86.

Sluice	Open wells in use		Tube wells in use		Open wells not in use	Irrigated extent		Total irrigated extent
	EM	OE	EM	OE		well owner's land	others	
1	4	-	4	9	-	24.16	8.76	32.92
2	11	-	7	1	5	35.90	9.08	44.98
3	3	1	6	1	1	12.41	4.06	16.47
4	-	-	-	-	1	-	-	-
Total	18	1	17	11	7	72.47	21.90	94.37

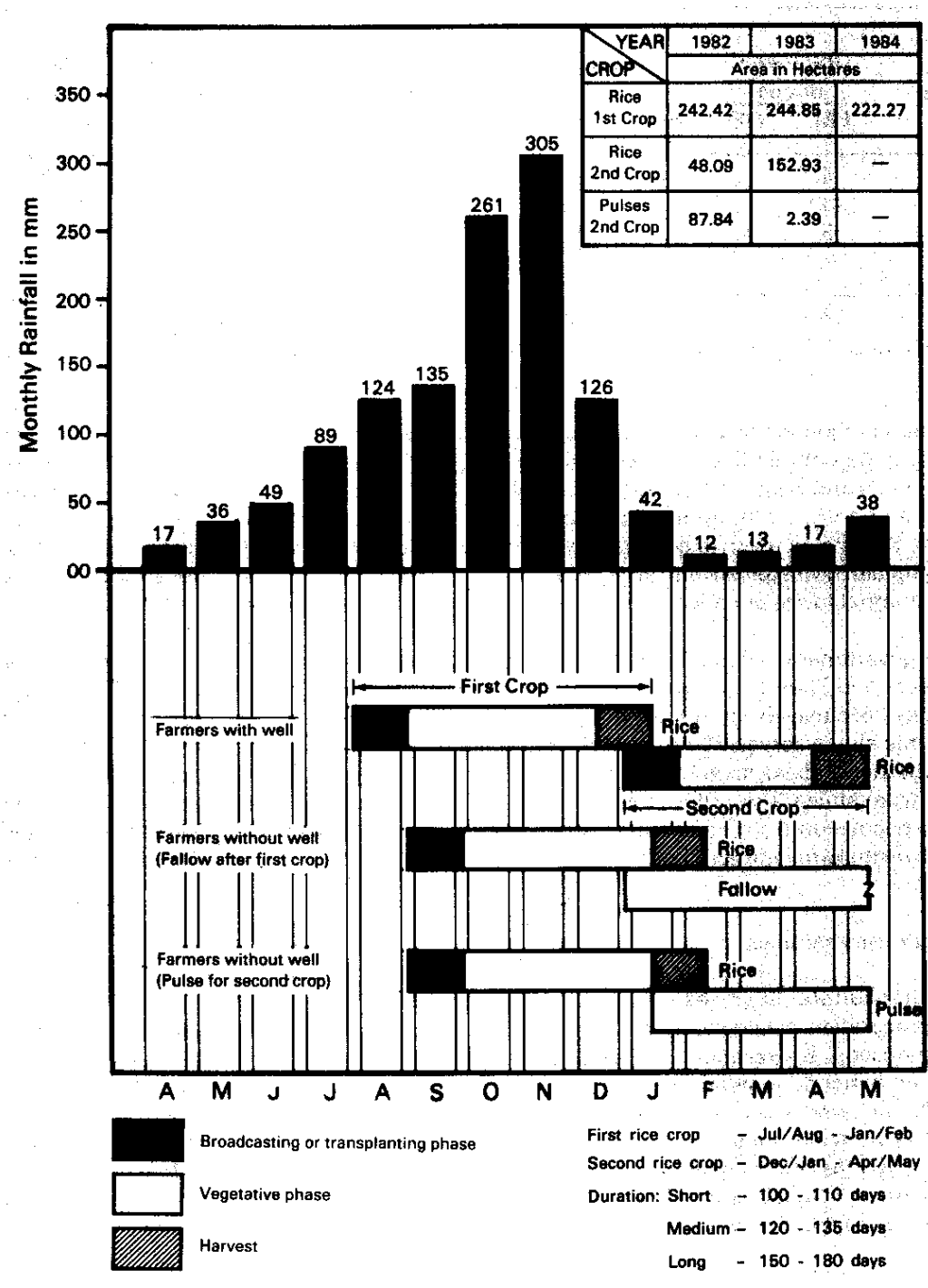
Water is regulated by a water guide (*Neerkatti*) employed by the farmers who pay him 25 kilograms (kg) of paddy per hectare of land irrigated by tank water per year. The water guide opens and closes the sluices and regulates the water to the land holdings on the basis of demand and mutual agreement among the land owners under the command of each sluice. So long as there is adequate water available in the tank to meet the total demand, no complaint is received but often the tail enders and farmers who are away from the main channel fail to get adequate supply when the level of tank water recedes.

The government has authorized a turn system by which the farmers in the villages of Palavoyal and Theerthakarayampattu draw the entire water supply from sluice 2 on alternate days exclusively to irrigate their 100 ha at the tail end of the system. On the other days, this sluice serves 35 ha in Padianallur village. Apparently, there is a need to examine whether Palavoyal and Theerthakarayampattu villages deserve a greater share of water from sluice 2 in order to receive an equitable distribution. But then, there will be strong opposition from Padianallur village for providing any additional water to Palavoyal and Theerthakarayampattu, as these villagers are latecomers in using the Padianallur tank system.

Agricultural Practices

The agricultural practices near the Padianallur tank closely follow the rainfall pattern. Land preparation commences in July or August after the first few showers of the southwest monsoon. Broadcasting of rice seed begins by about the middle of August and continues for a month or more. Usually, heavy rains are expected by the last week of September. Tank water is replenished during October, but the farmers do not use the tank water as rainfall is normally adequate from October to mid-December. The crop is irrigated with tank water only after the rain stops or when the interval between the rains is long. Generally, two or three irrigations are given to a depth of 8-10 cm each before the crop matures. Figure 2 gives the rainfall and the crop pattern prevailing in this command area.

Figure 2. Rainfall and crop pattern at Padianallur tank, 1982-84.



About 70 percent of the farmers raise a broadcast rice crop during the first season (August-January). The crop yield is about 1.7 metric tons per hectare (t/ha). The broadcast crop usually suffers due to vagaries of the monsoon and excess of weed growth. To avoid this, about 30 percent of the farmers raise transplanted rice using their well water for irrigating nurseries. The yield of transplanted rice is about 2.8 t/ha which is nearly 65 percent higher than the broadcast crop due to better weed control and fertilization. However, the net income to the farmers for the transplanted rice is Rs 550/ha (US$55/ha) and that for the broadcast crop is about Rs 500/ha (US$50/ha). About 60 percent of the farmers sow improved varieties like Ponni and IR 20, and others raise traditional varieties like Vadan Samba and Buyyagunda.

When the water level in the tank is high at the end of the first crop, about 20 percent of the farmers raise rice as a second crop and another 20 percent raise green gram. Only 3 percent of the farmers cultivate groundnut in the elevated fields which are well-drained. A few farmers cultivate gingelly (an oilseed crop) during April and May. When the water level in the tank is low, as it was in 1981-82, farmers switch to green gram for a second crop. When the early southwest monsoon rains are subnormal, *ragi* (millet) is raised in nurseries under irrigation from wells in July and August, transplanted after 25 days, and harvested two months later. The yield is about 2 t/ha.

Socio-Economic Survey

The baseline survey data on the socio-economic conditions of the farmers in the tank command were analyzed by classifying the farmers according to land holdings: small (less than 1 ha), medium (1-2 ha), and large (more than 2 ha), and subdividing them into head, middle, and tail end farmers. The data revealed that small-scale farmers constituted 80 percent of the total, while the medium- and large-scale farmers constituted 14 and 6 percent, respectively. About 10 percent of the farmers possessed supplemental sources of irrigation like wells (open and tube) and had field channels on their land. Ninety percent of the small farmers lacked field channels for irrigation. Although only 62 percent of the medium-scale farmers had field channels, all the large-scale farmers had them. In all, about 65 percent of the area lacked field channels. Therefore they have been following field-to-field irrigation.

Generally, water to a depth of 8-10 cm is applied to the rice crop in each irrigation by the three groups of farmers. Sometimes, the depth increases to 12 cm in head and middle reaches. Whenever there are heavy rains and the depth of water exceeds 12 cm, the farmers cut open their field bunds to permit surface drainage of the excess water. The lands are also drained just before applying pesticides and again about 10-12 days prior to harvest. Table 5 shows a breakdown by type of farmer and the irrigation schedule they followed.

About 85, 57, and 67 percent of the small-, medium- and large-scale farmers, respectively, expressed their dissatisfaction about the poor timing and inadequacy of water supply. All three groups of farmers in the tail end expressed their dissatisfaction over the water distribution. They all required augmentation of water supply by carrying out necessary improvements to the tank and distribution network.

Table 5. Breakdown of landholdings in different reaches and the farmers' irrigation schedule (total area in ha, irrigation intervals in days).

Location and farmer type	Number of holdings	Total area	Irrigation intervals	Number of irrigations
Head Reach				
Small	43	21.56	5	13
Medium	18	26.43	6	12
Large	3	12.34	7	10
Total	64	60.33		35
Middle Reach				
Small	65	30.21	6	12
Medium	19	27.26	6	11
Large	3	12.33	6	11
Total	87	69.80		34
Tail Reach				
Small	141	39.93	6	12
Medium	8	10.86	7	10
Large	5	56.59	6	12
Total	154	107.38		34

Note: Observed data for second rice crop during 1985-86. Rice planted is IR 50 (105 days to maturity). Nursery, 25 days. Last irrigation 10-15 days prior to harvest.

PROJECT IMPLEMENTATION

Based on the surveys, observations, and measurements made during the pre-rehabilitation studies, the deficiencies of the system were identified and measures to correct them were designed. The proposed rehabilitation measures were discussed with the farmer beneficiaries and their views were collected regarding the physical improvements envisaged for the irrigation system. The proposals were then modified to meet their requirements. New members who showed interest in the proper operation of the irrigation system were added to the farmers' committee responsible for managing the tank.

The design and specifications of the proposed rehabilitation, as modified by the suggestions of the farmers, were forwarded to the collaborating organizations for implementation. Their work was coordinated and monitored by Anna University. The improvements could be executed only during the off season when agricultural operations were not in progress. The working days were few in number and there were many interruptions to

field operations due to rain, scarcity of labor required for heavy earth work, and field staff of implementing departments being diverted to other work which slowed down completion of the envisaged improvements.

The PWD undertook improvements to earthen embankments, stone pitching, surplus weirs, sluices, and main irrigation channels. The Agricultural Engineering Department (AED) undertook the on-farm development (OFD) works. And the Forest Department (FD) carried out the tree planting on the tank bed. The Survey and Land Records Department identified government field boundaries in a small part of the command area and helped to fix demarcation stones to prevent encroachment by adjacent farmers. The farmers undertook emergency works, such as breach closing of the tank bund during floods and silt clearance of supply channels to augment water supply in the tank.

Completed Improvements

The following improvements to the physical facilities had been carried out as of 1986. Tree planting of about 12,000 *eucalyptus spp.* was done on 4 ha of private land on the foreshore during 1983 and with about 22,000 *acacia spp.* on 11.5 ha of government-owned tank bed during 1985. These tree plantations were meant to minimize silt accretion into the tank waterspread to some extent. The main feeder channel from the syphon to the entrance of the tank was excavated by the farmers as community work. Although not to the designed standard, it was enough to carry the inflow during low rainfall. The farmers requested desilting and deepening of the tank bed so that, even if it increased the dead storage, they could pump out that water for the last two to three wettings of the second crop because water shortage at that time (April) was critical. However, the PWD was not able to do this work due to the problem of where to dispose of the excavated earth. As a compromise, arrangements were made to permit the farmers to excavate the tank silt within a demarcated area in the tank bed and apply it to their fields. The earthen embankment of the tank bund with laterite stone pitching on the front slope had been strengthened at vulnerable places according to prescribed standards.

Clearing the choked-up syphon. The PWD cleared the vent way of the syphon conveying runoff from the intercepted catchment.

Surplussing arrangements. The broad-crested masonry surplus weir which was leaky in many places was grouted with cement and strengthened with concrete. Computations of the anticipated 50 year flood flow showed that the spillway capacity of the existing surplus weir was adequate. However, in order to prevent breaching of the tank bund at the northern end, where the fetch of the water spread is large, a masonry paved by-wash (overflow gate) was constructed in place of the existing earthen one.

Sluices. New sliding shutter and plugs and rods were provided for all four existing sluices. These sluices were also repaired and the leaks stopped. A new sluice was constructed north of sluice 1 to provide water for the elevated fields which had difficulty receiving water from the sluice 1.

Irrigation and drainage channels. The main earthen channels conveying irrigation water from the sluices to the fields in the tank command were all restructured to design specifications and deepened to the downstream sill level of the sluices. The meanders and sharp ends were eased to smooth curves or straightened where feasible. The side banks that had eroded and caved in were brought in line with designed side slopes after the removal of weeds and other vegetation. Stone pitching on the side slopes of the main channel was done for a length of 18 meters downstream of the sluices in order to stabilize the channel bank and permit precise flow measurements. Portable "V" notches and Parshall flumes were installed at these locations and the daily outflow of water from each sluice was computed.

On-farm development works (OFD). The AED has carried out OFD works in the command areas of sluices 1, 3, and 4. The 33 ha command area of sluice 3 was divided into three convenient blocks -- A, B, and C -- of about 11 ha each. Two bed regulators were constructed at selected points across the main channel to head up the required depth of water and to divert the designed flow to the lined laterals to irrigate one field at a time in each block. The carrying capacity of each lateral was 0.03 m^3/s (1.06 cusec). It takes 3 hours to apply 5 cm depth of water to 0.40 ha (1.0 acre). Irrigation was proposed only during the daytime hours from 0600 to 1800 each day and therefore each lateral can irrigate 1.60 ha (4.0 acres) in a 12 hour day. Thus it takes 6-7 days to complete one irrigation in each 11 ha block. Because the bed regulators permit simultaneous irrigation of one field at a time in each of the three blocks, all the blocks have the benefit of equitable water distribution, and the second irrigation can be taken up immediately following the first rotation in a predetermined order.

Physical facilities such as distribution boxes with mild steel (MS) plate sliding shutters, field channels, pipe inlets, and drainage outlets have been provided in many of the fields. The actual operation of distributing the water to fields within each 11 ha block is vested with the farmers' committee and the landowners for implementation.

OFD works were also executed in the command areas of sluices 1 and 4. After observing the actual working of the water distribution and application using these physical facilities, similar work was proposed in the command area of sluice 2. In this command water distribution is complicated by the larger area irrigated and by the need to supply two groups of villages with widely different areas to irrigate -- Padianallur (35 ha) and Palavoyal and Theerthakarayampattu (100 ha) -- on alternative days for 12-hour periods.

As the terrain of the command area is almost flat (0.05%), the quantity of water in the lateral flow (subsurface runoff) or return flow is minimal. Hence, the irrigation system was designed to meet the water requirements of the entire command for growing rice at its peak requirement, which is during the land preparation and puddling stages.

Proposed Improvements

The following activities were originally proposed but have yet to be undertaken and completed:

1. Tree planting in possible vacant lands in the catchment area which will further prevent sedimentation of the tank.

2. Closing the breach in the right bank of the Sholavaram lower supply channel which will further augment the water supply to the tank.

3. Completing the strengthening of the tank bund, providing gravel casing on the top and sides, and extending the tank bund on the north beyond LS 00 to meet the high ground, which will facilitate greater storage.

4. Constructing a causeway providing access to the tank bund from Padianallur village during the rainy season.

5. Providing a toe-drain to collect seepage water and divert it into the main channel to prevent flooding of fields.

6. Permitting the farmers and others to remove the silt from the tank bed within a demarcated zone to increase storage.

7. Providing a shutter for the newly constructed sluice as well as locking arrangements for the sluice shutters recently replaced.

8. Providing shutters for the bed regulator constructed in the first sluice head-reach.

9. Fixing survey stones and demarcating government land boundaries to identify encroachments.

10. Interchanging the sluice openings between sluices 2 and 3 to improve equity.

11. Desilting the supply channel to the tank and the drainage channel from Sholavaram, which also augments irrigation supply to the tank command.

12. Providing shutters to all distribution boxes and lining laterals as found necessary.

13. Reconstructing damaged lined laterals and distribution boxes in the OFD works.

14. Completing the excavation of field channels.

15. Evicting encroachers from government land and preventing further encroachment which aggravates sedimentation.

16. Counselling farmers more intensely about improved cropping patterns and agricultural practices.

17. Educating farmers on the benefits of improved water management practices.

This work had not been completed when this was written. Reasons include the lack of sanctions from the authorities concerned, lack of funds, lack of adequate labor, and the failure to realize the importance of the work. With the necessary conviction and commitment of the authorities and farmer beneficiaries, these works can be completed thereby providing the full benefits of the interventions to the farmers they were designed to help.

ASSESSMENT OF INTERVENTIONS

As this is a pilot project study, a critical assessment was made of the constraints encountered and of the benefits arising from the interventions. Although such an assessment of a local study is perhaps limited in its application to other farmer-managed irrigation systems, it provides valuable information on common problems which one might encounter in other tanks. Some of the benefits have been cost effective, while others resulted from motivating farmers to act in ways that promote the common welfare.

Tree Planting in the Foreshore Private Lands and the Tank Bed Area

When the plan was drawn up suggesting the planting of trees in the catchment area and the foreshore lands as a measure of soil conservation, it was given first to a large-scale farmer to plant a substantial portion of his lands to eucalyptus hybrids. The FD was to follow by planting the tank bed land with *acacia spp.*, which would minimize silt accretion into the tank.

Clearing of Silt and Debris by the PWD from the Choked-up Syphon

Though of low cost, this work helped augment water supply to the tank, increased its storage, and resulted in greater cropping intensity in its command area. It also motivated the farmers to clear silt from the supply channel between the syphon and the tank as community work.

Strengthening the Tank Bund

Flooding of fields in the head reach due to seepage through the bund has been minimized by strengthening and widening the bund. The threat to the bund by breaching has also been minimized. The widened tank bund now serves as a cart track to transport seeds, manure, other inputs from the village to the fields, and produce from the fields to the market. Communications have improved considerably.

Restructuring the Main Irrigation Channels and Providing Lined Laterals

The seepage loss during conveyance from the sluice to the fields was reduced due to weed removal from the main channels. Easing meanders and sharp bends and straightening the channel course have helped to convey the water to the lower fields with less travel time. Provision of uniform bed grade has helped provide non-erosive velocity to the water.

Similarly, providing lined laterals has helped to minimize operational losses and to convey irrigation water rapidly, a need of the tail end farmers. This in turn has helped to reduce the time lag in transplanting operations and to minimize moisture stress of crops. Providing lined laterals in a planned layout has prevented the farmers from excavating earthen channels every year and introduced discipline in the conveyance of water. It has also constrained the farmers who used to take water by cutting the embankment of the main channel and placing earthen blocks across it. Some farmers who had fields adjoining the main channel or the lateral have become tail enders in the newly laid out OFD works and therefore wait longer for the water to reach their fields. These farmers, as well as the water tenders of absentee landlords, seldom await their turn to receive water through the newly-constructed laterals and, instead, cut the banks at places adjoining their fields to expedite irrigation.

On-Farm Development Works

Previously, 65 percent of the landholders in the tank command lacked channels to convey water to their fields and practiced field-to-field irrigation. The OFD works have provided adequate irrigation channels at a density of 39 meters/ha for lined laterals and 175 meters/ha for earthen field channels. Considering that there are 336 fields in a 260 ha command area, this density is considered necessary for the water to reach every one of them. The layout of the water courses was decided upon in consultation with farmer beneficiaries who agreed to maintain them in good condition.

Repairs to the Leaky Surplus Weir and Sluices and Replacement of Worn-out Shutters

About 18 percent of the designed discharge was wasted through leaky sluices and leakage from the surplus weir. Repairs have eliminated these leaks thus preserving water in the tank. This additional water has helped farmers to increase cropping intensity in the area.

Day-time Irrigation

Hitherto, once the sluice was opened at the beginning of the irrigation season, it was closed only when the heavy monsoon rains inundated the fields and drainage became difficult. Water would otherwise flow continuously in the main channel and the farmers who needed it diverted it to irrigate their fields; at other times the water was wasted. A system of 12-hour irrigation from 0600 to 1800 was introduced with the consent of the farmer beneficiaries. This has also helped to conserve water for the second crop season and thus helped to increase the cropping intensity in the tank command. Table 2 gives the area irrigated during the different years, and shows a substantial increase both in the total area cropped and the farmers' preference for the price-supported cereal crops and cash crops.

Another progressive step by farmers was the switch from the traditional long-duration rice varieties, which covered about 20 percent of the area during 1981-82. High-yielding,

medium- to short-duration varieties like IR 20, Ponni, IR 50, and IET were adopted, which require the right quantity of water at the right time for a good crop yield. This switch was mainly due to the greater reliability of water ensured by the interventions.

Increase in the Number of Wells

The farmers were quick to realize the value of wells as a supplemental source of irrigation and the benefit of conjunctive use of tank and well water. Farmers owning wells could raise nurseries with well water and transplant the seedlings in time for the first crop to take full advantage of the monsoon rains. Similarly, wells could contribute at the critical stage of the second crop (Feb-May) to prevent moisture stress to the crop and thereby increase yield. As a result, farmers have sunk new wells in the 260 ha tank command area, and increased the number of operational wells from 38 to 47 in 5 years. Crop yields from the fields having supplemental sources of irrigation from wells have been generally higher.

Drum Culture Studies

Drum culture studies made in the field during the first (Sep-Jan) and second (Feb-May) crop seasons show that, when properly managed, rice can be grown with 95 cm of consumptive water use, providing a good yield during the first season. However, many farmers use 105-110 cm of water. This wasteful practice was highlighted in the field demonstration conducted at this tank command under the operational research project in collaboration with Tamil Nadu Agricultural University, Coimbatore. It showed that with 10-15 percent reduction in irrigation water, a higher crop yield of 12-14 percent could be obtained. The same farmers who over-irrigate their fields with tank water during the first crop season, use it economically during the second crop season when the water level in the tank recedes. The switch amounts to a 25 percent reduction in consumptive water use and illustrates the farmers' awareness that reduced water use need not be detrimental to the crop. This water conservation concept needs to be emphasized and encouraged to further increase cropping intensity in this area.

Investment Cost and Benefit

It is perhaps premature to make a systematic cost benefit analysis before the improvements contemplated in the entire tank irrigation system have been completed. However, it is worth studying the investments made in the rehabilitation project so far and their apparent benefits.

So far, Rs 709,201 (US$70,920) have been spent on this rehabilitation project by various organizations. This works out to Rs 2,955/ha (US$296/ha) of land benefitted. The main benefit to farmers that could be attributed to the improvements is a better water supply, resulting in increased crop yields and increased cropping intensity (from 120% to 140% under rice, Table 6).

Importance of Farmers' Cooperation

While all the farmers in the tank command expressed eagerness to acquire and store water in the tank, they did not show the same concern for its economic and equitable distribution. The farmers who used to divert water by blocking the main channel found it cumbersome and time-consuming to operate the bed regulator to head up the water and draw it through a lined lateral, a masonry distribution box, and an earthen field channel.

Table 6. Rice yields (in kg/ha) and profits (in Rupees/ha) related to improved water supply in areas of the tank command.

	Rice yield		
	In unimproved areas	In improved areas	Profits
Crop I	2200	2800	1040 (US$104)*
Crop II	3700	4500	1400 (US$140)**

*At Rs 130/bag of 75 kg; **at Rs 135/bag of 75 kg.

The main channels are on government land, while the lined laterals, distribution boxes, and field channels are constructed on private land. These common facilities, which pass through individual properties, create conflicts even though all the farmers concerned expressed their whole-hearted cooperation and willingness to have them located on their land for the benefit of all. Disagreement between two farmers over the excavation and maintenance of a field channel affects many others downstream who have to depend on this channel for irrigation. Although these difficulties could be resolved at the farmers' committee level or even among the farmers involved, often it ends up in damage to the field channel and denial of water to the farmers. Patient and persistent education of the farmers at the village level to adapt themselves to the changed pattern of water conveyance and application appears to be the only solution.

Frequent meetings, short training programs, pamphlets illustrating the irrigation system and its operation, visits to an efficient irrigation system, and films and videos about irrigation can make important contributions to farmer education. Simultaneously, punitive measures against water users who ignore the agreed code of conduct have to be taken if equitable distribution and economic use of water and proper maintenance of physical facilities are to be ensured. Unless these follow-up measures are taken during project implementation, the success of the project will be in doubt. People generally respond favorably when they benefit. As the rehabilitation project bestows a benefit on the community, that community would want to use the benefit to the best advantage. As rehabilitation projects are more advantageous than new projects in terms of investments and returns, they should be pursued with enthusiasm and dedication so that the projects which once provided an assured water supply could be improved to bestow increased benefits to the people of the area.

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DEVELOPMENT OF SMALL-SCALE LIFT IRRIGATION IN BANGLADESH

M.A.S. Mandal*

INTRODUCTION

Irrigation in Bangladesh has been developed under a variety of complex and diverse conditions. The physical and social environments of agriculture in this country have resulted in the development of a number of alternative small-scale lift irrigation technologies, such as deep tube wells, shallow tube wells, hand tube wells, and low-lift pumps. In addition, there are also traditional manually operated devices such as *dhones* (conical-shaped containers, usually 3.0 meters x 0.3 meters, used for lifting water for irrigation), swing buckets, and dug-wells. The operation of these irrigation technologies has been accompanied by a variety of administrative control and support services from government and non-government agencies, and as a result a number of farmers' organizational forms have evolved for the operation and maintenance of these installations.

This paper presents an overview of the development of small-scale lift irrigation in Bangladesh, and highlights recent field research on the organization and performance of irrigation systems. The background history of irrigation development in Bangladesh is also discussed, followed by a discussion of the role of irrigation agencies and farmer-agency interactions. The author's own research experiences in irrigation management and performance are discussed in the final section.

BACKGROUND OF IRRIGATION DEVELOPMENT

Physical Context

Bangladesh covers an area of 14.4 million hectares (ha) of which 9.1 million ha are available for cultivation. The remainder falls under forest or is unavailable for cultivation. Almost the entire cultivable land (95%) has already been brought under cultivation, and the proportions of land under single, double, and triple cropping are 54, 39, and 7 percent, respectively. This means that the required increase in agricultural production has to be achieved entirely through crop intensification on the existing land, which can be made possible primarily through the expansion of controlled irrigation and drainage facilities.

Two important climatic factors which have shaped peasant behavior in relation to uncertainty and risk aversion are annual flooding followed by monsoon rains in summer and drought in winter. Rainfall is over 200 centimeters (cm) per year, varying from 550 cm in northeast to 150 cm in the west. About 90 percent of Bangladesh is vulnerable to flooding

*Assistant Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

to different depths at one time or another in a typical year, but 70 percent usually experiences deep (1-4 meters) and shallow (0.3-1.0 meters) flooding, affecting crop selection by farmers.

Although the potential for ground water irrigation is not known at present, it is generally reported that about 50 percent of total cultivated area can be irrigated by exploiting both surface and ground water (Bottrall 1983). Small-scale lift devices are suggested for extraction of ground water but the choice of technologies (i.e., whether 2 cusec deep tube wells, 0.75 cusec shallow tube wells, or 0.02 cusec hand tube wells) depends on the groundwater level. For example, smaller devices like shallow or hand tube wells are inappropriate where static water level exceeds 6-7 meters during the dry winter months. In such situations deep tube wells are suggested, but in any area actual discharges from tube wells will depend on the conditions of the aquifer, soil permeability, drawdowns, or tube well-to-tube well spacing.

Social Context

Bangladesh is a densely populated country of 98 million people of whom 80 percent live in rural areas and directly or indirectly depend on agriculture. The density of population in 1984 was 680 per square kilometer. There exists a high inequality in the distribution of land which is the basis of rural wealth and power. Over 56 percent of total households are virtually landless including those possessing less than 0.2 ha of cultivated area with little or no homestead land, and they work mostly as agricultural wage laborers for their livelihood. Small farm owners operating less than one hectare constitute 70 percent of total farm households but possess only 29 percent of the farm land. At the other extreme, large farms operating land above 3 ha constitute less than 5 percent but own 26 percent of total farm land (BBS 1986).

Average farm size has declined from 1.4 ha in 1977 to 0.9 ha in 1983-84 with a high degree of land fragmentation. About 25 percent of farm land is cultivated under tenancy, mostly on 50-50 share-cropping arrangements without any cost-sharing for inputs. The terms for land mortgage are changing from the traditional fixed-term mortgages (*khailkhalashi*) to more stringent unspecified-term mortgages (*daisodhi*), and the extent and incidence of land mortgaging and share-cropping with not only land but also water are increasing with the spread of high yielding varieties (HYV) cultivated under irrigation (Mandal 1985).

Pattern of Irrigation Development

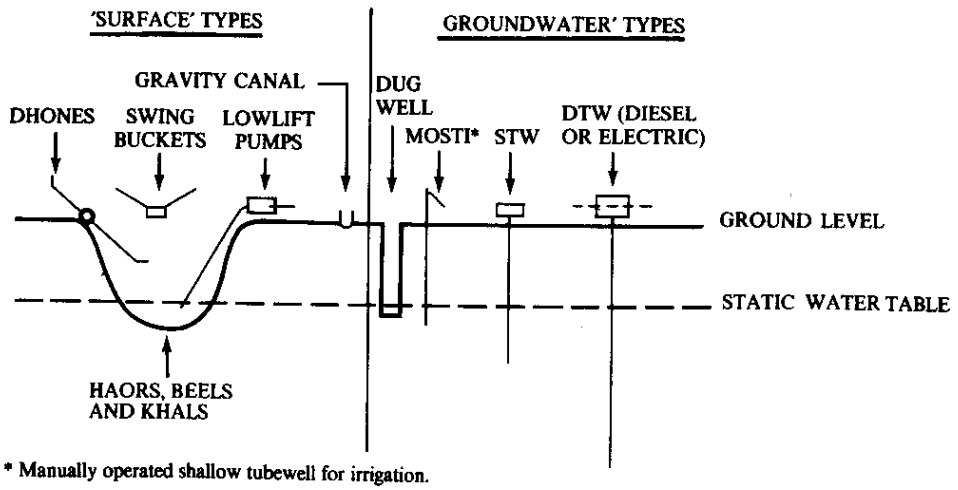
In many parts of the country, particularly in the low lying *haor* areas, farmers have been using surface water for irrigation with the help of the traditional manually operated lift devices, such as swing buckets and dhones. Even open dug-wells have been in use for extracting ground water in many areas for irrigation. Table 1 and Figure 1 present the underlying characteristics of different methods of irrigation currently used in the country.

Table 1. Characteristics of irrigation technologies related to command area ('000 ha, 1983-84).

Criteria	Dhone	Swing bucket	LLP	Gravity canal	Dug well	HTW	STW	DTW
Irrigation coverage	238.50	83.80	666.8	134.0	6.10	22.30	303.6	415.4
Irrigation Percentage	12.70	4.50	35.6	7.2	0.30	1.20	16.2	22.2
Motive power	M	M	D/E	D/E	M	M	D/E	D/E
Average design discharge (cusec)	0.04	0.06	1-2	-	0.01	0.02	0.50-0.75	2
Maximum pumping height from water level/water table (meters)	2.10	0.60	9.1-12.1	-	6.10	6.10	7.6	75.7
Capital cost (1981-82 taka*, '000)	0.06	0.02	50-90	-	0.185	0.80	35	400
Working life (years)	5	2	7	25+	3	7	7	7-15
Potential command area (ha)	0.40	0.10	16.2-32.4	-	0.10	0.20	8.1	32.4
Subsidy as % of capital cost (1981-82)	-	-	70-75	100	-	-	-	75-80

*Taka 21.96 = US$1.00; M = manual; D = diesel; E = electricity; HTW = hand tube wells; STW = shallow tube wells; DTW = deep tube wells. Source: Adapted from Biggs et al. (1978) and Bottrall (1983). Figures for 1983-84 irrigation coverage are taken from BBS (1985)Tables 4.31, 4.32, and 4.33.

Figure 1. Irrigation sources in Bangladesh.



* Manually operated shallow tubewell for irrigation.

The historical background of irrigation development initiated by the government has been a subject of interest or criticism in the country. The first major government attempt to expand irrigation was the creation of the East Pakistan Water and Power Development Board in 1959 (now Bangladesh Water Development Board, BWDB) and the formulation of the first water resources Master Plan in 1964, which emphasized flood control and drainage. This attempt was initiated when widespread floods occurred in the 1950s as a result of earthquakes in Assam. Also, there was a long tradition of gravity flow irrigation systems in the neighboring countries (Bottrall 1983). The immediate outcome of such attempts was the two large systems, the Ganges-Kobadak and Dhaka-Narayangonj-Demra Flood Control and Irrigation Projects, both of which use high-capacity pumps for primary lifting from the river.

Small-scale irrigation was started with the supply of low-lift pumps by the Bangladesh Agricultural Development Corporation (BADC) against fixed rental charges under an initial program called Mechanized Cultivation and Power Pumps Irrigation (MCPPI) in 1962-63, which was limited to low lying *haor* areas of Kishoregonj and Sylhet districts. Low-lift centrifugal pumps have a 1-2 cusec discharge capacity with a pumping head of 9-12 meters from water level and can irrigate 16-32 ha of HYV rice, depending on soils and topography (see Table 1). The number of low-lift pumps in operation increased from about 1,300 in 1960-61 to 39,556 in 1983-84 but the areas covered by pumps have fluctuated with a decreasing trend mainly because of inadequate water supplies in the traditional water sources (e.g., rivers, creeks, *beels*, and canals). Nevertheless, low-lift pumps are still the single largest irrigation source and cover about a third of the total irrigated area of the country.

The exploitation of ground water started in 1961 with the installation of 380 deep tube-wells of 4 cusec capacity in a compact field in the northern district of Thakurgaon as a special project of the BWDB. The subsequent development of tube well irrigation followed a high-cost strategy using sophisticated drilling techniques and imported materials. The well-publicized Thana Irrigation Programme (TIP) was established, and deep tube well pumps were rented to farmers' cooperative societies against payment of fixed annual rental charges. The supervision of cooperative management was given to the well-known Integrated Rural Development Program (IRDP) of Comilla, which has been recently renamed the Bangladesh Rural Development Board (BRDB). The costs of deep tube wells have always been heavily subsidized in the range of 70-80 percent, although the rate of subsidy has been gradually reduced. The number of deep tube wells has more than doubled from 7,407 in 1977-78 to 15,519 in 1983-84, to cover about 22 percent of the total irrigated area (see Table 1).

In the mid-1970s, the government encouraged the development of two more small-scale groundwater devices -- shallow tube wells and hand tube wells, often called MOSTI (manually operated shallow tube wells for irrigation). Government sponsorship promoted the development of MOSTI because these were much cheaper and easier to operate and manage with minimum organizational problems compared to deep tube wells (Planning Commission 1982). But these smaller devices were expected to give better equity results in terms of benefit distribution, a goal which remained unrealized with deep tube well

irrigation under the Comilla cooperative system. Shallow tube wells lift water 7.5 meters and have a 0.50-0.75 cusec discharge, while hand tube wells lift water to the same level but have only a 0.02 cusec discharge.

In recent years, there has been a shallow tube well boom so that their number increased rapidly from 20,931 in 1980-81 to 67,803 in 1983-84. These now cover about 16 percent of the total irrigated area of the country and, if the present trend of credit sale with huge default in loan repayment for deep tube wells continues, shallow tube wells are likely to overtake them. The recent rise in shallow tube well numbers has been accompanied by a government policy of privatizing irrigation equipment and other agricultural inputs.

The commonly used hand tube wells for supplying drinking water were promoted for irrigation following the serious food shortages after the 1974-75 crop failure caused by widespread flooding. UNICEF launched a MOSTI Project in 1975-76 by installing 10,000 pumps, and their number rose to 90,000 by 1979. About 22,000 ha (1.4% of total irrigated area) are currently irrigated by hand tube wells. A hand tube well is a small apparatus with 0.02 cusec discharge and can irrigate 0.1-0.2 ha by lifting water from a maximum depth of 7.5 meters. Although they are cheap, robust, and easily maintained, the expansion of hand tube wells is limited by the extreme drudgery involved in the task of pumping by hand. This is one of the reasons that hand tube wells are being replaced by machine-pumped deep and shallow tube wells.

One may wonder why the decision was not taken to sell irrigation equipment rather than to continue renting it out. The planning documents on the issue of privatization are not easily accessible but the BADC (1981) set out the grounds for selling deep tube wells. Deep tube wells would be sold if: 1) managers of the rented deep tube wells did not follow technical advice for operation and maintenance; 2) low quality fuels and lubricants were frequently used, damaging engines; 3) the engines and pumps were not properly maintained during the off-season; 4) irrigation coverage was low; and 5) farmers' participation in system maintenance was poor.

It is not yet known if there has been any serious evaluation of tube well performance by the agencies concerned following the privatization program, but sales have been promoted by many government and non-government agencies. Although it was initially expected that a certain proportion of equipment (e.g., 10% in the case of shallow tube wells under IDA credit) would be sold on a cash basis, field evidence shows that cash sales have lagged far behind expectation (Hamid et al. 1982; Mandal 1985).

FARMER-AGENCY INTERACTIONS IN IRRIGATION DEVELOPMENT

In recent years, a number of government and non-government agencies have been involved in organizing minor irrigation development in Bangladesh. In view of the physical and social environment of agriculture within which irrigation is promoted (as discussed in the previous section), different agencies pursue different approaches to organize and control irrigation groups. Tables 2 and 3 summarize the main management functions of the major government and non-government agencies involved in irrigation development.

Table 2. Government agencies involved in irrigation development and their management functions.

Government Agencies	Management Functions
Bangladesh Agricultural Development Corporation	
Rental	Supplying, siting, installing equipment; supplying oil, fuel, spare-parts, mechanical services; collecting rental charges,
Private	Selling, siting, and installing deep tube well (DTW) equipment; supplying major spare parts.
Bangladesh Rural Development Board	
KSS (Farmers' Cooperative Society)	Forming and supervising farmers' cooperatives, providing KSS loans, supporting landless irrigation.
KSS-IMP (Farmers' Cooperative Society-Irrigation Management Program)	Integrating back-up services, providing timely loans, and advising on improved water management and production practices.
Bangladesh Water Development Board	Providing irrigation equipment, improving the conveyance system, supporting operation and maintenance of installations, and collecting water charges.
Bangladesh Krishi (Agricultural) Bank	Own shallow tube well (STW) sale program providing loans for equipment and production; no responsibility for operation and maintenance.
Commercial Bank	Providing loans for purchase of equipment and production; no responsibility for operation and maintenance.
Grameen Bank	Supporting landless groups with loans for purchase and operation and maintenance of DTW and STW; negotiating with landowning farmers for command area; collecting weekly installments.

Source: Mandal, unpublished field survey, 1985-86.

Table 3. Non-government agencies involved in irrigation development and their management functions.

Non-government Agencies	Management Functions
Center for Human Development (PROSHIKA)	Providing security to landless groups for bank loans for equipment purchases; providing small operating loans.
Bangladesh Rural Advancement Committee (BRAC)	Providing financial and advisory support to landless groups in acquiring and operating irrigation equipment.
Cooperative for American Relief Everywhere (CARE)	Providing collaborative support for improving irrigation performance;, collaborating with PROSHIKA and Grameen Bank to support landless irrigation (under LOTUS program).
German Agency for Technical Cooperation (GTZ)	Providing loans for irrigation equipment purchases, support services, inputs, and advisory services in collaboration with BRDB.
Danish International Development Agency (DANIDA)	Supporting irrigation development in collaboration with BRDB.
Rangpur-Dinajpur Rehabilitation Service (RDRS)	Supporting mostly small farmers with irrigation equipment, design-improved MOSTI (Treadle pump, bamboo tube well).

Source: Mandal, unpublished field survey, 1985-86.

Management Functions of Irrigation-Related Agencies

The Bangladesh Agricultural Development Corporation (BADC) as the largest government agency has monopolistic control over the procurement and distribution of irrigation equipment. Under the new sales program associated with the privatization policy, BADC sells irrigation equipment to individual farmers or farmers' groups (according to recent regulations these have to be cooperatives for deep tube wells) against payments made in cash or through a bank loan. In the case of the sales program, farmers themselves are responsible for repair and maintenance of machines but BADC should ideally provide spare-parts on payment and mechanic's services free of cost. In reality,

farmers do not receive any mechanical support from BADC which means that they have to depend on private mechanics' services developed on local individual initiatives. Under the rental system, BADC is responsible for delivery, installation, and repair and maintenance of deep tubewells and low lift pumps against fixed annual rental charges to be paid by the farmers. BADC also has greater control over irrigation equipment under this system and hence can ideally influence the formation of irrigation groups and direct the management functions of the schemes. This is one reason why the BADC officials have been generally reluctant about the sales program, especially about the sale of previously rented tube wells to the KSS (farmers' cooperative societies) which are in control of the BRDB.

BRDB is mainly responsible for forming KSS, which are provided with credit to purchase irrigation equipment. The KSS members also get credit from BRDB for the operation and maintenance of equipment as well as for the production of crops with irrigation. Under the BRDB-IMP, the KSS members should ideally receive increased credit and back-up services in terms of timely supply of inputs, ensured repair services for irrigation equipment, and extension advice, all directed towards improving irrigation performance.

The three agencies, BKB, CARE, BADC, are jointly responsible for assisting farmers of different tube well schemes to increase production and income under a program called Deep Tube well Irrigation and Credit Program (DTICP). They provide improved methods of water delivery, arrange necessary credit and complementary inputs, and train farmers to practice improved crop production techniques.

Under its shallow tube well program, the BKB (Bangladesh Agricultural Bank) sells shallow tube wells directly to farmers against loans. The BKB takes responsibility for installing the shallow tube wells through its appointed dealers, but the operation and maintenance of the tube wells become the sole responsibility of the tube well owners.

A very recent and, to some extent, remarkable form of organizational support for irrigation is the introduction of a landless irrigation program with PROSHIKA as the pioneer. In recent years, Grameen Bank also started its landless irrigation program, which is concentrated mostly in Tangail. PROSHIKA provides security for bank loans advanced to the landless groups and also provides small operating loans if there is an emergency. On the other hand, Grameen Bank itself provides credit to landless and near-landless farmer groups to enable them to buy, install, operate, and maintain irrigation equipment (mostly shallow tube wells). The bank also assists the landless groups to negotiate with the land-owning farmers who put their land under the landless groups' command areas and use irrigation water. In this program, the group is entirely responsible for delivering water to farmers' plots and for the construction and maintenance of canals.

Some Areas of Farmer-Agency Interactions

The farmers have to interact with officials in a diverse and complex rural environment. Selected areas of interactions relevant to the acquisition and operation of irrigation equipment are discussed below.

Sanction of tube wells. The sanction of tube wells which are purchased through loans is dependent on the feasibility reports submitted by the representatives of the Upo-Zilla Irrigation Team (UIT). There are frequent reports that the feasibility reports are faulty in that the specified inter-tube well spacing requirements are violated or the installations are incorrectly sited, and that these acts are made possible through bribes. An immediate consequence of such interactions between tube well buyers and approving authorities is the widespread encroachment of deep tube well areas by shallow tube wells resulting in reduced command area per installation. Furthermore, such problems are often used by tube well buyers as excuses for not paying loan installments or tube well rent charges.

Sanction of loans. Credit-purchased deep tube well loans are sanctioned to the KSS which, in most cases, are dominated by a few members who have influence either through their connections with the officials or by virtue of their wealth and power in the community. There are allegations again that loans disbursed by the officials in the name of the KSS are actually allocated to those few who negotiate and keep on good terms with the agencies concerned. These few often divert the loan money to other profitable businesses. One of the serious consequences of this is the huge default in loan repayments, which ultimately affects irrigation performance because lenders are reluctant to make fresh loans for irrigation or crop production. The agencies concerned say that they have neither the authority nor enough incentives to enforce actions against loan defaulters.

Provision of electrical connections. Electrical connections are given to irrigation installations mostly through contractors against payment of exorbitantly high charges: Taka 30,000-40,000 (US$1,366-1,822) for deep tube wells and Taka 10,000-15,000 (US$455-683) for shallow tube wells. There are widespread allegations that most connections are not officially approved, but it is the sole responsibility of the contractors to negotiate with the relevant offices and obtain the connections. Field experiences suggest that because of private negotiation between the contractors and tube well owners, connections are given to installations which cannot be correctly sited according to the spacing specifications of the BADC, which ultimately results in reduced command area of the existing installations.

EXPERIENCE OF FIELD RESEARCH ON IRRIGATION

The irrigation-related agencies mentioned earlier have different approaches toward controlling or managing different lift-irrigation technologies, and therefore provide different incentive structures for the water suppliers, water users, and direct or indirect beneficiaries of irrigation installations. It is hypothesized that the pattern of ownership and control of irrigation equipment and other resources, including land, characterize the form of management in small-scale irrigation schemes and create differential incentive structures for participants in irrigation, which ultimately manifest in the different levels of irrigation performances and efficiencies.[1]

A broad study was conducted in 1985 at the Bangladesh Agricultural University (BAU), Mymensingh, as part of a Ford Foundation supported research project in order to verify the above hypothesis. The major objective of the study was to evaluate the performance of different lift-irrigation technologies which are sponsored and controlled under different management approaches by selected government and non-government agencies involved in irrigation development, and then to explain variations in performance in terms of physical, technical, social, economic, and administrative factors. The two major criteria for evaluating irrigation performance were productivity and equity. The detailed methodology of this study was discussed in Mandal and Dutta (1985, 1986) but the salient features are discussed below.

Research Design

The study was planned to be carried out in two phases, and a multi-disciplinary approach was employed by including engineers, economists, and agronomists on the research team. For the first-phase study, a broad survey was conducted on 100 installations, including deep and shallow tube wells and low-lift pumps under 7 different agency/management approaches in 2 different ecological zones of Tangail and Gazipur. These were: 1) BADC Rental Program, 2) BADC-private (sales program), 3) BRDB-KSS, 4) BRDB-KSS-IMP, 5) BKB Shallow Tubewell Sales Program, 6) Grameen Bank, and 7) BKB-CARE-BADC Deep Tubewell Irrigation and Credit Program (DTICP).

One requirement of this comparative study was the selection of irrigation units which were operated under different main streams with specialized management approaches but in a single area with uniform ecological characteristics. This required the research team to make extensive exploratory trips to the offices of the agencies concerned and to the fields in a number of Tangail and Gazipur district Upo-Zillas immediately before the start of the irrigation season. The initial selection of these two areas was made because of the presence of more specialized programs, such as the landless irrigation program under PROSHIKA and Grameen Bank in Tangail and the BKB-CARE-BADC program in Gazipur.

The irrigation units under study were randomly selected from the relevant lists provided by the respective agencies. Field verifications showed that some of the randomly selected units were either non-existent or not managed by the agency mentioned on the original list. In cases where the desired number of installations was not available (especially under specialized programs), matching combinations of other technologies and institutions had to be found near the infrequently occurring ones to limit the agro-ecological and socio-economic variations. Finally, 44 deep tube wells, 37 shallow tube wells, and 19 low lift pumps were surveyed, including 5 of the first, 10 of the second, and 5 of the third from each of the agency/management approaches selected in the 2 areas.

In this study, two types of survey were conducted simultaneously -- one on technical and the other on socio-economic aspects of irrigation. For the socio-economic survey, apart from managers/owners, one small-scale farmer, one medium-scale farmer, and two large-scale farmers, and two landless laborers working in the vicinity of the selected command areas were also interviewed because they were the individuals first encountered by the investigators.

In the second phase of the study, in-depth case studies were made on four selected irrigation sites: one deep tube well under private management, one deep tube well under KSS management, one shallow tube well under private management, and one shallow tube well under Grameen Bank landless group management. Both technical and socio-economic investigations were conducted at these sites by direct field measurement methods as well as through interviews. In addition, a quick follow-up survey was conducted to record changes in command areas and yields under those installations in Tangail which were studied during the first phase.

Organization of Irrigation Groups

Irrigation groups can be classified into three broad categories: 1) KSS groups; 2) informal non-KSS groups; and 3) landless controlled informal groups. KSS groups are the most formally organized, ideally having a representative management in which a committee adopts and implements decisions on the basis of group participation. These groups are required to maintain separate records of group activities, such as farmers' register, block register, cash book, land register, and receipt book, although in practice these are not adequately maintained. Informal non-KSS groups are formed or at least listed mainly to show the required irrigation command areas while applying to agencies for irrigation sets, loans, and other services. Under landless controlled irrigation, written or unwritten agreements are made between landless groups and the prospective landowning water users. In this case, landless groups are responsible for delivering water to farmers' plots, while the water users are responsible for applying adequate amounts of inputs on time and for paying water charges.

The methods of water distribution are flexible for most irrigation schemes. Empirical information from Tangail and Gazipur (Table 4) reveals that there are usually four different, but not necessarily mutually exclusive, methods for on-farm water distribution: 1) blockwise rotation, 2) canalwise rotation, 3) water delivery on demand, and 4) water delivery on demand against user's fuel.

In most tube well schemes, canalwise rotations are practiced in distributing water, but in actual practice a combination of these methods is followed to meet emergencies or to satisfy specific purposes. The worst form of distribution is the delivery of water against the user's own fuel because it hinders timely delivery of adequate water to fields. This system of water delivery affects irrigation performance seriously because priority is fixed not on the basis of crop-water needs but according to the individual irrigator's ability to manage his fuel. However, in the absence of an electrical power source, for schemes with variations in land topography and distances of individual plots from water sources (as found in some parts of Gazipur), individualistic methods of supplying fuel help to avoid misgivings and distrust and thus contribute to keep the schemes going.

Different systems of payment for water provide different levels of incentives for water suppliers and water users. Evidence from the field revealed four different systems of payment for water (Table 5). The most common practice is cash payments, usually fixed at

a rate per unit of land irrigated. One recent payment system is to pay with a share of rice, the share ranging from 20-25 percent of the harvest. This newly emerged system of share-cropping has accompanied the privatization of irrigation equipment and is expanding rapidly.

Table 4. Methods of on-farm water distribution in Tangail and Gazipur.

Methods	Main features	Remarks
Blockwise rotation	Command area divided into blocks, served water in weekly or daily rotations, supervised by line/drainmen.	Efficient water distribution requires extensive management time and skills, cooperation, and group management.
Canalwise rotation	Distribution by one or two main canals at a time, while other main canals are operated by turns, start irrigation from tail ends, needs supervision by line/drainmen.	Commonly practiced, flexible, problems arise with canals of different capacities and length serving plots at different distances from the turn-out.
Delivery on demand	Water delivered as and when demanded or drainmen report, no fixed preference.	Practicable with abundant water, problematic with low discharge, poor conveyance, or machine breakdowns.
Delivery on demand against user's fuel	Water delivered as fuel supplied, prioritized as "first come with fuel-first served with water."	Inefficient, inadequate irrigation, huge water loss, practiced where topography and plot distance vary widely.

Source: Mandal, unpublished field survey, 1985-86.

Salient Features of the Research Findings

The detailed analyses of the collected data and the preliminary results are presented in the proceedings of the workshop that was held at the Bangladesh Agricultural University in November 1985. Some of the major findings are presented here.

1. BRDB-KSS-managed deep tube wells and shallow tube wells have poor performance as evidenced by low command areas, low yield, and low output in both areas (Tables 6 and 7). This implies that the KSS suffered from internal contradictions and organizational weaknesses.

Table 5. Mode of payment of water charges in Tangail and Gazipur.

Mode	Water charges	Payment procedures
Cash (Fuel by water supplier)	Tk 1112-3758/ha (US$50.64-171.13/ha)	2-3 installments, at least part paid in advance, balance usually after harvest.
Cash (Fuel by water user)	Tk 706-1765/ha (US$32.15-80.37/ha)	2-3 installments, part in advance, balance mid-season and after harvest as in Gazipur.
Cash payment on hourly basis	Tk 30-40/ha (US$1.37-1.82/ha)	Payment usually made immediately after water delivery, common in Gazipur.
Crop-share payment (Fuel by water supplier)	20-25% of crop	Share of crop collected from fields usually by counting bundles of harvested rice as in Tangail.

Source: Adapted from Mandal (1985), Tables 5a and 5b.

Table 6. Indicators of economic productivity of lift-irrigation technologies in Ghatail-Kalihati, Tangail.

Agency/technology/ management/payment	No of units	Command area(ha)	Yield (kg/ha)	Total output ('000 kg)
DTW				
BADC-rental	5	16.48	5536	91
BADC-private	4	23.37	5124	120
BRDB-KSS	4	13.30	4975	66
BRDB-KSS (IMP)	2	26.95	5143	139
Grameen Bank	3	22.30	4700	105
Diesel	11	18.48	5112	94
Electricity	7	20.95	5128	107
All rental	9	19.39	5361	104
All private	9	19.48	4881	95
Cash payment	5	23.66	5344	126
Crop share payment	13	17.81	5006	89

All	18	19.44	5120	99
STW				
BADC-private	11	4.93	5656	27
BRDB-KSS	8	3.13	5227	16
BKB	10	4.98	5514	27
Grameen Bank	8	5.26	5855	31
Diesel	34	4.66	5586	26
Electricity	3	4.33	5787	25
All	37	4.63	5602	26
LLP				
BADC-private	5	8.15	4882	40

Source: Adapted from Mandal (1985), Table 6a.

2. BADC-rented deep tube wells have higher yields but low coverage per unit, while BADC-private deep tube wells showed higher coverage but lower yields because of inadequate water supply to larger command areas. However, when all rented deep tube wells were compared with all private deep tube wells, the rented ones did better in terms of total output, but the difference was not significant (Tables 6 and 7). Furthermore, water users using private deep tube wells had lower returns over water costs than those using rented deep tube wells. This raises serious questions about the efficiency of the privatization policy.

3. Deep tube wells under BRDB-KSS (IMP) show better initial performance compared to deep tube wells under other agencies or management approaches because of integrated back-up services provided by the support agencies. But the success is discounted by the many drop-outs from the program. The drop-outs occur when the promised assistance is not continued; it is also possible that only the better performing schemes are included in the IMP, which abandons those with problems (see Tables 6 and 7).

4. Specialized irrigation programs such as deep tube wells under CARE and shallow tube wells under Grameen Bank show high performance which seems due to strong support services by CARE and better water delivery by the landless groups under Grameen Bank, but these programs are also vulnerable to frequent drop-outs (for evidence on drop-outs, see Biswas 1985).

5. The major factor affecting irrigation performance appears to be the mode of payment for water. The share-cropping payment systems (in Tangail) and the systems where farmers bought their own fuel (in Gazipur) showed lower coverage, yield, output, and returns to farmers than cash payment systems.

Table 7. Indicators of economic productivity of lift-irrigation technologies in Gazipur.

Agency/technology/ management/payment	No of units	Command area(ha)	Yield (kg/ha)	Total output ('000 kg)
DTW				
BADC-rental	7	21.40	4947	106
BADC-private	4	27.73	4574	127
BRDB-KSS	6	18.16	4554	83
BRDB-KSS (IMP)	3	24.90	4962	124
CARE	5	23.60	5162	122
Diesel	22	22.54	4861	110
Electricity	3	22.12	4460	99
All rental	17	21.32	4970	106
All private	8	25.00	4527	113
Cash (managers' fuel)	15	25.33	5012	127
Cash (farmers' fuel)	10	18.24	4402	80
All	25	22.50	4814	108
LLP				
BADC-rental	5	16.49	4767	79
BADC-private	5	6.45	4942	32
BRDB-KSS	4	16.63	5619	93
Diesel	7	8.49	4856	41
Electricity	7	17.40	5222	91
All rental	8	16.74	5041	84
All private	6	7.88	5348	42
All	14	12.94	5112	66

Source: Adapted from Mandal (1985); Table 6b.

6. The distribution of benefits from irrigation is skewed strongly to those having control over water sources and land, and the process is further accelerated by the emerging hard contractual terms for water (e.g., share-cropping with water in Tangail), share-cropping with land, usufructuary land mortgaging, and money lending for usurious interest. These ultimately affect the performance of irrigation.

7. In spite of high profits accruing to equipment owners/managers, especially under share-cropping payment systems, there are many defaults in payment of loans and rents, implying a failure within the state bureaucracy.

NOTES

[1]A detailed theoretical discussion on the structure of incentives is presented in Palmer-Jones (1985).

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IDENTIFYING ASSISTANCE NEEDS OF FARMER-MANAGED IRRIGATION SYSTEMS

Honorato L. Angeles*

INTRODUCTION

The task of increasing food production to sustain the food requirement of a rapidly increasing world population would be made easier through the increased availability of irrigation. Sad to note, however, is the difficulty of developing water resources for irrigation. The cost involved has become prohibitive in most developing countries where more food production is badly needed. Thus, new projects and development of new water sources for irrigation development in most countries have been relegated to lower priority in favor of improving existing systems to maximize their utilization.

Farmer-owned and managed systems, estimated to represent more than half the total irrigated areas in most countries, have become the present focus of attention. In the Philippines, it is estimated that 56 percent of the irrigated area falls under communal and pump development projects. About 580,000 hectares (ha) of land are irrigated by systems that are owned and controlled by farmers (Bagadion and Korten 1980). Government assistance is made available to irrigator associations for the improvement of their systems. Some systems or portions of systems that were once managed by the government are now being turned over to farmer associations to own and manage because of the financial burden to the government and the belief that farmer associations have the potential to manage the systems more efficiently.

In order to harness the potential of farmer-managed systems, adequate support from all sectors, especially from the government, must be given. The kind of support and assistance needed should be properly identified, and the manner of providing assistance must be carefully studied if it is to serve its purpose. There are instances where assistance improperly timed and completed was detrimental to the effectiveness of the system (Coward 1983). Towards this end, the Central Luzon State University (CLSU) has embarked on research activities focusing on systems managed and operated by farmer associations. The purposes are to understand properly the manner in which this type of system is operated and managed and to identify the kind of assistance farmers need and the best way of providing such assistance.

Classification of Farmer-Managed Systems

To identify assistance needs, farmer-managed systems were classified into three categories based on the system's historical background: indigenous systems, modified systems, and government turned over systems.

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*Associate Professor and Dean, College of Engineering, Central Luzon State University, Munoz, Nueva Ecija, Philippines.

Indigenous systems. These are traditional systems that are built, owned, and managed by farmer-users which have not received any form of assistance from the government or from other sources for construction, operation, and management. Canal networks of these systems are usually crude and without permanent controls, measuring structures, or other facilities. The diversion structures are usually made of logs, stones, brush, and tree branches that are easily washed away when the streamflow swells.

Modified systems. These were indigenous systems until the government intervened and provided financial assistance to the farmer-users, particularly for improving the systems' physical facilities. Diversion dams that used to be made of logs, stones, and brush have been made permanent. Turnouts, checks, and other facilities have become more sophisticated.

Government-turned-over systems. These are systems that used to be owned, operated, and managed by the government. The irrigation facilities are mostly permanent and contain some degree of sophistication, as compared to indigenous systems. Systems that are a heavy burden to the irrigation agency in terms of financial viability are turned over to the farmer-users after some degree of physical rehabilitation in the systems' structures and organizing activities takes place. Farmers, not previously involved in the system operation and management nor having experience in such activities, are trained to manage system functions, such as water allocation and distribution, repairs and maintenance, and fee collection.

Research on Farmer-Managed Systems

A multidisciplinary research team composed of engineers, social scientists, and economists was organized at CLSU to examine the operation of different types of farmer-managed irrigation systems. The following discussion presents the observations and findings from a comparison between the indigenous-type systems and government-turned-over systems under study. Research activities on a modified system have barely started and as yet little can be reported.

Research Methodology

The research procedure is common to all systems under study. It consists of three phases. First, the observation phase documents the operation and management of the system. Close observations are made of the water allocation and distribution, system maintenance, financial and conflict management, farming practices, and socio-economic conditions of the people in the community. In this report, however, emphasis will be only on water allocation and distribution and system maintenance activities.

In the second phase, farmers participate in identifying and discussing problems regarding the operation and management of the system; these problems are then analyzed in order to arrive at solutions. Some degree of overlap, however, exists between this and the observation phase.

The third phase implements agreed solutions or actions regarding the identified problems. Implementation is done by the association after detailed discussion with farmers. Close observations and monitoring of farmers' attitudes and responses to these changes follow implementation.

Research assistants are assigned to the study area. Data is gathered using participant-observation methods. The research assistant resides within the locality which enables him to observe all farmer activities relevant to the management of the systems, such as meetings, surveys, sharing sessions, and group works. Unstructured interviews are held with farmers regarding issues and problems encountered in operation and management of irrigation systems.

INDIGENOUS SYSTEMS

Description of the System

A system with a service area of about 337 ha with 150 farmer-users was selected as the study site. The system is a run-of-the-river type and is operated and managed by an association of farmer-users which is headed by a president. The other officers of the association are the vice-president, secretary, treasurer, and three auditors. These officers are selected by an elected Board of Directors from Board members. In addition, a water master is selected from outside the Board and assists the president in water distribution and allocation activities. He is the only paid officer of the association and receives 12.5 kilograms (kg) of rough rice per year by every farmer who uses the system's irrigation water. When water is scarce and the water master cannot cope with work, water inspectors are hired and also given remuneration. The organizational set-up is shown in Figure 1.

The water is diverted from a stream with the aid of a brush dam placed across the stream. The streamflow at the location of the dam is shared with another irrigation system on the opposite side of the stream (Figure 2). The sharing arrangement is that the other system gets one-third of the flow during the wet season and gets one-day flow per week during the dry season.

Rice is planted during the wet season. Dry season crops include onion, garlic, peanut, corn, and vegetables such as tomato, eggplant, and various kinds of bean.

The whole service area of the system is divided into four divisions for water distribution (Figure 3). Water diverted from the stream is distributed to the system's service area through the four kilometer (km) long main canal. The main canal branches to a lateral canal about 0.75 km from the dam which serves a portion of Divisions I, II, and III.

Figure 1. Organizational structure of indigenous system.

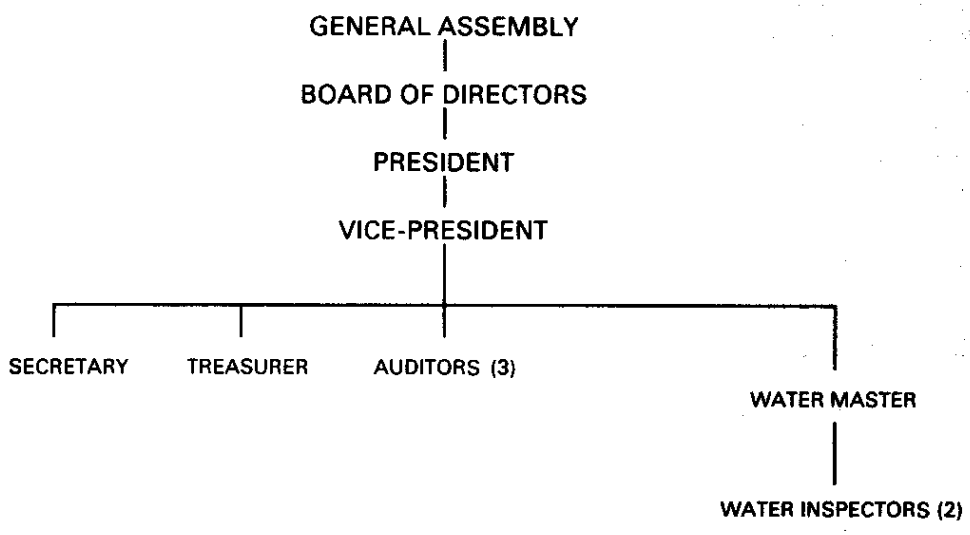


Figure 2. Brush dam method of sharing water with other systems.

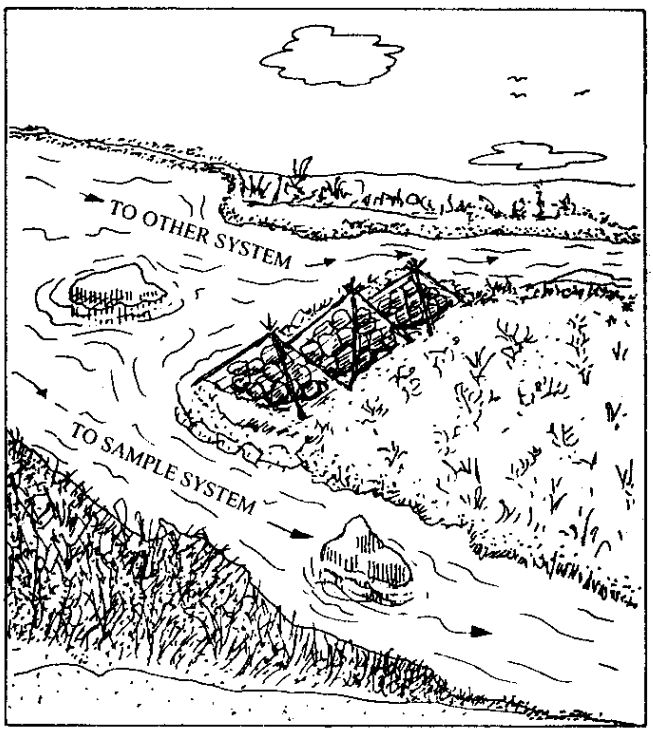
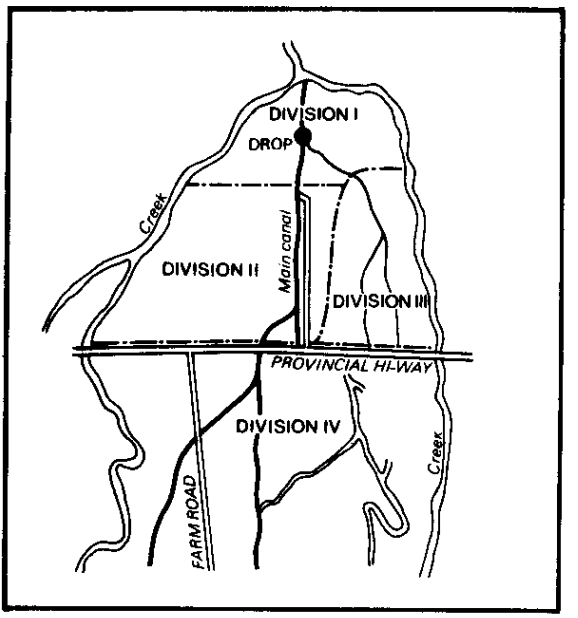


Figure 3. System layout showing location of divisions I-IV.



The limited amount of water during certain times of the dry season would hardly reach the far end of the system if allowed to flow through the main canal as it is quite wide, causing slow movement of water and more conveyance losses. To remedy the situation, the farmers constructed a small temporary canal parallel to the main canal to convey the small quantity of water to the far end of the system.

Irrigation Practices

Except for isolated cases, flooding is the general method of irrigation in the area. Irrigation enters into paddy fields directly from the canal by cutting the embankment. For farms far from the canal, during the dry season the farmers use temporary farm ditches to convey irrigation water to their fields. During the wet season, however, water is conveyed from paddy to paddy. The amount of irrigation needed depends on the individual farmers' judgement. No measuring device is employed. For rice crops, most farmers wait until water almost overflowed their paddy dikes before releasing the flow to the next farmer. In the case of upland crops, irrigation is stopped when all the fields up to the farthest end become wet.

Water distribution and allocation

The water sharing arrangement in the area is basically rotational. Rotation at different levels of organization is used for the wet and dry seasons. Although there are no measuring

devices nor permanent control structures employed, the institutional arrangements evolved by the farmers for water allocation have enabled the association to cope with the situation and distribute water to the fields.

Even before the research project started, the association had its own water distribution and allocation scheme which the farmers followed for many years. The association had adopted distinct rotation schedules for the wet and dry seasons and these were in use during the study observations. These are described below.

Wet season. During the wet season, the following irrigation schemes were implemented at different times depending on the amount of available water.

Continuous flow irrigation. This is practiced while there is still frequent rainfall and ample discharge from the source. Water flows continuously into the main canal and farmers use it anytime they want to. There are cases, however, where upstream farmers totally check the flow to downstream fields. If farmers downstream need water, they inform the upstream farmers and usually the problem is settled. In cases of disagreement, the intercession of the watermaster or the president is sought.

Rotation by division. This is used when continuous flow irrigation no longer works due to a decrease in the amount of water entering the system. Each of the system's four divisions receives water for a certain time period within a 13-day cycle (Figure 4). Distribution within the division is the farmers' concern and rotation usually goes from upstream to downstream. In some cases, all farmers in the division are not able to irrigate their fields during the division's scheduled time; these are given the first priority during the division's next turn. The cycle is repeated after the last farmer in the division has irrigated his fields.

Before irrigation by rotation is implemented, the four divisions are ranked according to urgency of their needs for irrigation water, based on the predominant condition of the standing crops in the area. This is done to determine who gets water first, which is decided by the president of the association upon the recommendation of the watermaster who is expected to know the condition in each division.

As can be seen in the schedule, there is inequality among divisions in area planted and irrigation time allotted. This is tolerated in the case of Division I because farmers in this division were the original users of the system when it was first built and have prior right to the use of water. In the case of Divisions II and IV, farmers can get water from another source to supplement their needs.

Rotation on a time basis within the division. Whenever water becomes insufficient such that a majority of the farmers in a division are unable to irrigate their farms during the prescribed schedule for the division, water is allocated to each farmer in the division on a time basis.

Figure 4. Rotational irrigation by division during the wet season.

Div	Area (ha)	1 M	2 T	3 W	4 Th	5 F	6 S	7 Su	8 M	9 T	10 W	11 Th	12 F	13 S	1 Su	2 M	3 T	4 W	5 Th	6 F	7 S
I	73.50	▬	▬	▬	▬										▬	▬	▬	▬			
II	88.00					▬	▬	▬											▬	▬	▬
III	39.00								▬	▬	▬										
IV	136.50											▬	▬	▬							
Other systems		Given 1/3 of the streamflow as continuous flow to its diversion canal.																			

It is worthwhile to mention that in the previously discussed rotation by division, water is diverted simultaneously into the fields of two or three farmers, depending on the volume of flow, and released only when their water needs are satisfied. This practice places the tail end farmers at the mercy of those upstream in their division. This situation usually becomes a source of conflict among farmers whenever there is water scarcity. To remedy this situation and to give equal chance to every farmer, the time allocation for each farmer is adopted.

In the rotation on a time basis, the total time allotted for the division is divided by the total number of hectares farmed in the division to get the time allocation per hectare. It becomes the farmer's responsibility to apportion the amount of water he is to receive within his time schedule. Regardless of whether he finishes irrigating his field or not, as soon as his time is up, the next farmer gets the water. The time allocation per hectare in each of the divisions is shown in Table 1.

Table 1. Time of irrigation per hectare for each division.

Division	Area planted (ha)	Time allotment (days)	Time per hectare (minutes)
I	71.5	4	80.6
II	85.0	3	50.8
III	35.4	3	122.0
IV	111.5	3	38.7

Dry season. In the dry season (December-May), a different water allocation scheme is used. The water flow into the system during this period is quite low due to decreased rainfall. Only about 40 percent of the total area is planted (mostly areas close to the canal and the upstream portion of the system). The following schemes for water allocation were used in the study site during the period of observation.

Rotation by division. Continuous flow was not practiced during the dry season. The first level of water allocation was rotation by division (Figure 5). During the first months of the season, water shortage was not yet critical. The crops were still small and only a few farmers planted their crops so that the amount of water entering the system was still sufficient.

Figure 5. Rotational irrigation by division during the dry season.

Div	Area (ha)	Mon			Tue		Wed		Thu		Fri		Sat		Sun	
		6am to 12n	12n to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am
I	73.5		▬		▬		▬		▬		▬					
II	88.0			▬				▬				▬				
III	39.0					▬				▬						
IV	136.5												▬	▬		
Other systems		▬													▬	▬

During the dry season, Division I irrigated on Monday from noon to 6pm and on Tuesdays and Fridays from 6am to 6pm, a total of 54 hours per week. Division II irrigated on Monday, Wednesday, and Friday from 6pm to 6am, and Division III irrigated on Tuesday and Thursday from 6pm to 6am. Division IV used water from 6am Saturday to 6am Sunday. The remaining hours of the week (6am Sunday until noon Monday) were given to the system on the other side of the stream. The whole irrigation flow was diverted to the division scheduled to use the water.

Although the wet season irrigation cycle is 13 days, the dry season cycle is only seven days. Farmers gave two reasons for the difference: a) Because the area planted to crops during the wet season was larger than the area planted during the dry (only about 40 percent of total area), a short irrigation period was not enough to irrigate one division. On the other hand, in the dry season a three day irrigation period for one division was found by farmers to be quite long, especially during the first few months of the season when the inflow is still large. b) Because the streamflow during the dry season decreases with time, shorter intervals during this period will give every division their turn when the flow is still large.

Rotation by subdivision. During January and February, the available irrigation water decreased tremendously and that, in combination with a maximum water requirement for the standing crops led to a water shortage in the system. Some farmers in one division were unable to get water during the division schedule; in some cases, even after two irrigation cycles. This was particularly true for farmers in the downstream end of the division. As a remedy, the division was subdivided and each subdivision given a definite schedule within the division schedule (Figure 6).

Figure 6. Rotational irrigation by subdivision during the dry season.

Sub-div.	Area (ha)	Mon			Tue		Wed		Thu		Fri		Sat		Sun	
		6am to 12n	12n to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am	6am to 6pm	6pm to 6am
IA	19.40		—													
IB	11.60				—											
IC	26.00						—									
ID	16.50								—							
IIA	31.75			—								—				
IIB	56.25							—								
IIIA	13.90					—										
IIIB	25.10									—						
IVA	94.75												—			
IVB	41.75													—		
Other systems		—													—	—

Rotation on a time basis in the subdivision. Another arrangement was adopted by the association during severe water shortages to give each farmer a chance to use water during the subdivision schedule. The total number of hours allotted for the subdivision was divided by the number of farmers to determine the time that each farmer could use water during their subdivision's turn. This is quite different from what was done during the wet season. The main justification given by the farmers for the difference was the need to give every farmer equal opportunity during the dry season considering that not all the area could be planted. This also discouraged farmers with plenty of resources from monopolizing available water by planting more land. It is interesting to note that during the dry season, the variation in area cultivated among farmers in the system was quite minimal.

During the period of observation, only one subdivision in the entire system implemented the time allocation schedule. Other subdivisions allocated water only according to rotation by division and subdivision. With the rotation on a time basis, farmers prioritize the use of water during their schedule: they first irrigate the portion of their field that badly needs water.

System Maintenance

To maintain the irrigation system's physical structures, the association from time to time organized group works. Work consisted primarily of repairs and reconstruction of the damaged portions of the canal network and the diversion dam, or cleaning and desilting the irrigation canals. When repairs and maintenance of major irrigation structures and brush dams were required, the association called for group work to do the job. Jobs which required less effort, like cleaning, weeding, or desilting of irrigation canals, were left to the individual farmers concerned. Specifically, if a certain length of the canal passes through or beside a farmer's fields, that farmer is responsible for cleaning and maintaining that portion of canal.

Group works are usually called by the association president upon recommendation of officers or members. Information regarding group works is disseminated to farmers by the watermaster who goes around the *barrio* (town or village subdivision) informing the farmers. He also requests farmers to pass on the information to others they meet.

During the first year's observation, four group works for system maintenance were performed by the association. The first consisted of deepening and narrowing a shallow but wide canal starting from the system's earth dam and going downstream. Only 40 percent of the 138 farmer members attended the activity. Some farmers who were not able to attend the group work said they were too busy at that time while others claimed they were not informed of the project.

The second group work was to repair the system's washed-out brush dam. Although this type of work required the participation of all farmer members, only about 70 percent participated. Some farmers brought with them bamboo poles for strengthening the dam foundation, while others brought jute sacks which were used as containers for sand and other filler materials. Brush and tree branches were also used. A month later, the newly repaired brush dam was again washed out. A second repair was performed by 43 farmers.

Another group work involved only farmers in Division III. It consisted of repairing an earthen dam used to divert water from the main canal to the lateral canal that services this division, and cleaning the lateral canal. The group work was arranged by the farmers in Division III with help from the watermaster and the barrio captain, who has a farm in the division. It was also observed that some downstream farmers, especially those suffering from reduced canal flow to their farms, followed the canal upstream to check for and remove obstructions in the canal.

Problems and Needs

Based on observations of the system, it could be safely said that its operation and management is quite satisfactory. The association has water allocation and distribution schedules to cope with different situations that occur. It has also demonstrated its capability, to a certain extent, to mobilize labor for system maintenance activities, to

resolve conflicts among its members regarding water use, and to collect fees for use by the association. It is believed, however, that the operation and management of the system could be further improved if identified problems could be solved and needs provided for. These are discussed below.

Limited water supply during the dry season. The nature of the system as a run-of-the-river type suggests that the most obvious problem is the scarcity of water during the dry season. The solution is to provide a water impounding reservoir to store water during the wet season for use during the dry. Improvement of the system's diversion structure by making it permanent would have minimal effect in solving the problem. Although the present diversion dam is crude and could be easily washed away during heavy rains, it is capable of diverting the entire streamflow during the dry season if necessary. With a large and more permanent diversion structure, the service area of the system would be increased but this is not the concern of the association. Apart from the financial burden, if a permanent diversion dam was constructed, maintenance of the dam when silted would be a potential problem for the association.

The construction of a storage reservoir for the system is definitely not within the financial capability of the farmers. Only the government could provide this kind of assistance. However, considering the financial situation of the government, it may be limited as well. A water impounding project was initiated in the system last year only to be halted for lack of funds after a change in administration.

Complacent attitude of the farmers. The tendency most people have to maintain their traditional ways is not conducive to improving the operation of a system. The farmers have become accustomed to the water allocation and distribution methods passed to them by their ancestors, and few would care to change them, even for the better.

There should be a program aimed to activate irrigator associations and to motivate them to improve their systems. In the system under discussion, the presence of the research team in the area rekindled the interest of the farmers in their system and the association became more active without direct motivation by the team. The government could do a lot in this direction.

Lack of exposure to new ideas on system management and modern agriculture. One factor that contributes to the complacent attitude of some farmers is their lack of exposure to alternative procedures and techniques. Farmers should be introduced to new ideas and techniques of system management. Training programs, seminars, and workshops should be conducted where irrigators' association officers and members could participate.

In the system under discussion, workshops on system management were facilitated by the research team using training modules prepared by representatives from different government and private agencies involved in communal irrigation in the Philippines. In the workshops, the irrigators' associations were able to examine thoroughly their operational procedures in managing their system, which led to a revision of their water allocation schemes, system maintenance plans, and administrative regulations.

In the case of the water allocation schemes, for example, the inequity in favor of the upstream division caused a revision in both upstream and downstream allocation schemes. Figure 7 shows the revised allocation scheme for the wet season. Previously, the upstream division usually irrigated for four days while the downstream divisions were allotted only three days each. All the divisions now are given three days. The argument of prior right to justify the inequity was not accepted because land ownerships have changed in the area and most of the original farmers or their descendants are no longer in the upstream division. Furthermore, the upstream farmers already have an advantage with easy access to water.

Figure 7. Rotational irrigation by division during the dry season.

Division	Area (ha)	1 M	2 T	3 W	4 Th	5 F	6 S	7 Su	8 M	9 T	10 W	11 Th	12 F	1 S	2 Su	3 M	4 T	5 W	6 Th	7 F	8 S
I	73.50																				
II	88.00																				
III	39.00																				
IV	136.50																				
Other systems	Given 1/3 of the streamflow as continuous flow to its diversion canal.																				

After implementation of the revised schedule, there was a general feeling of satisfaction among the farmers. Even upstream farmers who resisted the change felt that the decrease in the time allotment for their division had not affected their farming activities. On-farm water management should also be considered in a training program or seminar for farmers. Proper understanding by farmers of this aspect should lead to the improvement of the management of the system.

GOVERNMENT-TURNED-OVER SYSTEMS

A system turned over by the government irrigation agency to a farmer organization for operation and management is one type of system that the CLSU Irrigation Management Research Team is currently studying. The specific objectives are as follows:

1. To obtain comprehensive knowledge about the experiences of irrigators' associations taking over the management of an irrigation system.

2. To identify the kind of assistance needed by users in the operation and maintenance of an irrigation system.

3. To formulate and implement action programs to assist the farmer associations in managing their system.

Research activities in this system have been underway for over a year now and are still in the observation and problem identification stage.

System Description

This is a pump irrigation system which receives its water supply from the main canal of a large gravity-type system. Two 8-inch (20.3 centimeters) pumps are being used to lift water for irrigation. The pumps are driven by two 150-kilowatt electric motors and are operated alternately. The system was constructed by the National Irrigation Administration (NIA) and became operational in the early 1970s under NIA management. The high operational cost and low irrigation fee collection rate prompted the NIA to turn over the management of the system to the association.

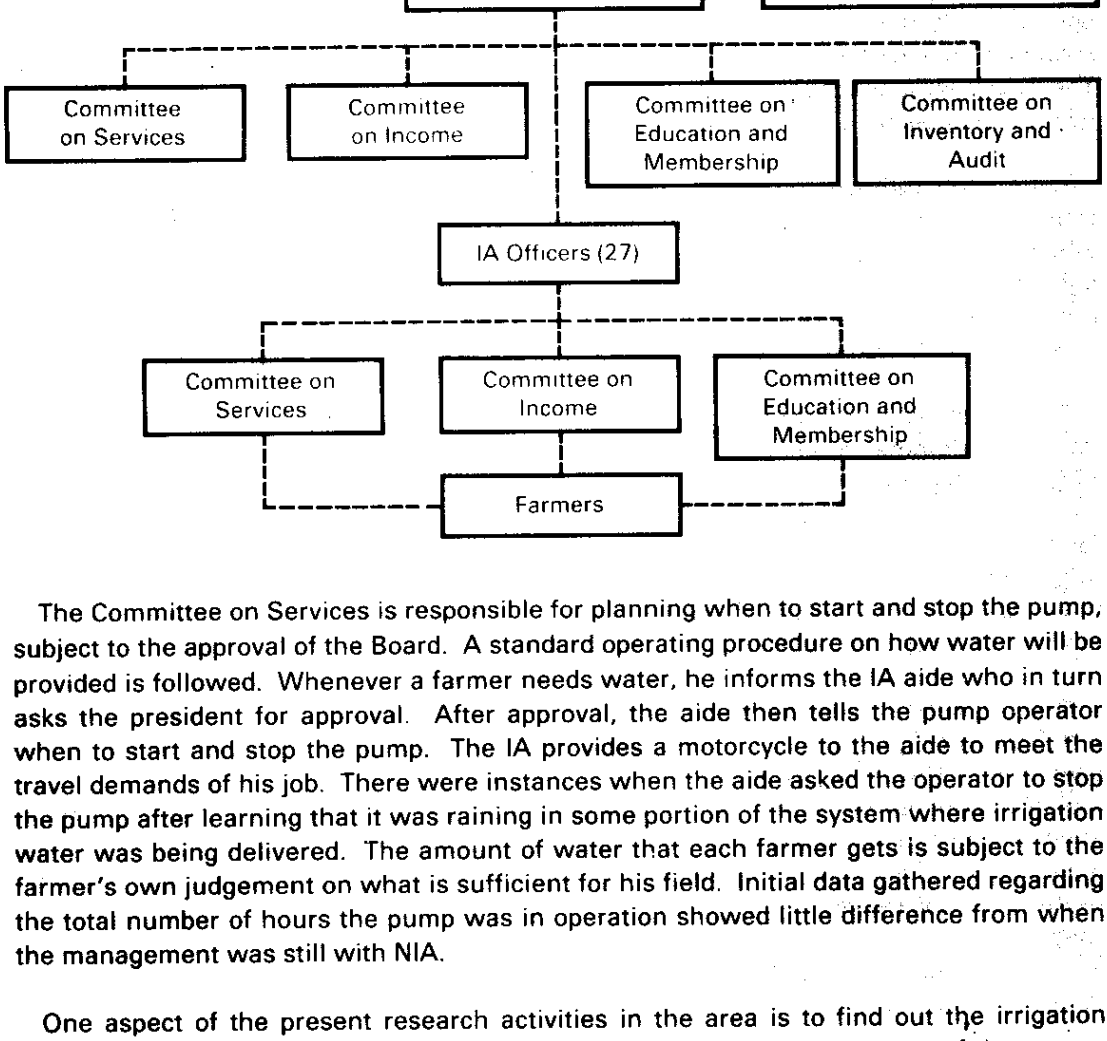
Before the turnover, however, NIA did general rehabilitation work on the system. Damaged irrigation structures and farm roads were repaired. The NIA provided materials while some of the labor requirements were contributed by the irrigators' association. The agreement is that the association will pay the NIA one-half *cavan* (25 kg) of rough rice per hectare per year for 25 years. Also prior to turnover, organizing activities were done. The system was fully turned over to the association at the start of the 1984 wet season.

The system is divided into 28 divisions based on the number of turnouts. Each one has its own irrigators' association which is locally known as the *Bukete ng Samahang Magpapatubig* (irrigators' association, BSM) headed by a chairman. The BSM chairmen form the Board of Directors. The Board then elect among themselves a set of officers for the irrigators' association (IA) for the entire system. The system's service area was originally 688 ha but, because of the suspension of one BSM for not paying their dues to the system IA, the remaining area is 653.72 ha for 27 BSMs. The IA's organizational structure is shown in Figure 8.

The president acts as the head of the system IA. The vice-president is the chairman of the Committee on Services. The second vice-president serves as co-chairman of this committee. The secretary is automatically the chairman of the Committee on Education and Membership, the treasurer is the chairman of the Committee on Income, and the auditor serves as the chairman of the Committee on Audits and Inventory. Other Board members not elected as IA officers join the different committees as members. Members of the Board were given ₱ 30 (US$1.50) for every meeting attended, whether regular or special meetings. Absentees were fined ₱ 30. The IA at present has three employees: an aide, an accountant (who doubled as billing clerk), and a pump operator. Each employee receives a salary of ₱ 940 (US$47) a month.

Water distribution. The function of the IA aide is to regulate the flow of water entering every turnout. A water delivery schedule formulated by the NIA was adopted by the association. The schedule is supposed to be followed strictly by the IA both during the dry and wet seasons. However, the IA has no specific sanctions imposed on violators of water distribution rules.

Figure 8. Organizational structure of a government turned over system.



The Committee on Services is responsible for planning when to start and stop the pump, subject to the approval of the Board. A standard operating procedure on how water will be provided is followed. Whenever a farmer needs water, he informs the IA aide who in turn asks the president for approval. After approval, the aide then tells the pump operator when to start and stop the pump. The IA provides a motorcycle to the aide to meet the travel demands of his job. There were instances when the aide asked the operator to stop the pump after learning that it was raining in some portion of the system where irrigation water was being delivered. The amount of water that each farmer gets is subject to the farmer's own judgement on what is sufficient for his field. Initial data gathered regarding the total number of hours the pump was in operation showed little difference from when the management was still with NIA.

One aspect of the present research activities in the area is to find out the irrigation efficiency and to identify possible improvements to reduce operation hours of the pump. Initial reports from the research team indicated that farmers have a tendency to fill their paddies with water, thus eliminating the value of any rainfall. This is one area that should be explored to minimize pumping costs.

Maintenance activities. The maintenance of the main canal was divided among the 27 BSMs. Each turnout association was given a 500 meter portion of the main canal to clean and maintain. Canal cleaning is done by the IA twice per cropping season, once at the start and once mid-season. In general, all BSMs should clean their assigned canal sections simultaneously. However, there are some groups that did not comply. Maintenance activities were supervised by the chairman of the Committee on Services and assisted by the members. Some BSMs checked the attendance of their members but others did not. Each BSM was given ₱ 750 (US$38) per cropping season for their expenses during maintenance activities. All BSMs did not charge the same fine from absent members during maintenance. Some charged ₱ 50 (US$2.50), others ₱ 30, while others charged in-kind fines. The maintenance of lateral canals is the responsibility of the BSM where a particular lateral is located.

Financial management. The IA collects the following fees from each member: a) a one-time enrollment fee of ₱ 10 (US$0.50), b) annual dues of ₱ 5 (US$0.25), and c) irrigation fees of 5 cavans/ha (250 kg/ha) during the dry season. The Committee on Income prepares the plan for fee collection, and the treasurer collects the fees. Five percent of the total collection is given to any BSM that attains 100 percent collection.

In the 1984 wet season, the irrigation fee collection rate was 84 percent. This increased to 96 percent in the 1984-85 dry season but dropped to 81 percent during the 1985 wet season, which was attributed to crop damage by a typhoon. However, the collection rate attained by the association is far better than what the NIA attained: an average of a little over 50 per-cent. This is either an indication of the effectiveness of the IA's collection mechanism or an indication that farmers are more willing to pay their obligations to their organization than to the government. The farmers might feel that any investment of the government should be given free to the people.

CONCLUSION

Farmer-managed irrigation systems are an important resource that must be harnessed to maximum advantage. The documentation activities on two communal systems showed the capability of the irrigators' association to allocate irrigation water under a variety of conditions and to mobilize labor for the maintenance of the system. The ability to collect irrigation fees was well demonstrated by one system where fee collection reached a record of 96 percent. Under government management, the rate of fee collection in that system was a little over 50 percent on the average.

The capability of the farmers to manage an irrigation system must be reinforced with adequate support from government and other sectors, whether financial or technical, in order to derive the maximum benefits. Properly identifying the irrigators' association's needs for efficient operation and management of their system, and providing appropriate assistance will translate into better living conditions for the rural people in particular and the country in general. For indigenous systems, assistance needs are both financial and technical; for turned over systems, the need is more technical.

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SMALL-SCALE IRRIGATION SYSTEMS IN MOROCCO: PRESENT STATUS AND SOME RESEARCH ISSUES

R.M. Abdellaoui*

BACKGROUND

Irrigation in Morocco is secular. The Romans colonized and exploited irrigated lands in many areas of the North Atlantic portion of Morocco, but the few archeological studies of the ancient Roman systems are incomplete and uncertain (Moulay R'chid 1982). In the 7th century, the Arab conquerors brought a new irrigation technology and laws based on the Koran. Many cities were established and desert areas irrigated. During the last part of the 15th century, the Moslems were chased out of Andalusia by the Christians and settled in various parts of Morocco and influenced the local irrigation systems. Influence may also have resulted from the presence of Portuguese and Spanish settlements along the coasts. Ayad (n.d.) notes tl at around Azemmour, on the coast of the Atlantic, the development of irrigation was enhanced following the increase of commercial exchange with the Europeans in the second part of the 19th century and particularly after the Madrid Agreement (1880), and later on after the Algesiras Treaty (1906). From 1912-56, Morocco was a French and Spanish Protectorate and the colonists left their own marks on the Moroccan irrigation systems. After independence, an important program of large-scale irrigation development, usually called "the dams policy," was undertaken.

PRESENT STATUS OF IRRIGATION SYSTEMS IN MOROCCO

Two types of irrigation systems are frequently distinguished in Morocco: small- and medium-scale systems (SMSIS), which range in size from 50 hectares (ha) to about 3,000 ha, and large-scale systems (LSIS), which range from about 3,000 ha to several hundred thousand hectares. SMSIS may be traditional or modern systems; however, they are always farmer-managed. LSIS are modern systems, at least in their upstream portions, usually with storage reservoirs, and the main structures are always managed by the Offices Regionaux de Mise en Valeur Agricole (ORMVA), which is a government agency. There are presently nine ORMVA (ANAFID 1979). Although action has been taken to encourage farmer involvement in those systems, so far it has been limited (El Hallani 1979).

SMSIS represent a large potential (Tables 1 and 2). To understand fully the current status of SMSIS in Morocco, three aspects need to be studied: 1) the formation of water laws, 2) the irrigation policies followed by the Protectorate authorities and the Moroccan Government after independence in 1956, and 3) the irrigation organizations and their evolution.

*Maitre de Conference, Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco.

Table 1. Potential irrigated areas (in 1000 ha) in Morocco.

	LSIS	SMSIS			Total
	(ORMVA)	ORMVA	DPA*	Subtotal	
Perennial waters	790	115	305	420	1250
Seasonal waters	-	80	90	170	170
Flood waters	-	65	100	165	165
Total	790	260	495	755	1545

*Provincial Directorate of Agriculture; source: Ait Kadi 1986.

Table 2. Presently irrigated areas (in 1000 ha) in Morocco.

	LSIS	SMSIS			Total
	(ORMVA)	ORMVA	DPA*	Subtotal	
Perennial waters	415	180	220	400	815
Seasonal waters	-	175	90	265	265
Flood waters	-	65	100	165	165
Total	415	420	410	830	1245

*Provincial Directorate of Agriculture; source: Ait Kadi 1986.

The present Moroccan water laws are the result of the successive historical contributions of customs, Islamic laws, and modern laws. These three components still co-exist because no single component could supplant the others (Bouderbala et al. 1984). Customary regulations varying from one area to another are still extensive in the majority of SMSIS. Customs are a "real water code, although not formal" (El Alaoui 1979:41). The Islamic law (*Chraa*), "can be of a moral reference but never had practical applications" (Bouderbala et al. 1984) because it is too general. The Malekite Islamic rite in Morocco like the Chafei rite considers that when an individual settles in a land and brings water to it, he owns both the water and the irrigated land together with the "dead land" in which the water flows (Attar 1984).

According to Islamic laws, however, there are limits on the uses one can make of his own private water rights. The French, considering water a public good, declared all water resources in Morocco part of the public domain (laws of 1914 and 1919) with one exception: the water rights acquired before the law was decreed remained in force. However, as these water rights were never completely surveyed, it is difficult to say which rights were acquired prior to 1914. The colonial laws of 1914, complemented by those of 1919, were intended to allow the colonialists to corner and control all of the water

resources. In that respect, the French were more successful than they had been in Algeria and Tunisia (Bouderbala et al. 1984). After independence, the French modern laws were completed (sic) and amended as required for irrigation development. There are presently 65 main laws, of which 38 are post-1956. These laws were gathered and analyzed by Attar (1984) and Bouderbala et al. (1984). A good analysis of the Moroccan water laws can also be found in El Alaoui (1979).

To reach its aim of "creating large production units, irrigated if possible, to produce for the metropolitan state" (Kerbout 1983:5), the colonial powers used various methods to control both lands and water, such as despoliation of lands and turning away of waters to the colonists and their collaborators (ibid). According to Popp (1984), three periods can be distinguished in the colonial policy towards irrigation: 1) from 1912 to the mid-1930s the colonial states (France and Spain) were still busy with the "pacification" of the country, and the hydraulic structures built during this period were mainly for hydropower production and municipal water; 2) from the mid-1930s to the mid-1940s some small irrigation projects were developed; and 3) from the mid-1940s to 1956. During that period, the official and private colonial lands accounted for about one million hectares, and the French government started constructing large-scale irrigation systems to satisfy the growing needs of the colonists (the majority of irrigated lands were owned by non-Moroccans except in the Beni Amir and Boulaouane irrigation projects; ibid.:35).

Morocco as an independent state continued constructing LSIS, first at a slow pace and then, in the late-1960s, gradually increasing their implementation until LSIS development represented as much as two-thirds of the total public investments in agriculture (during the 1978-1980 triennial plan). In contrast, the public investments in SMSIS were almost insignificant. It seems that government development of SMSIS resulted from compassion and generosity toward farmers (Bouderbala et al. 1984). The actions undertaken in existing SMSIS were usually scattered, incomplete, and sometimes incoherent (see, for example, SCET MAROC 1977, and Zaghloul 1981), and were limited to construction of the headwork intakes, lining of some main canals, and installation of some flow measuring devices. Few actions were undertaken in terms of developing water user organizations and encouraging farmer involvement. The new SMSIS built since independence were usually planned with the LSIS methodology in mind and no actions were taken to insure their adequate management. Some successful actions in SMSIS within ORMVA's boundaries have been reported (El Hallani 1979, Madani 1983, Outabiht 1981).

Water allocation and distribution in SMSIS is presently undertaken by two main types of farmer organizations: a traditional type organization, and the Associations Syndicales Agricoles Privilegiées (ASAP), a legacy of the French Protectorate.

Almost all of the SMSIS located in areas where man has occupied the land intensively for a long time, as along the Atlas Mountains limits or in the pre-Saharan oases, are farmer-managed. Traditional farmer organizations, although not formally recognized and regulated, have precise and effective internal regulations transmitted from generation to generation. These organizations take care of all the management problems (including conflict management); planning, allocation, and distribution of irrigation water; and maintenance, control, and repair of the irrigation network.

The main structure of the water organization is the *jmaa*, an assembly of either irrigators, land owners within a given community's limits, owners of water rights, or members of the community concerned. The assembly may elect in a somewhat democratic way its representatives or simply nominate a council from among the oldest or more capable members. The general assembly may take place once a year and may be followed by a ceremony where people dance and sing. Watermasters are also chosen, together with their aides who can be chosen by the watermaster himself. These may have extensive powers ranging from the control of the water schedule to conflict management. They may have, for instance, the power to designate the irrigators who need to participate in maintenance works and fine those who refuse to do so. They may also declare a general mobilization (*touiza*) whenever repairs on the irrigation network require a large amount of labor. In some traditionally-managed SMSIS, watermasters do not exist because every member of the community knows his rights and duties (Bouderbala et al. 1984). The organization, the procedures, and the regulations vary greatly from one area to another because of differing natural, social, economic, and historical conditions. The decline of traditional farmer organizations is accelerating because the adequate environment for their activity is disappearing at a rapid pace (Bourras n.d., Kerbout 1983).

The Jmaa has lost much of its freedom to become the instrument of the administrative authorities and is now confined to the role of a transmission network for the administration (Bourras n.d.). Most traditional farmer organizations are, however, still performing well enough (SCET MAROC 1977).

Where land occupation was relatively recent and the density of the population was low, land was generally occupied by foreign settlers during the French Protectorate. Consequently the ASAP system for water management is the most common type of water users' organization on ex-colonial lands. The ASAP were decreed in 1924, at a time when the French Government wanted to give extensive powers for land reclamation to farmer organizations and the ASAP objectives included these activities. Intended primarily to satisfy the growing needs of French farmers, ASAP developed to include about half of the settlers in Morocco (Bouderbala et al. 1984). Today, all of the colonial lands that were not directly purchased by Moroccan farmers have been either distributed to Moroccans as part of agrarian reform, or are still exploited by government companies. The ASAP within these lands still formally exist but few are functioning. New laws are being written to replace those associations which are no longer adapted to the present situation.

ADVANTAGES OF SMALL- AND MEDIUM-SCALE IRRIGATION PROJECTS

Besides their importance in terms of area served, SMSIS projects, usually farmer-managed, present many other interesting features (Anouallah 1981, Pereira 1981, Zaghloul 1981).

1. These projects are "closer" to the farmers and thus improving them results in a more rapid increase in agricultural output than large and new irrigation projects.

2. The investment costs in small existing projects are lower than in large new projects for an equivalent increase in value added. This assertion needs to be verified.

3. The investments in SMSIS are gradual, resulting in high and rapid returns when compared to large projects where it may take decades before a storage dam and conveyance system are completed and fully used.

4. A better equilibrium between various areas of the country is reached when investments are put in small irrigation projects.

The above points, together with the financial problems facing many Third World countries are increasingly pushing governments to take action to improve small farmer-managed irrigation projects. Morocco is following the same trend but, at the same time, government officials together with technicians and researchers in Morocco are finding out that they lack both experience and knowledge in this area and that small farmer-managed schemes are more difficult to study and rehabilitate than new and large projects.

PROBLEMS FACING THE IMPROVEMENT OF SMALL FARMER-MANAGED IRRIGATION PROJECTS

Many government agencies are facing problems relating to the improvement of farmer-managed irrigation systems in Morocco. These problems may be classified into five categories: 1) a lack of data concerning these systems; 2) problems related to the remoteness of these irrigation systems; 3) difficulties in solving land ownership problems because of their old and intensive occupation by farmers; 4) secular water rights are common in these systems; and 5) a series of unanswered questions related to administrative, legal, and financial policy issues.

Lack of data. The lack of data is frequent if not general in SMSIS. Although there is considerable progress in technology, the expense and time required for data gathering and analyses are problematic. Concerning the quantity and quality of water resources, for example, it is still difficult to install and manage a large number of gauging stations on remote streams and springs. Water table monitoring is also difficult for similar reasons. Water resources data gathering cannot be confined to the derivation point of a particular SMSIS but should include the entire watershed, aquifer system, and existing water rights both upstream and downstream of the derivation point. A fierce competition for water is taking place around large cities such as Fes, Meknes, and Oujda, and high quality data will be important in solving this problem.

Remoteness. Although Morocco has a good railway and road system and is open to both the Mediterranean Sea and the Atlantic Ocean, remoteness of SMSIS is another constraint. Remoteness can be measured in terms of distance to markets and to agriculture industries; if an intensive cropping system is to develop on SMSIS, market availability is a requirement. Remoteness can also be measured in terms of relative distance to sources of agricultural inputs, to extension personnel, and to the technical

environment in general. In some SMSIS, it has been found that modern pumping is almost impossible because it may take months to purchase spare parts or to repair a pump.

Land ownership statutes. Another problem is the complexity of land ownership statutes in SMSIS and in Morocco in general because not all lands are privately owned. Collective, *Guich, Public Habous*, and State land ownership statutes can be encountered. Collective lands are collectively owned by tribal groups under the guardianship of the Ministry of the Interior, while the use of these lands is individually left to the members of the tribal groups. Procedures for partition and use of these lands vary from one tribe to another. Tribal groups used to make a new partition of the land every year, taking into account deaths and new rightful owners (through marriage, for instance) but there is a trend toward the disappearance of these practices by a de facto privatizing. Guich lands are similar to collective lands in that their use is given to tribes. Two major differences, however, are that the tribes are given use of the land as compensation for their ancient participation in the army (prior to 1912), and that the lands are actually owned by the government. Public Habous lands are donated by pious individuals to religious foundations and are cultivated under various conditions. Like collective and Guich lands, they are inalienable. State lands are owned by the government and cultivated by government companies.

The large variety of land ownership statutes and the often precarious way in which the lands are cultivated, prevent intensive cropping and investment. Furthermore, land registry does not encompass a large proportion of the lands because cadastral surveys are limited in some areas of the country. Also, the fact that a high proportion of the farms are very small (less than a few hectares) and may be divided into many scattered lots of various sizes and geometric shapes makes intensive farming difficult.[1] As a result of successive inheritance, the farming lots may become so small that partition is stopped and the undivided lot is consequently cultivated in common. Another major concern is the fact that in some areas, land, water, and tree ownerships may be separated resulting in as many as three owners for the same lot.

Secular water rights. The existence of water rights is another important problem. These rights are old and often unsurveyed, and their evaluation and continuous survey and updating are difficult, time consuming, and costly, and, if not correctly conducted, may result in social unrest. The evaluation of water rights is particularly difficult because of: a) the lack of standard measuring devices on traditional irrigation systems, b) the fact that the notion of water rights may be directly linked to the physical structures of the irrigation systems (capacity of a derivation point or a canal, design of a water partition device); and any change in the physical system may result in a change in the water rights, and c) traditional or religious beliefs (e.g., a government agency was prevented from modernizing a flow partition device on a spring because the villagers strongly believed that any modification of the structures would result in the drying of the spring). Water rights are in many cases independent from the land (i.e., "single") resulting in a large inequity in land and water ownerships. Some private water rights are so small or geographically scattered that they cannot be beneficially used unless sold or let out.

Policy issues. The above problems result in a series of questions related to the appropriate policy to use when dealing with SMSIS, the correct legal framework and particular organization required for that policy to succeed, and the method needed to mobilize both financial resources and farmers to reach the goals. The answers are difficult because of the complexity of the problems and the variety of environmental, technical, social, and political implications of any decision. SMSIS are a result of a historical process sometimes slow, sometimes violent. Any hasty intervention, however small, will destroy a state of equilibrium with unpredictable consequences. This is why government agencies are so reluctant to interfere with SMSIS, although they recognize the urgency of such interference. A key role is consequently left for research.

SOME IDEAS CONCERNING RESEARCH ISSUES

The few studies on farmer-managed irrigation systems in Morocco were conducted by sociologists, historians, geographers, and scientists in the human sciences. Consequently, the technical aspects of irrigation were not studied in much detail.

A SMSIS is a technical, social, economic, political, and historiçal entity. Consequently, its study should be conducted as a multi-disciplinary team effort. Because SMSIS differ, it is useless to identify causal factors unless the observations are made in a large number of systems. The single most important research issue is the study of the irrigation system itself. One of the main objectives of research is to establish a typification of SMSIS. This typification should be problem focused, not descriptive (Bouderbala et al. 1984); that is, it should try to answer specific questions that face those who want to intervene in the systems. Such questions might include: What particular difficulties are linked to land ownership statutes? Is it possible to consolidate water rights and lands? How efficient is the present system? If the irrigation network is to be modernized, could the old layout of the system be modified without major difficulties? The study is consequently not conducted for the sake of the study itself but with the problems to be solved in mind. Such an approach would facilitate the comparison of different systems and the analysis of the data gathered. The study of any system should include at least five aspects:

1. General information concerning the location, the climate, the soils, the crops, land ownership statutes and distribution, and water resources quality and quantity to define the setting of the irrigation system.

2. Irrigation network layout, capacity, structures (that is, the technology used), and on farm water management. Besides the water efficiency of the system, the relationships between (and the reasons for) the layout, the slope of the canals, the location of the intake structures, and the ethnic and natural environment.

3. Irrigation system management; that is, the organization for water management; the methods of irrigation water planning and distribution (and how well these methods respond to both the crop water needs and to equitable water distribution, particularly during periods when water is scarce); and the organization of system maintenance, particularly because maintenance works is often the price paid for water.[2]

4. Water rights;[3] that is, who has access to water and how much can he take? These are difficult questions because the answers may depend on particular circumstances such as the hydrology of the particular year or season, or the way water rights are quantified and the way measurements are made.[4]

5. A methodology for research in SMSIS is still difficult to suggest, at least for the Moroccan systems. It may take a few years of intensive study of many SMSIS before such a methodology can be developed.

CONCLUSION

For public intervention in farmer-managed irrigation systems to succeed, a clear policy is needed. The improvement of the irrigation system itself is but a small part (and the last stage) of public intervention. Prior to that, farmers should be involved and organized, a clear legal framework should be instituted, production structures and cropping systems should be improved, water resources quantified and if possible augmented, and adequate administrative structures should be created. Research in this area is still badly lacking while it is the basis of any policy to be undertaken.

NOTES

[1]Although it has been observed that the most intensively farmed land holdings are those located in oasis type areas where the fields are among the smallest of the country.

[2]In some irrigation systems in Morocco, water rights are lost in case of non-participation in maintenance works.

[3]Some researchers in Morocco prefer the concept "right to water" to the notion of "water right" (Hammoudi 1982).

[4]Time is certainly the most common means of measurement, but modern watches and clocks are relatively recent. Solar clocks are still used in many traditional irrigation systems in Morocco.

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PUBLIC INTERVENTION IN FARMER-MANAGED IRRIGATION SYSTEMS: A THAI PERSPECTIVE

Sacha Sethaputra*

INTRODUCTION

This paper describes a procedure adopted by the Thai Government to deal with farmer-managed irrigation systems, which are viewed as a component in the overall development activities for small-scale water resources. The objectives of this development effort are to provide water for drinking, domestic, and agricultural use in most areas of rural Thailand.

Irrigation systems in the context of the small-scale water resources program are usually on the order of 20-60 hectares (ha) of irrigated land. Annually, the government provides a budget for constructing headworks (i.e., permanent structures, such as spillways, embankments, and weirs for storing or diverting water) for selected irrigation project requests. The government expects farmers to take responsibility for construction of water conveyance facilities, operation, and minor maintenance of the systems. Projects are selected according to a set procedure which outlines various steps and the agencies involved.

There is disturbing evidence that of more than 2,000 weirs and tanks built under the procedure, only about one in five is being used effectively. Effective use means water made available by the construction of weirs or tanks is justified economically. Common uses are supplementary irrigation of rice and dry season vegetables. On the other hand, the available water in ineffective projects is used for domestic purposes and livestock. These uses, although benefitting farmers, cannot justify the cost of structures. Sources such as shallow wells can serve these purposes with much less cost.

The paper is divided into two sections: the procedure and analysis section outlines the procedure, reports observations, and offers an analysis of both. The second section presents suggestions for improvements arising from the analysis. These suggestions are tentative and are intended for discussion only. This paper and its analysis are the result of an on-going research project supported by the Ford Foundation and conducted by the Water Resources and Environment Institute, Khon Kaen University.

THE PROCEDURE AND ITS ANALYSIS

This section first describes the procedure in its theoretical form (i.e., as set by the government). Observations are then presented on the procedure at work. Finally, an analysis explains the observations.

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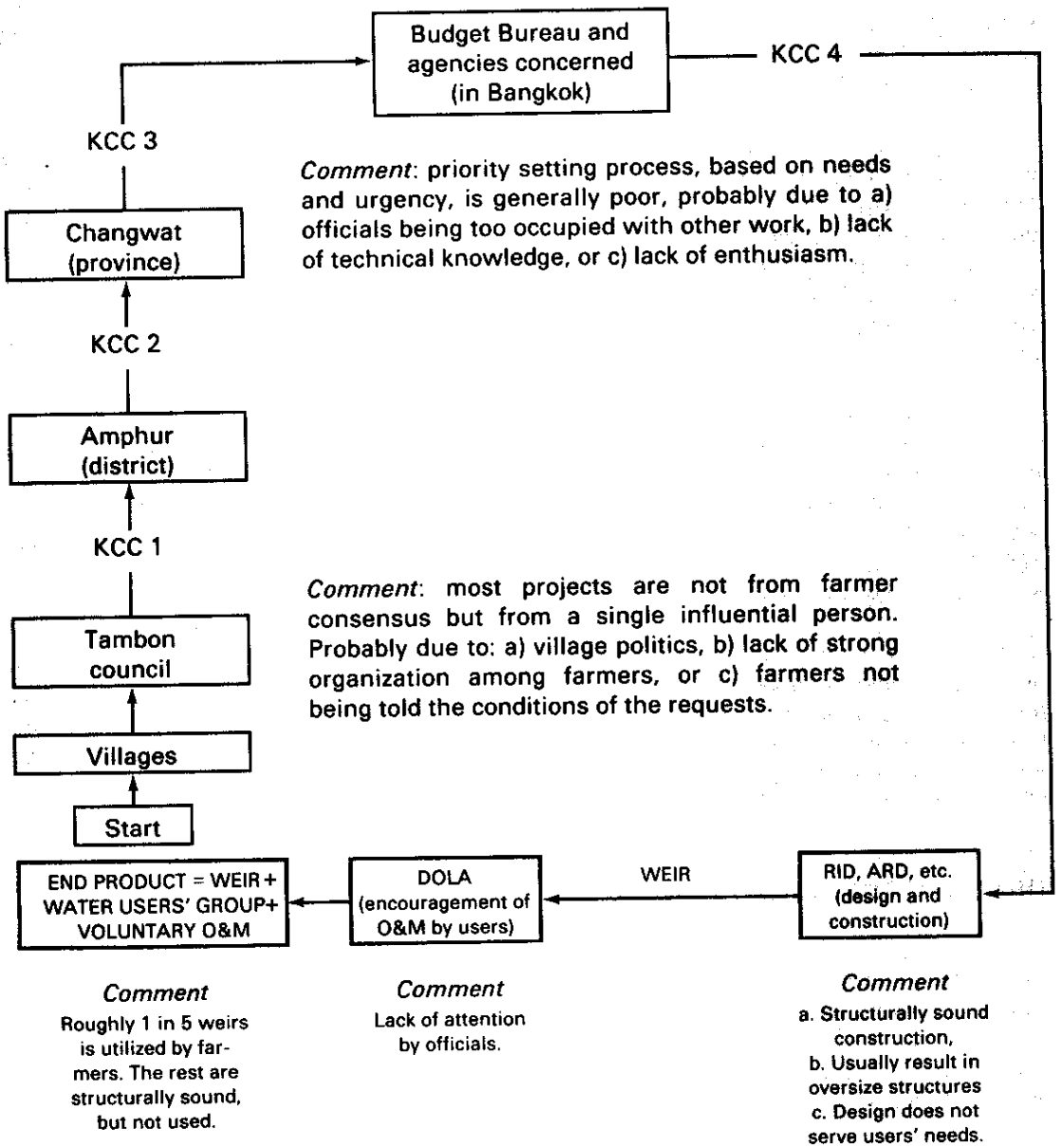
*Associate Professor, Water Resources and Environment Institute, Khon Kaen University, Khon Kaen, Thailand.

The Procedure

The procedure is shown in Figure 1 as a simplified flow chart. The boxes indicate groups of people and agencies. Phrases written in capital letters outside boxes are inputs or outputs to the boxes. Paragraphs alongside the flow chart are observations to be discussed later.

Figure 1. Implementation procedure for development of small irrigation systems.



To facilitate the discussion the following terms need to be clarified. Administratively, a group of villages forms a *tambon* (subdistrict), a group of tambons forms an *amphur* (district), and a group of amphurs forms a *changwat* (province). There are 73 changwats in Thailand. Bangkok, the capital of Thailand, is a changwat.

The flow chart starts at its lower left end and moves up. In every village there exists a village committee (at least on paper). The village committee makes a request, such as to have a weir built, to the tambon council. The council is supposed to screen all requests according to the need and urgency. It then passes on the list, called "KCC 1," to the amphur. Each tambon council is advised by a committee comprised of government officials representing the Ministries of Health, Education, Agriculture and Cooperatives, and Interior.

At the amphur level, a similar screening process is supposed to occur -- the outcome of which is the list of projects called "KCC 2." At present, amphur committees do not have any members with technical backgrounds. The committee is chaired by the amphur head administrator.

At the next level, a changwat committee, chaired by the governor of the changwat, prioritizes requests in KCC 2. Representatives from technically oriented agencies are present. Output is a list of requests called "KCC 3."

Everything described so far occurs within the changwat where requests originate. The KCC 3 is then sent to Bangkok for consideration by the Budget Bureau, agencies involved in design and construction, and other agencies concerned with securities. Feasible requests are approved, budgets allocated, and projects assigned to different agencies for design and construction. The output of this step is a list of projects and the agencies responsible for construction. The list is called "KCC 4." At this stage, all projects listed in KCC 4 are usually constructed unless exceptional technical difficulties are encountered. Important agencies responsible for design and construction are the Royal Irrigation Department (RID) and the Office of Accelerated Rural Development (ARD). Although there are several other government agencies involved in this phase, RID is responsible for the majority of the projects. Outputs from this phase of the procedure are headwork structures such as weirs or tanks.

Once the construction of the headwork structures is completed, the Department of Local Administration (DOLA), under the Ministry of Interior, is responsible for forming water users' groups and encouraging the groups to operate and maintain the facilities. Output from this phase is the end product: the headwork structure and voluntary operation and maintenance (O&M) by the water user group. This marks the end of the procedure.

With respect to time, the activities from KCC 3 down to the end product occur annually according to the Thai fiscal year. The activities from the start of the procedure up to KCC 3 are not affected by that fiscal year constraint. Site survey, design, and construction work are done between October and March every year. The time required from request to completion of construction varies from about 18 months to several years.

Before the procedure outlined in Figure 1 was introduced, requests were initiated through many uncontrollable channels. For example, an abbot of a village temple might initiate a request simultaneously to a parliament representative and to the RID. The representative might then contact other agencies. Sometimes, it happened that more than one agency intended to have a weir built in the same village without any knowledge of each other's intention. Request procedures were chaotic, inefficient, and unfair to other villages. This procedure was introduced to eliminate such problems.

Observations

The following observations made during the study relate to Figure 1, where summary comments are provided. The first observation concerns the steps from the village level to the KCC 1 list. The majority of requests originated from a single influential person such as a village headman or tambon headman, rather than from a group. This is probably due to 1) village politics, 2) lack of strong organization among farmers, or 3) farmers not being told the conditions of the request.

The second observation is made for steps from KCC 1 to KCC 3. Here the screening process was ineffective. It is normal to see requests processed without any field checks. According to a random check, only 4 out of 30 requests were technically feasible. Most requests did not meet the needs of the majority of users (as a consequence of factors noted in the first observation). The poor screening by the amphur and changwat are due to: 1) officials being too occupied with other work and routine responsibilities, 2) lack of technical knowledge, or 3) lack of enthusiasm.

The third observation is made at the design and construction step with KCC 4 as an input and permanent structures, such as weirs, as the output. Most structures observed were structurally sound but too large for the intended service. The design lacked flexibility and did not serve users' needs.

The fourth observation is made at the step where a water users' group is set up and O&M carried out. The task is assigned to the Department of Local Administration (DOLA). Lack of attention by officials is most apparent here.

Output of the previous step is the end product, which, in theory, should consist of the structure, the water users' group, and voluntary O&M. In reality, approximately one in five projects met the above expectation. The rest were structurally sound but not used for irrigation as planned. They were used for supplying water for domestic use and livestock. Such uses could be served more cheaply by other means.

The low percentage of successful end products (e.g., weirs) is the main concern. Several million dollars are spent annually. The government cannot afford to continue this kind of investment. At present, the Budget Bureau is already criticizing the program.

The lack of enthusiasm by farmers for O&M reflects their attitude toward the government-constructed headworks. Given the existing conditions, non-government weir

construction programs have indicated that the percentage of successful weirs could be much higher with less construction cost. This is in sharp contrast to the government program. This difference can be attributed to three factors: design of a weir (hardware), approach (software), and cooperation among agencies.

Design of a weir. The aspects involved in weir construction are location and dimension. Location refers to the exact place where the weir is to be built. Government weirs are often built without consulting farmers, which is unfortunate because, in most cases, farmers have better knowledge of flow in that vicinity than government designers. Farmers usually want a weir built on the stream at a particular place. Building a weir usually implies that the weir will not be larger than the width of the stream, and hence does not occupy agricultural land nearby. Thus there is no land ownership problem to settle. However, such a weir will not be able to pass the maximum flow during flood. This does not mean that the weir will be washed away with flood water. With proper design, the weir will be inundated during flood but not damaged. Government designers are too conservative to accept such design concepts. This results in a much larger weir than necessary and at a location further away from the stream, hence requiring an extra channel connecting the weir to the original stream. It is normal to find that government weirs cost about 10 times more than what is required. In many cases government agencies build weirs further upstream in order to store more water. This is contrary to the farmers' requirement that, to be beneficial, the water must be available at a particular location.

The crest level of a weir is another important aspect since it determines the water level. Too high a level will cause adjacent land to be inundated. Weirs with crests too low will not enable water to flow to desired locations. During the preliminary site investigation, it is always difficult to determine proper weir crest level. Variable weir crest level is therefore justified. Design measures such as provision for "stoplogs" is simple and serves the purpose satisfactorily. It took an incredibly long time for government designers to accept such a simple change.

Approach. Approach refers to the way agencies interact with farmers before weir construction. A suitable approach is a prerequisite to successful weir projects and increases the chance that the weir will meet the needs of the users. In Thailand, it also creates the sense of belonging that is crucial to voluntary O&M. Weir projects are joint ventures between two parties: the government and the farmers. It is therefore reasonable to have both parties informed of all conditions that exist (e.g., cost, location). In the past, at least for the RID, a respectable effort has been made to try such approaches in the agency's weir construction. However, constraints on time, personnel, budget, and lack of coordination with the design section prevent translation to fruitful results.

Cooperation among agencies. The procedure described earlier requires government agencies to cooperate. For example, once the RID completes weir constructions, it will hand over the weirs to district officers under DOLA to organize water users' groups. It is clear that lack of interest and enthusiasm by DOLA personnel exists. One explanation for this is that DOLA does not like what it is expected to do. The procedure outlining the

responsibility of various agencies is like a conveyor belt manufacturing process where each agency performs a particular task. Some like it and some do not. For example, if works in earlier steps are done improperly then the task assigned to DOLA is made more difficult or impossible, and the responsibility assigned to DOLA does not enable it to command a large budget. Nevertheless, the blame for the failure of the program is usually focused on RID even if it is due to poor performance by DOLA. This explanation is reinforced by the recent effort by DOLA to experiment with its own weir construction program.

RECOMMENDATIONS

Technically the solutions to the problems above already exist. The question is whether these solutions will be acceptable to government policy making bodies and practicable to implementing agencies. In this respect the recommendations must be based on practicality rather than ideology. Recommendations should also be accompanied by lobbying and persuasion, and contain sufficiently detailed procedures.

Because the research work is ongoing, the following recommendations should be taken as preliminary rather than final. The recommendations are based on the assumption that the procedure presently followed by all government agencies is here to stay. Drastic change of the procedure is likely to cause confusion rather than improvement, and hence only modifications are recommended.

Short Term Measures

These focus on RID's weir design practices and the approach used to interact with farmers when the KCC 4 list is released. The aim is to help RID prepare projects before construction, to increase the chance of building weirs that meet users' needs, and to promote voluntary O&M by users.

One suggestion is to have a community organizer stationed in a village where a weir will be built from the project inception (i.e., when the KCC 4 list is released) until construction is complete. This community organizer is expected to facilitate communication between farmers and the RID.

Stationing community organizers in villages will add to the cost of the project. It is therefore necessary to assess the marginal increase in benefit against additional cost. Analysis based on risk assessment and expected value is ongoing.

Long Term Measures

Long term measures focus on attacking inefficiency due to lack of cooperation among agencies. It is suggested to charge an agency with responsibility for the whole stream of events from the release of KCC 4 to the end product. More than one agency will be assigned such tasks in parallel. In this way, the end product of each agency can be compared and used to create competition leading to better results.

RESEARCHING VILLAGE IRRIGATION SYSTEMS IN SRI LANKA

Jayantha Perera*

INTRODUCTION

The Government of Sri Lanka emphasizes as its main agricultural policy goal the need to achieve self-sufficiency in food. The government has adopted two main strategies to reach this target: the expansion of the area under food crops -- mainly rice -- under major irrigation schemes, and the intensification of agriculture on lands that are already under cultivation.

With substantial financial and technical aid from foreign donor agencies, massive investments are being made to develop large-scale irrigation schemes to bring new land under cultivation and to improve the efficiency of existing schemes. For example, in the 1981-85 Program of Public Investments, Rs 29 billion[1] (US$1.04 billion) was allocated as capital expenditure for the Mahaweli Development Project, while Rs 3.6 billion (US$128.6 million) was allocated for the development of all other irrigation works (Economic Review 1986:3).

The expansion of new rice lands is now facing natural limits. Therefore, the government has to pay more attention to a strategy based on the intensification of agricultural production on existing cultivated land. In this respect minor irrigation systems[2] can play a vital role as over 50 percent of the total irrigated land is fed by village tanks (small reservoirs) and *anicuts* (weirs).

Moreover, it is believed that the rehabilitation of minor irrigation systems, which are scattered in many parts of Sri Lanka, will: 1) arrest to some extent, the economic disparities between regions; and 2) control inflationary pressures that have been created by highly capital-intensive, long-gestation irrigation schemes.

However, current investments for the improvement of village irrigation systems show a lack of understanding of the technological, managerial, and organizational issues pertaining to minor irrigation systems. This is a result of a lack of appreciation of the socio-economic changes that have been taking place at the national level and within the confines of small-scale village irrigation systems, and of the myopic policy that these systems have somehow remained unchanged and display attributes of continuing strong social cohesiveness that can be tapped for purposes of irrigation management.

In fact, the World Bank, which finances the Village Irrigation Rehabilitation Program (VIRP) stresses the importance of going back to traditional practices of water management in order to correct certain weaknesses in the water management programs introduced during the post-independent era by different governments. The World Bank (1981:4) notes:

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*Deputy Director, Agriculture Research and Training Institute, Sri Lanka.

> With the passage of the Paddy Lands Act in 1958, its subsequent amendments, and its replacement by the Agricultural Lands Act of 1973, the Government attempted in various ways to replace the traditional system with elected committees under official sponsorship. During the 1960s, this system appears to have functioned fairly well, but further administrative changes weakened the effectiveness of the elected committees, with the result that the traditional system of control was undermined without being replaced by an effective alternative. Recognizing this, the present government has abolished the system of elected committees, *replacing it with one which in some ways returns to traditional practice* (emphasis added).

Such a return to traditional practices is evident in the water management programs introduced recently under rehabilitated village irrigation systems. Some components of the program were introduced on the assumption that they had contributed to improving the efficiency of village irrigation in the past and their renovation would improve irrigation efficiency in the present. This assumption derives from two interrelated conclusions about the village community: 1) mechanisms of efficient water management did play a vital role in village irrigation systems in the past, and 2) village communities still are structurally the same, making it possible and desirable to reintroduce the traditional mechanisms of water management.

This paper specifically deals with institutional aspects of water management programs under recently rehabilitated village irrigation systems. It attempts to highlight the characteristics of the village community within which traditional mechanisms of water management operated in the past with some success, the factors that have changed these characteristics, and the socio-economic factors operating in village irrigation systems today and how they clash with certain institutional mechanisms that were introduced under the current water management programs. In doing so, the paper makes a case for further research into different aspects of the village community and irrigation management.

The paper is divided into the following sections: 1) rationale for present investments in village irrigation rehabilitation programs; 2) current approaches to village irrigation management; 3) historical overview of village irrigation activities during the latter part of the 19th century; 4) discussion of the appropriateness of some components of the present water management programs both from social and economic view points, and 5) some possible areas for research on village irrigation management.

RATIONALE FOR PRESENT INVESTMENTS IN VILLAGE IRRIGATION REHABILITATION PROGRAMS

Since the 1970s, investments in village irrigation systems have been substantial (Table 1).

Table 1. Investments (in million Rupees) in village irrigation schemes, 1950-82.

Period	Amount
1950-54	16.4
1955-59	11.0
1960-64	6.4
1965-69	23.3
1970-74	70.4
1975-79	196.6
1980-82	285.4

Source: Economic Review (1986:5)

The rationale for the revival of village irrigation systems springs from several factors. Village irrigation systems can be cost effective, can increase farmer income, and can reduce drought related risks.

Cost effective. Village irrigation systems account for about 54 percent of the 450,000 hectares (ha) under irrigation, carry 35 percent of the paddy extent, and contribute 22 percent of the rice production (Gunadasa et al. 1980). The government and foreign donor agencies have estimated that of some 23,000 village irrigation systems in the country only about 50 percent are in working condition, while 30 percent of the irrigable area remains utilized or under-utilized for rice cultivation. It is estimated that about 50,000 ha of new lands can be brought under cultivation by refurbishing existing village irrigation systems. This means that 50,000-75,000 farmer households can be provided with adequate irrigation facilities without resettling them (ibid.). Such a program is cost effective as the average cost of village tank rehabilitation is estimated at Rs 10,000/ha (US$357/ha), which is about 20 percent of the cost for developing a hectare of irrigated land under the Mahaweli Development Project (Economic Review 1986:8).

Increased farmer income. Low average yields and small land parcels characterize irrigated lands under village irrigation systems. As a result, the socio-economic conditions of farmer households have deteriorated. And, from a welfare perspective, there is an urgent need to improve irrigation facilities through the rehabilitation of village irrigation systems so that the majority of rural households can earn more from their paddy holdings.

Risk reduction. In the past, villagers cultivated rice mainly for family consumption and seldom sold any in the market. Nearly every household cultivated a *chena* (slash and burn) plot, and this reduced the subsistence risks associated with frequent droughts in the Dry Zone. At present the government does not allow villagers to cultivate chena in many parts of the Dry Zone. Also, increased population pressure has increased the demand and

limited the land available for chena cultivation. As a result, many farmers now depend exclusively on their paddy holdings to earn a living. To assure water for two seasons a year the government intends to refurbish structures and introduce a water management program for village irrigation systems.

DIFFERENT VILLAGE IRRIGATION REHABILITATION PROGRAMS IN SRI LANKA: THEIR OBJECTIVES AND STRATEGIES

The following four village irrigation rehabilitation programs are of primary interest: Village Irrigation Rehabilitation Project (VIRP), Integrated Rural Development Project (IRDP), Anuradhapura Dry Zone Agricultural Project (ADZAP), and Small Reservoir Village Community Rehabilitation Program of the National Freedom From Hunger Campaign (NFFHC).

Although the volume of investments and the geographical spread of rehabilitation activities vary, the water management activities of the first three programs are similar to each other. Therefore, for the purposes of this paper, these three will be treated as one approach to village irrigation rehabilitation. Thus, one may identify two main approaches or strategies to village irrigation rehabilitation programs in Sri Lanka: state-sponsored programs and non-governmental organization (NGO) sponsored programs. The NFFHC is the prime example of the latter approach.

State Sponsored Village Irrigation Rehabilitation Projects

Village irrigation rehabilitation projects have two distinct components: the physical rehabilitation of irrigation structures and the implementation of a water management program. The former is carried out by the Irrigation Department and the latter is implemented by the Department of Agrarian Services (DAS) with the help of farmers, who are the beneficiaries of the program. The assumptions behind these projects are: 1) farmers do not have the necessary capital or skills to launch a physical rehabilitation program to improve the irrigation efficiency of their village water source, whether tank or anicut, even if they desire to do so; therefore, 2) the government should intervene to refurbish village irrigation systems; and, 3) because the village irrigation systems are still operated as communal property, the government should allow the community to operate and maintain them.

Physical rehabilitation work includes desilting tanks, strengthening tank bunds, repairing and improving sluices and spillways, and installing measuring devices (to measure discharges and evaluate seepage losses), and on-farm development to facilitate water management activities.

Each rehabilitated tank or anicut is supposed to have a water management program. These programs share the same objective of making efficient use of rainfall and tank-stored water for cultivation of the command area. This is done in two ways: improving the dependability of the water supply, and sharing water equitably among farmers in the command area.

NGO-sponsored Village Irrigation Rehabilitation Program

The NFFHC has undertaken the restoration of abandoned tanks in the Dry Zone through its Small Reservoir Village Community Rehabilitation Program. The NFFHC is a voluntary agency which receives financial support from the European Economic Community (EEC). It operates under the auspices of the Ministry of Agricultural Development and Research.

The main objectives of the program are: 1) to improve the living standards of poor rural communities by restoring their irrigation tanks; 2) to revive ancient customs which, in the past, assured the maintenance and repairs of the village tanks; and 3) to reduce chena cultivation by providing an assured supply of irrigation water to cultivate rice lands in the command area of village tanks.

The NFFHC handles the refurbishment of tanks, and all earth work is done by the farmers under the supervision of the agency's technical assistants (TA). Villagers are paid for contributed labor at the rate of 50 percent of the standard payment prescribed for the Irrigation Department's laborers.

Farmers are solely responsible for the operation and maintenance (O&M) of their village tank. They are members of a reservoir council (RC) and all the decisions regarding the operation of a tank lie with the RC, which meets two to three times a month. Each farmer contributes two bushels of unmilled rice per acre (41.75 kilograms per 0.4 ha) per cultivation season to a common fund called the Reservoir Maintenance Fund to meet the costs of maintenance and repairs to the tank.

STRATEGIES FOR WATER MANAGEMENT AT THE VILLAGE LEVEL

The water management program carried out by the DAS has two main components: improved agricultural practices and system management. The first includes dry sowing of rice in *maha* (wet season) with early rains; plowing immediately after maha and *yala* (dry season) harvests to facilitate early land preparation for the following season; growing subsidiary food crops in yala; and promoting short-duration rice varieties in both maha and yala.

The system management component includes establishing farmer organizations for O&M and for implementing water management programs; cultivating only part of the command area during periods of water shortage; implementing a rotational water supply system with a fixed delivery plan; and allocating water to tail end areas before head end areas.

The tanks that have been rehabilitated by the NFFHC are generally small and irrigate about 20 ha each. The stored water in a tank is used to prevent crop failure during dry spells within a cultivation season. These tanks do not need an elaborate water management program because only an average of 20 households control and use the water in the tank (Wijetunga 1986:9).

Water management programs are supposed to guarantee (sic) at least a minimum amount of food and income to all farmers in the village at all times. Some components of the water management package are claimed to be derived from traditional customs and agricultural practices which were in existence during the pre-modern period of irrigation history in Sri Lanka. The prevalent belief is that these customs and practices had evolved over several centuries and had promoted community cohesion and a form of subsistence ethics in Sri Lankan villages. Therefore, the adoption of these practices, policy makers believe, would allow farmers to cultivate their paddy lands regularly on a cooperative basis.

VILLAGE IRRIGATION REHABILITATION UNDER BRITISH RULE

Because many references are currently made to past experiments in irrigation water management as a basis for new institutional mechanisms and agricultural practices, it is worth discussing the salient features of British policy and practices in village tank renovation exercises, particularly during the second part of the 19th century.

British irrigation policy for village irrigation systems reflected a combination of paternalism and self-interest: paternalism because the colonial government felt an obligation to help the peasants through investment in irrigation works and self-interest because it believed that this would resolve the food crisis and guarantee peace and order in the countryside at minimum cost. Officials argued that for the cost of restoring one major tank, which would benefit a few villagers, several small tanks could be repaired to benefit many villagers. Thus, priority was given to village tank rehabilitation. In the 1870s, the British discarded their initial principle that public works should be judged solely by their capacity to generate revenue. This allowed many benevolent and energetic officials to refurbish abandoned tanks all over the Dry Zone, and marked the beginning of a process of encapsulation (sic) which linked the entire country with the central administration.

The village tank restoration program had two distinct phases: the rehabilitation of physical structures such as sluices and tank bunds, and the O&M of the tank for efficient water management. The activities of the first phase were guided by the policy that the government should work along with the villagers and that their feelings, habits, and interests should be respected in doing so. Support from villagers in the form of labor and money was also provided. Thus, from the late 1860s, the approach to restore village irrigation works consisted of two components: monetary contributions and technical supervision by the government, and voluntary local labor and the payment of "water rates" by the farmers. This was known as the "grant-in-aid" system.

With regard to institutional arrangements for irrigation water management, the British rulers attempted to reintroduce what were presumably traditional forms of village social organization, such as *gamsabhawa* (village council), and activities such as compulsory labor in community work. They hoped that this would promote village cooperation and increased agricultural production, while remaining consistent with the British policy of indirect rule (Perera 1985a, Abeyratne 1986a).

These ideas were very evident in the Paddy Lands Irrigation Ordinance of 1856. However, the Ordinance was framed in general terms as these customs varied from region to region and the government agent (GA) was given powers to decide which customs were applicable to his area of authority.

Generally, the GA or his assistant convened a public meeting at his own discretion or, more often, at the request of at least 10 cultivators in a district to determine by majority vote whether ancient customs relating to irrigation and cultivation of paddy lands should be revived. The customs would then be defined by a committee of cultivators with the help of government officials. The customs became rules only after they were accepted by at least two-thirds of the general body of cultivators, after which the rules were sent to the governor for his ratification. Such rules were binding on all cultivators. A *vel vidane* (village irrigation headman) was elected by the village community to supervise the water distribution and the maintenance of headworks and channels, and to report wrong-doers to the gamsabhawa. A breach of rules was investigated by the gamsabhawa, which comprised 3-13 cultivators, and a representative of the GA. The guilty cultivators were fined. Many of these rules became very popular. For example, in Badulla District, there was a rule that requested the vel vidane to inspect the village tanks three times a week. Another popular rule was that a cultivator could hold Crown Land as private property on condition that he cultivated it regularly (Balasingham 1968:74).

These institutional mechanisms brought many changes in water management practices. Provided with masonry sluices, villagers began regulating the flow of water from the tank. The crude, wasteful habit of cutting bunds was largely abandoned. With strengthened bunds and proper spills, the tanks retained more water and as a result, paddy cultivation expanded rapidly. Farmers who used to cultivate only a portion of their holdings due to water shortage, now began to cultivate the entire area, and some bought additional land. Thus between 1870 and 1900, several thousand hectares of new land under restored village tanks were sold by the government at the rate of Rs 25.00/ha (Rs 10.00/acre).

Between 1856 and 1904, an estimated total of Rs 13.5 million was spent on irrigation works of which over 90 percent was allocated to village irrigation. As a result, during this period, paddy acreage increased from 160,000 to 240,000 ha. Rice production also increased rapidly. For example, between 1874 and 1877, annual rice production increased from 73,499 to 313,465 bushels (1,533.9 to 6,542.0 metric tons). This allowed the government to collect more grain tax from the peasants and the latter, according to Governor Gregory (1872-1877), became more healthy and resumed habits of industry (Bastiampillai 1970).

Until the 1930s, several factors facilitated the smooth functioning of the gamsabhawa and the efficient performance of the vel vidane's duties at the village level. The village was a closed community. In other words, many aspects of the village -- economic, political, and familial -- took place primarily within the socio-geographic context of the "natural" village. Thus, the village was, in a sense, a "community of fate" which allowed its members little mobility or choice.

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In a traditional village there was congruence between the status rankings involved in the different sets of activities of its members. Thus the vel vidane was one of the biggest landlords in the village, was elected by the villagers as their principal officer, and was legitimated by the GA to oversee village agricultural and irrigation matters. He possessed every attribute and power to devise his own strategy of water management. Together with the village headman, he possessed administrative experience which assured confidence in the exercise of authority. Generally the vel vidane was better educated and well-connected with outside influentials, and better-off economically than others. These traditional attitudes of loyalty and respect convinced others to accept his leadership as right and proper (Perera 1985b).

The village community also acted as a moral community. Single caste, single *variga* (kindred group) identities made every villager a shareholder of the village estate and its appurtenances, such as common grazing lands, reservoirs, and forests. The villagers considered themselves to be one group of relatives. Therefore, each had a moral obligation to help the other and subsistence ethics prevailed as a social insurance against draught, wild animal damage, and the encroachment of outsiders on their property. This cohesion, in turn, allowed them to enjoy various cooperative activities such as *bethma* (cultivating only a portion of the paddy tract communally due to the scarcity of water), *attam* (exchange labor in paddy cultivation), and *kaiya* (cooperative labor).

Villages were also expected to be self-sufficient in food and security. Remoteness, lack of communication, and illiteracy made them self-dependent. Heavy dependence of the community on the irrigation system for agricultural and domestic needs induced them to take part in planning and restoration of village tanks on a communal basis.

These characteristics of the village community began to change after the 1930s as a result of the rapid penetration of State activity into rural areas, the concomitant process of politicalization, with the introduction of universal franchise and secret ballot, and the substantial devolution of administration to the locally-elected ministers.

The British colonial rulers believed that the security of private property was essential for establishing a suitable foundation for agricultural development. Ordinances such as the Waste Land Ordinance of 1840 and its amendment of 1897 were enacted to ensure the security of land tenure and to protect Crown Land from encroachment. The implementation of these ordinances caused far-reaching changes in the village communities. For example, the ordinances required the mapping out of all types of land in the villages and, as a result, cadastral surveys were made and the ownership of ancestral land was regularized and demarcated from Crown Land. When the government refurbished village tanks, they too became Crown property. "As a result, the State was in a position to redefine the hydraulic community boundaries, sometimes permitting the asweddumization of new lands by outsiders who had access to them at public auctions"[3] (Abeyratne 1986a: 5). The introduction of new concepts of property, redefinition of the boundaries of the hydraulic community, and the emergence of village land as a marketable commodity disturbed the traditional village social structure and value system.

In the 1930s, the functions thought proper to central government began to grow as a result of the process of politicalization. The development of communication, market networks, transport facilities, and welfare agencies opened the hitherto closed village community and made it a part of the wider economic, social, and political system (Perera 1985b:181).

These changes in a sense transformed the village community to a "community of choice" from a "community of fate." This process resulted in a gradual decline in the autonomy of the "closed" natural village community, diversification of occupation and income structures, the decay of extended kinship systems (such as the variga, which bound villagers by various obligations), and above all, an increase in the mobility of the villagers. In place of a subsistence economy and the barter system, a money economy and attendant values gradually penetrated the villages. In the sphere of irrigation, village boundaries expanded to cover more paddy lands beyond what could be irrigated by the village tank. Such paddy lands became essentially rainfed and therefore not dependent on irrigation water (Abeyratne 1986).

INCONGRUENCE BETWEEN POLICY AND RESEARCH: A CASE FOR FURTHER STUDY

Under the current village irrigation rehabilitation programs, the government does all physical rehabilitation work and expects farmers to take part in irrigation-related tasks subsequent to rehabilitation. By doing rehabilitation work with minimal consultation of farmers, the government has managed to concentrate and consolidate its role in village irrigation systems. This is radically different from the tank rehabilitation activities under the British. Previously the government made a single-shot investment in village irrigation systems and thereafter withdrew, leaving villagers to operate and maintain these systems. Moreover, physical rehabilitation was carried out with the help of villagers. Such a strategy of intervention did not disrupt the villagers' perception of village property as the government intervened only to facilitate their communal activities. But now the continuous and increased intervention of the government leaves little doubt in villagers' minds as to who owns their irrigation systems.

In recently refurbished village irrigation systems, the majority of the villagers believe that the government owns the irrigation system and is therefore responsible for ensuring system O&M. Thus, it is difficult to expect farmers to act as if they were the owners of irrigation systems and to look after these systems as a community. This difficulty is further aggravated by the gradual erosion of many of the characteristics of traditional closed village communities. Although policy makers believe that the village community is still traditional and closed, except for its manageable size and typically homogeneous character, in reality it has changed radically. Thus a water management program premised on the expectations that farmers would act according to the traditional norms of community organization, which emphasizes communal property and the exclusiveness of the village, is destined to be unsuccessful.

A second related point of misfit between policy and research is that several components of the water management program under the rehabilitated village tanks and anicuts are designed on the basis of the technical information available at research stations. Such information is often not applicable to village irrigation and agricultural systems and, as a result, these activities set targets which are high for villagers to achieve given the economic, technical, and environmental problems that prevail in remote villages.

Below are some of the components which appear to be the basis for many water management programs and which are introduced to demonstrate the kinds of difficulties that arise when policy prescriptions are premised on certain expectations of the socio-economic and cultural environment, expectations which may have no current empirical basis.

Organizing Farmers for Irrigation System O&M

As there are over 20,000 village irrigation systems scattered over Sri Lanka, their proper management and operation is almost impossible without farmers' assistance, and the modus operandi for the latter is considered to be through farmer organizations. Thus the establishment of farmer organizations has been incorporated as one of the main strategies of State-sponsored water management programs (Department of Agrarian Services 1984:5). The government's interest in establishing farmer organizations derives from two interrelated assumptions about the village community: village irrigation systems decayed as a result of the decline of traditional mechanisms for water management, and the government's presence in the village is needed to invest in physical rehabilitation and to organize farmers to look after the refurbished water sources. Thus the irrigation water management programs have to involve both the government and the community. "Since it is difficult for individual farmers to change this system, and since outside government assistance alone is unlikely to be effective, it will be necessary to strengthen both the government's capacity and the community's capacity to make these changes" (World Bank 1981).

Under the VIRP, for example, an attempt has been made to organize farmers or at least their representatives into the tank committees (TCs). The block-level farmer representatives come together with government officials under the chairmanship of the vel vidane to decide on the operations for the particular season, such as organizing agricultural inputs, providing agricultural extension advice, and resolving conflicts. There is a rough division of work between the farmer representatives and field-level officials within the TC. Irrigation and agricultural activities are generally performed by the latter as such tasks need extra-community activity, while matters that strictly concern the community are left to the former for mediation through the vel vidane (Abeyratne 1986b:6).

TCs are supposed to revive the principles of the traditional gamsabhawa to evolve an efficient water management system under tanks and anicuts. For the government, such an attempt is convenient as certain irrigation-related responsibilities can be given to the community. This would reduce government expenditures and the need for an

administrative set-up at the village level. Additionally, the involvement of farmers in O&M activities, the government believes, would allow them to develop some sense of proprietorship over the water source and this in turn would provide feedback on field performance to the irrigation officials.

From the farmers' viewpoint, the TC is not a farmers' organization. It was introduced by the government and its decisions are primarily taken by the officials because they have the necessary legal and administrative backing to implement certain decisions and remedial actions (Abeyratne 1986a:7). Such officials are not accountable to farmers but to the government. As a result, the TC derives its authority more from the State than from the farmer community. These factors undermine the importance of farmers' participation in water management activities in village irrigation systems.

Little opportunity to participate is sometimes compounded by little incentive to participate. For one thing the village tank does not enjoy the primacy that it had in the past and landholdings under the tank are extremely fragmented and do not meet subsistence requirements. All these factors make it difficult to elicit even the limited farmer participation envisaged from the village-level organizations (Abeyratne 1986b:18).

Another factor limiting community-wide farmer participation in water management is that the village community is not always coterminous with the community represented in the organization. Earlier, only the proprietors took part in seasonal meetings; now the representatives of all operators of land and several field officials take part in the TC meetings. Sometimes, after rehabilitation of a tank, different groups within a village may compete for water for different purposes. Kehellanda Village in Monaragala District is a good example. Here two main groups -- farmers and fishermen -- have conflicting uses for the water in the tank (see Abeyratne and Perera 1986, Abeyratne 1986a:19). Unless there is a clear and realistic delineation of irrigation and other water-user boundaries, it is difficult to elicit farmers' cooperation in O&M tasks.

Another factor that discourages farmers' participation in water management is that the traditional notions of property clash with present-day legal definitions of property. In the past, the farmers considered the tank and its products, fish and water for paddy fields, as village property; unless one could show claim over village communal property, one was not treated as a member of the village community. The rights over communal property were derived from membership in a kindred group called village variga, which was decided by the village elders. However, with the granting of land deeds for individual property and the sale of new lands served by village tanks after their rehabilitation, ambiguity exists as to who owns the irrigation works. For example, in some village irrigation systems studied in the Monaragala District, this ambiguity was evident. As mentioned earlier, in already rehabilitated tank systems, two-thirds of villagers said that the government owned the irrigation system. On the other hand, in those systems that had not yet undergone rehabilitation, the farmers said that they owned the irrigation systems and thus they felt an obligation to maintain them.

Therefore it seems useless to expect farmers served by rehabilitated tanks to take part in O&M unless some compulsory rules are introduced. As history demonstrates, this was the case even in the 1870s when the government enacted rules directing every farmer to contribute his free labor toward maintaining the tank. Each farmer had to work 60 days during the first year after the renovation of the tank and 30 days per year thereafter.

Farmers cannot be expected to spend time organizing themselves to undertake collective action unless they can derive substantial economic benefits from that activity. Many of the tanks refurbished so far, especially in the North Central Province, still do not provide enough water to cultivate the entire *yaya* (tract) even in maha. "Owing to the uncertainty of availability of irrigation water, however, the chances of raising a successful crop even in the maha is estimated at less than 75 percent in some areas" (ADB 1980). Therefore farmers are unlikely to organize themselves for maintenance of their tanks and adoption of better water management practices under all conditions.

What is really needed in present-day village irrigation systems is strengthening of the capacity of existing farmer organizations by providing them with technical and financial support. The TC or the *wew-sabha* (reservoir council) may be capable of maintaining tanks as long as maintenance work involves only human labor. But if maintenance involves some technical know-how, then the farmer organization may be unable to perform the task. In such a situation, farmers need money and technical help. The NFFHC has evolved a sound strategy to meet both requirements. The wew-sabha is responsible for all construction and maintenance, and in this regard, the farmers get comprehensive training on how to maintain and repair tank bunds and channels. The Reservoir Maintenance Fund with regular contributions from farmers will eventually be the source of finance for such activities.

Cultivating Part of the Command Area in Periods of Water Shortage (Bethma)

The present water management programs under village irrigation systems attempt to revive the traditional practice of bethma to stop the wastage of water in yala. The main principle behind this practice is to cultivate a portion of the paddy field using the limited water in the tank which is not sufficient to cultivate the entire tract. When it is decided at the seasonal meeting to do bethma cultivation, a portion of land adjacent to the tank is demarcated by the farmer representative (FR, previously referred to as the vel vidane) as the area that will be cultivated by the entire community for that season. One important aspect of bethma is the exclusion of tenants, leaseholders, and mortgagees from the season's farming activity. The permanent boundaries of each *pangu* (share) are ignored for the time being and the group collectively cultivates the area that has been demarcated. The harvest is thereafter divided according to the size of the pangu each member holds in the entire paddy tract (Abeyratne and Perera 1984:80).

Under the tanks restored by the NFFHC's wew-sabhas, bethma is an in-built component of the agricultural system. The entire paddy area served by the tank is divided into upper, middle, and lower fields. In each field all the villagers hold plots. Therefore, the wew-sabha can decide the extent the community should cultivate according to the amount of

water stored in the tank. In years of poor rainfall, the wew-sabha may decide to cultivate the upper field only. In the years of normal rainfall, the middle and lower fields may be cultivated.

In the Dry Zone villages, bethma is no longer practiced during yala even when there is water in the tank. An Asian Development Bank (ADB, 1980) study concluded that 87 percent of paddy land was allowed to lie fallow during yala in Anuradhapura District. However, the water management program proposes to stop wasting water from non-cultivation during yala by re-establishing the bethma practice through farmer organizations. Historical evidence shows that bethma had never been a regular practice in Sri Lanka. Farmers in the Dry Zone cultivated rice only in maha and concentrated on chena cultivation during yala. However, when farmers could not cultivate rice for several seasons due to drought, they tended to cultivate a small portion of paddy land collectively close to the tank to raise at least rice for seed for the subsequent season. This practice was then known as the "distribution of seed paddy equally among villagers" (Perera 1985a).

The decay of the bethma practice is more an outcome of the changing patterns of the production system than an outcome of social decay or the disappearance of traditional customs in rural Sri Lanka. The more plausible reason for its disappearance would be the increase in the area irrigated by the tank which reduces water availability during yala even in rehabilitated tanks. Begum (1985) has shown that in 18 out of 20 village tanks studied in the North Central Province, the area of irrigated land served by each tank had increased significantly during the last several decades from the original size of the *purana-wela* (old field). Such increases resulted from several changes: first, the government began to sell new lands after the refurbishment of tanks; these are known as *akkara-wela* (new-fields). Second, population pressure in the tank-based villages increased. When farmers cultivate "reservation" lands and new lands below the tank without increasing the tank's storage capacity, the tank will not have enough water to irrigate the total area, even in maha. In such cases, there is little possibility of cultivating even a small section of the command area during yala. Third, the majority of irrigated lands in the Dry Zone are prepared for cultivation using tractors. Tractors facilitate dry sowing in some soil types where non-mechanized dry land preparation is not always possible. This sometimes encourages the cultivation of land beyond the akkara-wela.

In some villages, although officials reported the practice of bethma, the actual practice seems to be the purchase of a farmer's rights by a wealthy farmer or a group of farmers. Thus, some farmers sold their bethma right, mainly because of the lack of capital to cultivate even a small portion of land during yala. They thus freed themselves from paddy cultivation to concentrate on chena cultivation on a full-time basis. The buyer of such cultivation rights either cultivated his leased-in land or left it fallow according to the amount of water available in the tank.

Quite often, the land operators in the purana-wela tended to cultivate their holdings with the limited amount of water available in the tank. The old practice of annual alternative cultivation of purana-wela and akkara-wela is now rarely practiced.

When water is inadequate to cultivate even the purana-wela, some individual farmers who have land holdings close to the tank cultivate them privately (Abeyratne and Perera 1986).

These new practices reflect some of the radical changes that have taken place in villages during the last few decades. The main characteristics of the traditional village communities, such as subsistence ethics and social insurance, are no longer visible in the production system. Thus, any attempt to reinstitute traditional features of village economic organization will be unsuccessful if the policy makers fail to understand: 1) the organizational set-up which existed in the past and the factors which contributed to their operation, and 2) the factors that have caused structural changes in the village communal forms.

Allocation of Water from Tail end to Head end Reaches

Until recently, the cultivation of tail-end (*agatha*) holdings in the command area under village tanks had low priority in development planning. The main problem faced by tail-end cultivators is insufficient supply of water. This situation becomes worse in times of water scarcity, resulting in reduced yield or crop failure. Water management programs try to overcome this by reversing the water distribution from head-to-tail to tail-to-head.

However, to implement this strategy successfully, there should be: 1) suitable field channels and control structures to facilitate its operation, and 2) changes in existing water management practices requiring farmer participation and cooperation.

Rehabilitation programs have focused on the first requirement, and in many villages farmers have cooperated in accomplishing it. However, when implementing the second, problems began to emerge. This practice completely ignores the tradition-bound claim the purana-wela farmers have over the water in the village tank. Thus, tail-to-head allocation of water is likely to antagonize the head end farmers who may view this as an intrusion of established rights of cultivation.

Tail-to-head water allocation is being reported from recently rehabilitated anicuts in Moneragala District. In Pussellawa anicut system, for example, the tail end receives water first and then the middle field, and finally the head end. This is a new strategy and farmers explained that this was possible because of the availability of sufficient water in the stream for irrigated rice. When asked how they expected to distribute water from the anicut during a period of water scarcity, they said that they did not know, and indicated that they would probably allow the head end farmers to cultivate their fields. In case of unanticipated water shortages in the anicut after cultivation starts, the farmers expect to give up cultivating the tail end first followed by the middle field to allow the head-end farmers to cultivate their holdings.

The question of tail-to-head water distribution in tank-based village irrigation systems arises only when there is a shortage of water to cultivate the entire paddy field In such instances, farmers would prefer to resort to well-established traditional practices such as bethma or to give up paddy cultivation for the season in order to concentrate on chena cultivation.

The irony is that when water is abundant, the tail-to-head allocation becomes redundant; when water is scarce, it becomes impracticable and irrational. In the latter case, the appropriate method would be to allocate water to some plots at the head end to avoid a total crop loss.

A main difficulty in the tail-to-head allocation of water is that water is to be conveyed to the tail end through the head end fields. If there is any doubt about getting sufficient water to their plots, the head end farmers certainly will not allow water to pass their plots without irrigating their own fields. This prior physical access to water allows the head end farmers to resort to various methods of illicitly channeling water to their plots, such as by blocking field channels and cutting the main channel. On the other hand, the irrigation bureaucracy or farmer organization is unable to supervise the delivery of water to the tail end first because it requires a 24-hour vigilance. Such "policing" may lead to clashes among the head-end farmers, the officials, and the tail-end farmers.

Another major obstacle comes from the influential head end farmers. Usually, rich and influential farmers own large tracts of the best land just below the tank. In the past, the vel vidane, village headman, and other influentials possessed the most prized lands below the tank. Thus, they managed to get the water first. However, when the government began to sell Crown Land in the akkara-wela, these influentials managed to buy new lands and attempted to get water to these lands too. For this reason, the practice of issuing tank water to the purana-wela during maha and to the akkara-wela in yala was introduced (see Perera 1985b).

Farmer representatives who own land at the head end of the paddy tract still obtain water for their fields first, along with their relatives and friends who too own land adjacent to their land. Begum (1985) mentions a case where a FR ignored the seasonal meeting decision to follow the tail-to-head allocation of water. He, together with his relatives and friends, obtained water first for their fields in the purana-wela despite the protests of other farmers about their behavior.

Furthermore, influential farmers at the head-end can sabotage the operation of tail-to-head water allocation if they think such an allocation disturbs the cultivation of their land. Their wealth and personal connections with politicians provide them with enough influence over the villagers and officials. Political pressure from the local politicians to change the water allocation program decided at a seasonal meeting and getting non-cooperative officials transferred are not uncommon in many of the major irrigation systems. This is also true of the village irrigation systems.

CONCLUSIONS: SOME POSSIBLE RESEARCH AREAS ON VILLAGE IRRIGATION SYSTEMS

From the above discussion, several conclusions can be drawn in relation to village irrigation communities in particular and to rural Sri Lanka in general. One is that there has been a process of accelerated State intervention into Sri Lanka's rural areas -- village

irrigation rehabilitation programs sponsored by the State are a prime example of this process. As a result, the State has managed to concentrate and consolidate its role in village irrigation systems. This inevitably develops an interaction between the government and the village community. This paper has shown the far-reaching changes that have been generated by State intervention into villages over time. However, in the course of the discussion on various strategies for water management, it became evident that the government has not fully understood the dynamics of community organization and as a result it has introduced several strategies which are destined to be unsuccessful. In this regard, further research is necessary on the nature and type of government-community interaction in both diachronic and synchronic perspectives before any meaningful strategy is designed for refurbishing village irrigation systems by the State. It is important to decide the degree of each party's involvement -- both financial and in terms of decision-making responsibility -- in the rehabilitation process.

Related to this is the issue of community or village capacity to handle village irrigation affairs. At present, although both State and community capacities are emphasized, in reality, the emphasis is on the former as reflected for example, in the composition of the TC under the VIRP. In this regard, some systematic archival research into the village community's role in both physical refurbishment of village tanks and their management in the latter part of the 19th century may throw some light on why some institutional mechanisms for water management functioned well in those days and why they cannot be reintroduced today to play an equally effective role in water management. Such a historical survey will show whether the traditional water management mechanisms decayed over time or were intentionally abandoned as a result of changing priorities in the development activity (e.g., from small village tank rehabilitation to large-scale irrigation works) of the State. Research will also show the contribution of the State to this change over time. Such research will help in identifying factors that strengthen a village's capacity to handle its own water management activity.

Further research is urgently needed on socio-economic and cultural patterns of community life to understand how and why villagers accommodate or reject new strategies. An understanding of these patterns can inspire social engineering of the proposed changes so that they fit the social and cultural systems of the village community.

NOTES

[1]Exchange rate in 1986 was US$ 1.00 = Rs. 28.00.

[2]Minor irrigation systems are defined as those where the area irrigated is less than 80 ha. The terms village irrigation system, minor irrigation system, and small-scale village irrigation systems are used interchangeably.

[3]Asweddumization is an English word derived from Sinhala and means leveling land and constructing bunds around a field to retain water for rice cultivatoin.

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AGENCY INTERVENTION PROGRAMS

PROBLEMS, PROSPECTS, AND OPPORTUNITIES IN DEVELOPING FARMER-MANAGED IRRIGATION SYSTEMS IN NEPAL: THE DEPARTMENT OF AGRICULTURE'S FARM IRRIGATION PROGRAM

Mahesh Man Shrestha*

INTRODUCTION

Agriculture is a strategic sector in the Nepali economy engaging almost 94 percent of the population and making up almost two-thirds of the annual Gross Domestic Product (GDP). However, the current decline in agricultural productivity against an accelerated population growth is leading to an imbalance between food supply and demand. To reverse the trend, cereal production must at least double the present level by the year 2000.

To achieve this, attempts are being made to raise crop yields under rainfed conditions. However, at best, rainfed agriculture can achieve only a fraction of the productivity of irrigated areas. Nepal must develop irrigation to obtain maximum grain production. Presently, using local practices, irrigated rice yields about 3.0-3.75 metric tons/hectare (t/ha). Provided there is timely irrigation, production can be increased to over 4.5 t/ha if farmers adopt improved cultivation practices and apply recommended doses of fertilizer and related inputs. Because the lack of sufficient water is one of the main constraints to increased production, using each unit of water with maximum productivity should be the aim.

GOVERNMENT AGENCIES INVOLVED IN IRRIGATION DEVELOPMENT AND THEIR APPROACHES

Department of Irrigation, Hydrology and Meteorology (DIHM)

DIHM, under the Ministry of Water Resources, is the principal organization involved in irrigation development in Nepal. Functions presently carried out by DIHM include: investigation, design, construction, rehabilitation, and operation and maintenance (O&M). DIHM undertakes projects with command areas larger than 500 ha in the Tarai and larger than 50 ha in the hills. At the regional level, the functions and responsibilities of DIHM are carried out through five directorates.

Project Board Management

Some of the larger projects are carried out through semi-autonomous organizations called "project boards." Separate project boards function for some donor-assisted irrigation projects under the Development Board Act of 1956. Management under this

*Chief, Farm Irrigation and Water Utilization Division, Department of Agriculture, Ministry of Agriculture, Nepal.

system gives autonomy in personnel recruitment and financial flexibility. The composition and practices of the individual project boards, variously described as autonomous or semi-autonomous, are virtually all the same. Each board is formed with representatives from the ministries of Finance, Agriculture, and Land Reform, and is chaired by the Secretary of the Ministry of Water Resources. One representative each from the National Planning Commission, Department of Agriculture, and DIHM is also included as a member of the Board. The General Manager/Project Manager/Project Engineer works as a member-cum-secretary of the Board. In certain cases Regional Directors of Agriculture and Irrigation are also included as members. It is said that the Board represents the symbol of cooperation at the highest level.

Ministry of Panchayat and Local Development (MPLD)

This Ministry is responsible for various local development works including: village water supplies, construction of small bridges, upkeep of tracks and trails, maintenance of *panchayat*[1] buildings, and assistance to small irrigation schemes.

In 1970, the Department of Minor Irrigation was established and the responsibility for the implementation of minor irrigation was given to the chairman of the district panchayat. Due to the lack of professional manpower at the district level, it was merged into the Irrigation Department in 1971. The Irrigation Department then took the responsibility of managing irrigation systems with command areas over 50 ha. Irrigation schemes serving less than 50 ha were given to the MPLD. Technicians are appointed by the MPLD to the District Technical Office which is responsible to the Local Development Officer for implementing local development works at the village level.

Agricultural Development Bank of Nepal (ADBN)

ADBN, which is mainly responsible for providing credit to farmers for agricultural activities, finances irrigation schemes. It grants loans for three types of irrigation development programs: 1) the Farm Irrigation and Water Utilization Division's (FIWUD) irrigation schemes, 2) pump irrigation, and 3) gravity irrigation systems. Although ADBN investment in irrigation started in 1968, the intensive irrigation program under ADBN began in 1981.

Over 11,000 shallow tube wells have been installed under this loan program making irrigation facilities available on more than 45,000 ha. The loans are given primarily to individual farmers for pump-sets and related materials and are to be paid back in seven years. The government provides a labor subsidy of up to NRs 3000 (US$150) for installation. O&M costs are paid by the pump-owner. ADBN has collaborated with CARE to finance a few gravity irrigation systems. CARE provides 50 percent of the total cost, farmers take 30 percent as a loan, and provide 20 percent as labor or cash. Implementation has not reached the target level due to problems with group formation and high staff turnover where there are alternative employment opportunities in less remote areas. The estimated cost of such schemes is US$800-900 per ha (in 1984 prices).

Farm Irrigation and Water Utilization Division (FIWUD)

The Ministry of Agriculture, through FIWUD, is responsible for farm level irrigation development and water management. FIWUD was established in 1973 under the Department of Agriculture to bridge the gap between the engineering services of the DIHM and the extension services of the Department of Agriculture in public and farmer-managed irrigation systems across the country. Most of FIWUD's technicians are agricultural engineers with some knowledge of basic agriculture.

FIWUD's mandate is to: 1) provide irrigation and drainage facilities at the farm and the field level to ensure the optimum amount of water, 2) assist in operating tertiary irrigation systems in large- and medium-scale projects, 3) organize water user groups and guide and monitor their activities, 4) provide training to water users in tertiary system O&M and on-farm water management, and 5) develop ways of increasing cropping intensity through coordination with agricultural research and extension services and through the introduction of new irrigation technology.

At present, FIWUD is working under two types of programs, the Water Utilization Program, and the Farm Irrigation or Small Irrigation Program.

Water Utilization Program. The Water Utilization Program concentrates on large- and medium-scale public irrigation projects. This covers gravity and deep tube well systems in the Tarai areas. In this program, structures like dams, main and secondary canals, and deep tube wells are constructed by DIHM. It has been found that many require additional conveyance and control structures for better water management. In addition to building the necessary lower level control structures, this program assists with land improvement and other measures for increasing the cropping intensity and efficient water utilization.

The work is carried out by forming water user groups which are informal voluntary organizations without legal authority. The maintenance of the field channels is the responsibility of these water user groups. However, operation of the system and maintenance of the control structures and larger channels are done by DIHM. In the Water Utilization Program, farmers' involvement begins in the middle stage of project implementation rather than in the project formulation stage.

Farm Irrigation or Small Irrigation Program. The aim of the Farm Irrigation Program of FIWUD is to help farmers in constructing, improving, and maintaining their own irrigation systems, and to make optimum use of the available water for increasing production by using simple technology. The beneficiaries are involved in all stages of planning and implementation. Attempts are made to incorporate their ideas and experience without killing their self-help attitude. FIWUD has developed a "high farmer participation concept." This approach is most suitable to small systems. By mid-1986, FIWUD completed 106 projects in the hills and Tarai covering approximately 19,600 ha. There are 81 projects in different stages of construction and feasibility studies of another 105 projects have been completed. Table 1 gives a breakdown of completed and ongoing work. FIWUD now has over 25 senior

engineers and agriculturalists and over 40 overseers and technicians on its staff. The estimated cost of FIWUD schemes is NRs 4,000-5,000/ha (US$190-238/ha) in 1984/85 prices.

Table 1. Frequencies by district of irrigation schemes completed (COM), under construction (UC), and surveyed (SUR) by the Farm Irrigation and Water Utilization Division (FIWUD), Department of Agriculture, Nepal.

Zone	District	COM	UC	SUR	Zone	District	COM	UC	SUR
Janakpur	Ramechhap	12	11	5	Seti	Baitadi	-	3	-
	Sindhuli	10	13	2		Achham	-	1	1
	Dolkha	2	-	-		Kailali	2	-	1
	Mahottari	1	-	-		Kanchanpur	1	-	-
	Dhanusa	32	10	1		Doti	-	1	1
	Sarlahi	-	2	-		Bhajanng	-	-	1
Dhaulagiri	Parbat	6	-	3	Narayani	Makwanpur	-	-	2
	Baglung	1	1	4		Persa	2	-	3
	Myagdi	2	1	-		Rauthat	1	-	4
	Gulmi	-	-	-		Chitwan	3	-	8
Koshi	Terthum	3	2	4	Rapti	Rukum	-	5	3
	Dhankuta	-	2	1		Salyan	-	1	6
	Bhojpur	1	1	1		Dang	-	1	-
	Sankhuwasava	-	-	1		Jajarkot	3	-	6
	Sunsari	2	-	1		Kalikot	2	-	-
	Jhapa	1	1	-		Rolpa	-	-	4
	Morang	-	-	1		Dolpa	-	-	1
	Taplejung	-	-	1					
	Panchthar	2	-	-	Bagmati	Nuwakot	3	5	9
						Dhading	2	2	5
Sagarmatha	Khotang	3	3	4		Sindhupalchowk	1	-	-
	Okhaldhunga	-	1	3		Kavere	1	2	-
	Sirha	1	-	2		Rasuwa	-	1	-
	Sofukhumbu	-	-	1		Bhaktapur	1	-	-
	Udaipur	-	-	4		Kathmandu	1	-	2
	Saptari	-	-	2		Lalitpur	1	1	2
Lumbini	Palpa	-	4	2					
	Arghakhachi	-	1	1					
	Rupendehi	2	3	3					
	Kapilbasstu	1	-	-					
Total							106	81	105

As a part of the strategy, improvements of existing irrigation schemes are jointly financed by the government and the beneficiaries. Of the total estimated cost, 75 percent is contributed by the government as a grant for materials and construction of structures, while the remaining 25 percent comes from the farmers. The farmer's contribution is proportional

to the land owned by each farm family in the command area. To qualify for new construction or improvements in an existing system, 5 percent of estimated costs must be paid in cash.

The beneficiaries must form a construction committee. This committee consists of five to seven members with the ward chairman and *pradhan panch* (village headman) as ex-officio members. The construction committee determines the proportion of each beneficiaries' contribution to the construction of the project. The 5 percent cash contribution must be paid into a bank account before work can be started and must be supported by a formal declaration by the committee to take responsibility for construction and future O&M. The rest of the farmer's contribution can be either in cash, as a loan from ADBN, or in the form of free labor.

An account is opened in ADBN in the name of the scheme, and the 5 percent cash raised by the beneficiaries is deposited. The account is handled by the joint signatures of the representative of the construction committee and the FIWUD officer-in-charge of the scheme. Funds are withdrawn to purchase materials and equipment and to pay contract labor for specialized work. Records of expenditure are kept for accounting purposes. Under this arrangement, the farmers' construction committee itself purchases and transports the construction materials to the site and thus by-passes the cumbersome and time-consuming contractual and competitive bidding formalities.

Besides providing 75 percent of the costs of the total scheme, FIWUD's contribution consists of technical assistance in identifying and evaluating the system, designing structural works, supervising and managing construction, and providing any specialized labor that is required.

The farmers contribute local resources, including haulage to the site and labor for the improvement or construction of the distribution system. The construction committee is renamed the water user group after construction is completed, and is responsible for allocating irrigation water among the beneficiaries, and for system O&M. FIWUD strengthens the water users group by giving training in system O&M and on-farm water management.

After completing construction or improvements, FIWUD's field staff initiate the Water Utilization Program with the help of the Agriculture Development Officer and staff from other line agencies working in the field. Further involvement of FIWUD is limited to monitoring and evaluating the system in order to improve the design of future systems, and giving advice on maintenance and water management at the request of the water users group.

The FIWUD small irrigation program was implemented five years ago. At the start of each new fiscal year, FIWUD staff from all the Zonal Offices have a general meeting at the central office in Kathmandu to discuss their experiences and problems. This is an opportunity to find solutions to problems and to establish a new strategy for the smooth

operation of the program. For example, after the government introduced the Decentralization Act, modifications were made in the way the program was implemented. The details of the implementation procedure are given in the following sections.

Project identification. The first step is the identification of viable small irrigation schemes. The request for assistance for irrigation may come in writing through the ward concerned, village panchayat, district panchayat, or another agency to the District Agriculture-Irrigation Committee.[2] When an application comes to a zonal office or directly to FIWUD, it is immediately forwarded to the District Agriculture-Irrigation Committee for necessary action. This committee forwards the application to the Zonal Farm Irrigation Office with the recommendation of the district assembly, or to the District Panchayat. This is usually done once each year. Based on the list of applications received, inventories are prepared for further action by the Zonal Farm Irrigation Office. The project identification work is scheduled a year ahead of its implementation.

The initial application originates from the beneficiaries. It must contain the necessary information to enable the concerned authorities to determine the feasibility of the scheme. Applications contain precise information on the following points: a) signature of all the beneficiaries; b) brief description of the command area; c) present and future cropping pattern; d) description of water resources; e) distance of water source from the command area; f) area to be irrigated; g) number of households to benefit; and h) village panchayat, ward number, etc.

Site survey. A FIWUD topographic survey team goes to the area and arranges a meeting with the beneficiaries. The technicians explain in detail all the procedures for the implementation of a scheme. A working committee of six or seven members is formed and one member of the committee is selected as chairman. Sometimes the chairman is elected by a raised-hand vote and usually the decision is unanimous.

Farmers are asked to accompany the technician in the survey and walk along the canal alignment. This activity provides information about the area and irrigation sources as well as an opportunity to discuss advantages and disadvantages of alternative canal locations. In this stage the team identifies the prospective beneficiaries and completes a questionnaire of the preliminary investigation, which includes details about the existing crops, soil, land, water resources to be tapped, availability of construction materials, and other physical and social information. It also includes a declaration by the beneficiaries of a commitment to the procedures of FIWUD.

Based on their experience and the guidelines provided by FIWUD, the survey team can usually determine the feasibility of the proposed scheme from the preliminary investigation. If the team decides that the project is feasible, it conducts a detailed survey to be used in design. If it is obvious that the project is not feasible, they leave the site after doing only the preliminary survey, without giving any promises to the farmers.

Design and estimation. After the field survey is complete, the design work is done at the Zonal Farm Irrigation Office. For the design to be approved, the following minimum list of

items must be submitted: a) salient features of the scheme; b) details of the intake and site plan; c) detail profile of the canal alignment with types of structures shown on it; d) drawings with structural details; e) if possible, the elevation of the intake and the highest point of the command area; f) application from the beneficiaries and their recommendation; g) preliminary investigation report; h) rate analysis as well as the District Panchayat's rate analysis; i) bill of quantities and cost estimate; and j) benefit/cost ratio and any recommendation by the survey team.

Criteria for approving the schemes. Although the benefit/cost ratio is the major criterion for approving the schemes, three more factors are also considered: a) length of canal and number of crossing and other structures, b) total cost of the scheme, and c) cost per hectare.

Approval, notification, and formation of construction committee. After approval of the scheme, a letter of notification of the feasibility of the scheme is sent to the community concerned.[3] An estimate of the cost is included along with instructions for the necessary actions that the beneficiaries must take which include: a) forming a construction committee, b) depositing 5 percent of the estimated cost in an account with ADBN in the name of the scheme, and c) formal signing of the agreement form by the construction committee members signifying their acceptance of the FIWUD procedure for implementation of the scheme.

FIWUD procedure for implementation. After the construction committee is formed, it is the responsibility of the committee to send a letter through the panchayat office to the Zonal Farm Irrigation Office. The signature of all the members of the construction committee must be on the letter. As necessary, the FIWUD staff helps to organize the construction committee and to arrange a loan through ADBN.

If the construction committee is not formed and/or their commitment is not forthcoming, the project is not implemented. FIWUD requests a statement as to why the community does not want to go forward with the project and forwards the statement to the district panchayat, who can intervene at this stage to try and clear up any misunderstandings. In the event of the cancellation of a scheme, a new scheme is selected from the contingency list prepared during the survey and identification of projects.

Implementation of the scheme is carried out by the construction committee. The FIWUD engineer is responsible for providing technical support, supervision, and advice to the committee. He also supplies information about availability of material and equipment.

The construction committee records the minutes of meetings in a register that they call their minute book. They also record work awards to local people, details of hiring and contracting labor for special work, resolution of disputes in the alignment of the canal, expenditures for material procurement, labor payments, and all other decisions of the committee. This book is open to whoever wishes to check any information.

The FIWUD engineer measures and records the progress of the construction work in a separate book that he maintains. All of the work done is entered into the measurement book at intervals of about 15 days. Payment is made according to the approved estimate even if the work completed is greater than the estimate. The work completed above the estimate is considered a part of the voluntary contribution. The construction work is awarded by the committee to various beneficiaries, preferably as piecework.

After completion of the scheme, an inspection and final approval is made by FIWUD upon receiving a written request from the construction committee. A certified copy of the expenditure accounts, along with all the documents, is forwarded to the zonal office by the construction committee for the Zonal Farm Irrigation Office records.

Formation of the water users group. As soon as the construction is over, the FIWUD technicians inform the construction committee that it should convert itself into a water users group to take care of future operation and maintenance. This is according to the FIWUD rules that are agreed to by all beneficiaries before starting the project. One amendment that is made to the composition of the construction committee when it becomes a water users group, is to increase the number of members.

The beneficiaries may decide to raise funds for future repair and maintenance work. This money can be kept in the ADBN account. The regular repair and maintenance of the scheme is carried out by water users groups with technical assistance from the Zonal Farm Irrigation Office. Neither water taxes nor other irrigation fees are collected by the government in these projects.

ISSUES STEMMING FROM FIWUD-SUPPORTED IRRIGATION DEVELOPMENT

Project Selection

The political influence in project selection and implementation is minimized by setting strong selection criteria. In the early days of this project, much political pressure was experienced by FIWUD. But on the basis of experience and by using technical reasoning supported by actual field data, FIWUD developed appropriate criteria. Now projects presented for consideration must be recommended by the district panchayat or district assembly. Final approval is then made by FIWUD.

Formation of the Construction Committee

In most of the FIWUD schemes the construction committee is formed smoothly by the beneficiaries without complaints, but there is competition for the post of chairman. In such cases, the chairman frequently finds it difficult to remain in his post when he encounters problems. In some instances he has been forced to leave the post because of misdeeds. If the beneficiaries decide that the chairman is working against their benefit, they force him to resign. This happened in one of the projects of Ramechhap where the chairman wanted to divert money from FIWUD as an advance for other work awarded to him by contract

a few years earlier. Similarly, in one of the schemes of Kalikot district, the chairman (ex-pradhan panch) was forcibly changed by the beneficiaries when he wanted to exploit the laborers.

Depositing Five Percent of the Cost Estimate in ADBN

In most cases the compulsory 5 percent deposit comes from the beneficiaries, but in some cases only a few people or a single person deposit the total amount on behalf of everyone. If all contribute to the deposit, the work progresses much faster than if only one or a few do so. Concern about the use of the money they have deposited encourages the beneficiaries to participate in implementing the scheme. The requirement of a cash deposit is a good tool for sorting out projects that need help.

In some cases, it has been found that all the beneficiaries are not able to deposit 5 percent cash in the bank. Instead they offer to contribute 25 rather than 20 percent of the estimated cost as labor. Or they ask committee members or other people to pay the cash on their behalf. Thus, a few people pay 5 percent of the total estimated cost and later recover this amount from those who do the extra voluntary work. It is FIWUD's experience that this approach works best in schemes where only improvements are needed rather than in new schemes without an existing organization. If there is no existing organization, beneficiaries who have promised extra labor instead of cash may refuse to pay after the project is approved, putting those who have paid in an awkward position, ultimately hampering progress.

This arrangement gives some flexibility to the beneficiaries in paying with either cash or labor contribution. It also assists FIWUD because the persons who have paid extra cash work hard to organize and mobilize the voluntary work of the scheme so that they can recover their deposits.

Voluntary Labor Contribution

The construction committee is responsible for raising the 20 percent voluntary labor contribution from beneficiaries. However, engineers from FIWUD help in assessing the contribution. The total labor contributed by each person is computed and payment is made for all contributions above the 20 percent mandatory voluntary labor contribution. Payment is made to the workers after deducting 20 percent contribution from the total work accomplished. It is the responsibility of the construction committee to give fair and just payment according to the individual record of work done. This is a difficult task and tests the effectiveness of the construction committee.

It has been observed that wherever the construction committee is strong and effective, the voluntary contribution is accomplished smoothly. In both new schemes and operating schemes, fewer problems are encountered in implementation and improvements if the committee is formed from among the farmer beneficiaries. However, if local or outside politics are involved in forming the committee, there are always problems in implementing the scheme.

Sometimes it is difficult to mobilize the voluntary labor due to local miscreants. Many instances have been observed where voluntary labor has been exploited in the name of the project. In such cases, a copy of the project approval paper is forwarded to the Chief District Officer to enable him to take action against the culprit.

The payment of employed laborers is generally done by the construction committee. If the workers feel that they are being exploited in payments, they complain first to the chairman of the construction committee who then must solve the problem. There have been examples where the workers were exploited by the chairman, as in the Kalikot case mentioned above. In such cases, the FIWUD staff may intervene if the conflict continues. The FIWUD staff tries to resolve problems with the help of the chairman and construction committee but, if conflicts continue, further payments are stopped by FIWUD until the problem is solved. If the chairman or a committee member misbehaves, the matter can be sent to the district panchayat and the chief district officer for settlement.

Although it is possible for the beneficiaries to change the chairman or committee members, money that has already been given to them may need to be recovered. The construction committee and FIWUD staff along with other beneficiaries try their best to solve the problems locally. However, when the miscreant is backed by influential people, the situation becomes complex. In this situation, the chief district officer intervenes on the request of the beneficiaries.

Long Duration for Project Implementation

Projects having a long (10-12 kilometer) canal to construct in the hills, take a long time to complete. First, because of the large amount of work, there is unwillingness to contribute the required amount of voluntary labor and cash. Second, because such projects involve various ethnic groups, different wards, and panchayats, it creates a difficult situation for coordination. Third, the difficult terrain, landslide zones, stream crossings, and complex issues involving water rights make the work difficult. And, fourth, at times political pressures and conflicting propaganda from local factions delay the implementation of a scheme.

Cash Balance after Construction Completion

Frequently in FIWUD schemes 5-15 percent of the estimated cost remains after the project is complete because of the energetic involvement of beneficiaries instead of a contractor in the construction. Inspection and supervision costs are reduced because beneficiaries themselves, as well as FIWUD technical staff, monitor the construction work. Although local workmen often lack skill in applying finishing touches to structures, the quality of the materials used is good and the results are durable. The money that is left after completion of the scheme is kept in the account and reserved for future repair and maintenance work.

Maintenance of the Schemes

Maintenance requirements differ from system to system. The water user groups are responsible for repair and maintenance of canals in FIWUD schemes. Although the water user groups are committed to raising funds for repair and maintenance of the system, in practice virtually no cash is mobilized for this purpose. Labor contribution by the beneficiaries is the most common feature of resource mobilization in these schemes. Large landholders must contribute more than small landholders.

The groups become more active just before the rice season. Usually they call a meeting and decide the ways and means of doing repair work. In many schemes the water user group employs two persons to patrol the canal during the rainy season, and at times these persons also look after and distribute irrigation water to farmers. Repairs which are within their capability, they do themselves. In case of massive damage, they immediately inform the leader as well as beneficiaries. In emergency cases almost all the beneficiaries go to the work site.

In FIWUD schemes where farmers have strong organizations (e.g., Dhaitar in Kavre district and Hoste Khola in Sindhupalchowk district) there are regular mass mobilizations of labor, called *urdi*, for maintaining canals twice a year: once before land preparation for rice in May or June and another before sowing the winter crop. During urdi one person must come from each house for the work. Generally the repair work lasts four or five days. A fine of NRs 10 (US$0.50) is charged to any household that does not contribute labor during the work period.

During the winter season, damage from rain and flood is minimal and individuals or small groups of farmers take care of their channels. In some cases the water users group allows a water-powered grain mill to be installed using water from the system. The mill owner then takes care of the canal maintenance work upstream of the mill.

If there is massive damage which is beyond the control of the beneficiaries, they can go to the Zonal Farm Irrigation Office for technical and financial help. In exceptional cases, FIWUD gives a nominal grant for repairing the system. This is only done if the results of a detailed survey indicate it is necessary. However, massive damage is not defined by fixed criteria. Farmers are considered capable of doing repairs involving earth work and dry stone work. However, massive stone masonry construction, or moving large stones and debris after a landslide (i.e., work which requires technical skills or machinery) are considered beyond their ability.

FUTURE FIWUD STRATEGY FOR STRENGTHENING FARMERS' PARTICIPATION IN IRRIGATION MANAGEMENT

Many irrigation projects fail to achieve the potential level of crop production possible. This is often due to defects in the management and application of irrigation water. Factors related to poor water management are closely linked with poor design and improper O&M. Such

problems lead to a reduction in benefits for farmers.

Another serious problem is environmental degradation caused by the construction. This is related to the topographical, geo-morphological, and geological conditions of the construction area. Landslides take place when water saturates the steep slopes and lubricates the soil layers. This may be caused by leakage from irrigation canals, from over-watering fields, or from excessive infiltration of rain water on terraced slopes. While surveying the site, a detailed study is made of the probability of these problems occurring, and the construction is modified accordingly.

In addition to these physical problems, efficient managerial aspects must also be considered. As competition among farmers for available water increases, improved system operation and management is called for to ensure widespread and equitable distribution of irrigation water. To achieve this, a coordinated effort to strengthen and improve existing organizations wherever necessary is suggested. This should take place in conjunction with a training program in system O&M. It is desirable to offer the farmers training on when, how, and how much to irrigate; canal system O&M; rotational irrigation during periods of water scarcity; improved terracing and cropping systems; and land preparation.

To address these problems in farmer-managed systems, FIWUD will establish another 6 zonal offices, thus providing staff and equipment to cover all 14 zones in Nepal effectively. Water management training along with a trial demonstration and production program will be extended in the completed schemes with the help of the agriculture development officer and staff of other related line agencies.

Permanent solutions to canal maintenance and landslide problems in the construction areas include soil conservation measures, such as tree planting on the uphill side of the canal. Terrace improvement work will also be gradually introduced as needed. A monitoring unit will be established to monitor the completed schemes and observe their performance to find ways to improve present construction methods and techniques. Survey and design criteria will be further refined with experience. The accounting procedure to be maintained by the construction committee will be further simplified and improved so that the committee can maintain satisfactory accounts.

During the seventh 5-year Plan, an additional 40,000 ha of land is to be irrigated. This will be covered by FIWUD as stated in the 1986 National Planning Commission Report.

Issues Regarding Government Intervention in Farmer-Management Irrigation Systems

1. Identification of schemes in terms of such factors as size, length, capital cost, and available time of beneficiaries, that would promote effective participation by farmers.

2. Development of simple procedures, which are also acceptable to the auditor, for recording expenditures by the construction committee.

3. Development of acceptable techniques for constructing channels in steep rock without major cutting and blasting.

4. Development of intake structures which can divert water efficiently at low river discharges.

5. Development of low cost diversion structures for the Tarai which can safely pass high discharges with a large amount of silt for both shallow and wide rivers and narrow and deep rivers.

6. Development of successful organizational models whose features could be incorporated into the systems that need improvement.

7. Development of low cost structural designs for the long stream-crossings in the hills.

8. Development of simple technology to check the seepage loss in the hill canals.

9. Test simple procedures for mobilizing voluntary contributions from the beneficiaries of irrigation schemes.

NOTES

[1]Panchayat also refers to a local and district level administrative unit.

[2]The District Panchayat Chairman is the chairman of District Agriculture-Irrigation Committee and other line agencies like ADBN, Agricultural Input Corporation, and cooperatives are represented. The irrigation engineer, local development officer, and agriculture development officer are also members. This last is the member-secretary of the District Agriculture-Irrigation Committee.

[3]A copy of the letter is also sent to the district panchayat, local development officer, chief district officer, agriculture development officer, area and central office of the ADBN, and the department of agriculture.

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STATE INTERVENTION IN SRI LANKA'S VILLAGE IRRIGATION REHABILITATION PROGRAM

Jaliya Medagama*

INTRODUCTION

The main objective of this paper is to discuss state involvement and its implications in the implementation of the Village Irrigation Rehabilitation Program (VIRP) in Sri Lanka.

Sri Lanka has a total area of 6.1 million hectares (ha; 23,500 square miles) with an estimated population of about 15.5 million. About 75 percent of the population lives in rural areas. Agriculture accounts for over 25 percent of the Gross Domestic Product (GDP), 50 percent of total employment, 70 percent of export earnings, and 40 percent of government revenue. Out of a total of about 2.25 million ha under permanent cultivation, rice accounts for about 0.7 million ha which is divided between the two zones, dry and wet. The Wet Zone is situated in the southwest quadrant and the Dry Zone lies in the north eastern, and south eastern areas of the island.

The Dry Zone contains 70 percent of Sri Lanka's irrigation and 93.4 percent of these are village irrigation works (Gunadasa et al. 1980:1). Population density in the Dry Zone is only 28 per 100 ha (73 per square mile), whereas the Wet Zone has 270 people per 100 ha (700 per square mile).

Importance of Village Irrigation Systems in Sri Lanka

Village irrigation (minor irrigation) is classified as an irrigation work serving below 80 ha (200 acres) of agricultural land.[1] Although it is difficult to get an accurate count of village irrigation works, the Lands Ministry estimates that there are 23,000 of which 13,000 are village tanks (small reservoirs used for irrigation and domestic water supply) and 10,000 are *anicuts* (weirs) or stream diversions. About 50 percent of these are in working condition, although their efficiency varies. According to the Food and Agriculture Organization (FAO), there are 7,758 village tanks. The Freedom from Hunger Campaign estimates that there are 18,000 village tanks, and that there could be another 12,000 tanks abandoned, of which 52 percent are in working condition. A Department of Agrarian Services (DAS) study suggests that there are about 8,500 working tanks in the Dry Zone.

Village irrigation schemes in the country play a pivotal role in the agricultural economy. Of the 0.7 million ha under rice nearly 30 percent is commanded by village irrigation schemes, of which 75 percent are located in the Dry Zone. The following discussion will be restricted to the Dry Zone where most schemes are tank schemes. Although VIRP envisages rehabilitating tanks in the Dry Zone and weir systems in the Wet Zone, a greater emphasis is given to the former.

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*Deputy Commissioner, Department of Agrarian Services, Colombo, Sri Lanka.

Background of Irrigation in the Dry Zone

History shows that people who settled in the Dry Zone constructed earthen bunds across the natural drainage basin to collect runoff water. Nearly 70 percent[2] of the annual total rainfall in the Dry Zone occurs during the Northeast Monsoon from late October to January, the main rainy season. It was imperative for the Dry Zone settlers to build these village tanks in order to supplement rainfall for agriculture in the wet season and to conserve water for domestic and agricultural activities in the dry season. These tanks have become the focal point of rural social, economic and cultural life in the Dry Zone, and the presence of many village tanks shows how successful the village community became as an agricultural economy by overcoming the acute shortage of water in the area. Water rather than land ultimately set the limits to cultivation and to the size of the population that could be supported (Somasiri 1978). Over time, these village tanks deteriorated and, because the seat of the kingdoms shifted from the Dry to the Wet Zone, most village tanks were abandoned and are now in a state of disrepair.

Sri Lanka (Ceylon) was under three foreign rulers -- Portuguese, Dutch, and British -- from 1505 until 1948. The British, who ruled Sri Lanka from 1796-1948 -- from 1796-1815 they ruled only the maritime provinces -- realized the importance of irrigation networks to the rural economy. An irrigation department was established in 1900 to renovate and maintain major irrigation works, while the Provincial British Government Agent attended to maintenance of the village irrigation works.

The first ordinance to facilitate the revival and enforcement of ancient customs regarding irrigation and cultivation of paddy lands was enacted in 1856. Thereafter it was revised on six subsequent occasions. The last ordinance, Number 32 (1946), made an attempt to define village irrigation as any that is: 1) constructed by the proprietors without government aid or with the aid of masonry works and sluices supplied free of charge by the government, and 2) maintained by the proprietors.[3]

After independence in 1948. it has been every successive government's priority to attain self-sufficiency in food. To achieve this goal, one strategy was to expand the irrigable area under rice through the development of major irrigation works and national ventures like the Accelerated Mahaweli Scheme. Meanwhile, governments could not neglect the large number of farmers who lived below poverty level under the village irrigation schemes. In order to raise their living standards, the State intervened by rehabilitating and modernizing village irrigation schemes to overcome the water constraint and to intensify cultivation under these village schemes.

STATE INTERVENTION IN IRRIGATION PROJECTS

The Village Irrigation Rehabilitation Project (VIRP)

Objectives. The Government of Sri Lanka with the assistance of the World Bank has embarked on a program to rehabilitate 1,200 village irrigation systems and modernize another similar 500 schemes, and to promote systematic water management in the

rehabilitated and modernized schemes. In addition to these activities, VIRP envisages strengthening the major government departments involved with village irrigation works, particularly the Irrigation Department (ID), by providing survey, drawing, construction, maintenance, and quality control equipment in support of the civil works program, and by strengthening DAS's capacity to service the operation and maintenance (O&M) of minor irrigation works by providing additional staff, training, equipment, and transport facilities.

Benefits. Through the physical rehabilitation of deteriorated village irrigation schemes and the introduction of improved water management, VIRP envisages increasing agricultural production and farmer income. The rehabilitation work is expected to minimize uncertainties relating to irrigation water on 31,500 ha, benefitting 20,000-25,000 farm families. It is also expected to increase cropping intensity from 82.5-116.2 percent in the rehabilitated and modernized schemes, with an increase of 43 percent in per capita income.

Project area and costs. VIRP covers 14 administrative districts, mostly within the Dry Zone. The Project period was five years (1980-85), but an extension has been given up to the end of 1987. The total investment cost of the Project is Rs 784 million (US$28 million)[4] with the main budget going to civil works, equipment, staff costs, training, and evaluation assistance (World Bank 1981: Annex A).

Implementing agencies. The ID is responsible for the VIRP's rehabilitation works. Rehabilitation includes repairing and remodelling tank bunds, sluices, and spillways, and improving the distribution systems, including the provision of appropriate field structures. The DAS is responsible for introducing water management activities. Specific water management programs are to be drawn up for individual tanks in consultation with farmers.

Tank rehabilitation.

1. Selection criteria. In general, the emphasis in the selection of tanks and anicuts for rehabilitation is on schemes that would give maximum returns with minimum cost. Lowest priority is accorded to minor works that have been abandoned long ago and are in need of almost complete reconstruction. The following specific criteria are used for the selection process:

a. The tank's command area should not be less than 8 ha (20 acres), unless a tank is in a cascade system where water flows from one tank to another and improvements are required to provide safety for the tanks downstream.

b. Tanks in inhabited areas with easy access should be given priority.

c. The useful storage of the tank should not be less than 0.91 hectare-meters per hectare (ha-m/ha; 3 acre-feet per acre or ac-ft/ac) for command areas in the Dry Zone, 0.76 ha-m/ha (2.5 ac-ft/ac) for the Intermediate Zone, and 0.46 ha-m/ha (1.5 ac-ft/ac) for the Wet Zone.

d. The useful tank storage should not exceed 70 percent of the yield potential computed from the iso-yield curves of the ID.

e. The tank should benefit at least 10 families.

f. The area brought under direct *maha* (wet season) irrigation should be at least 10 times the privately irrigated submerged lands or 3 times other cultivated submerged lands.

g. The soils of the catchment area, reservoir, and command area should be suitable for their respective purposes.

2. Rehabilitation costs. The maximum cost for a project, including all civil works and physical contingencies valued at mid-1980 prices, excluding price contingencies, engineering and administration, should not exceed Rs 12,350/ha (US$441/ha) for existing areas plus Rs 24,700/ha (US$882/ha) for incremental areas (ibid). Since 1986, the pro-rata cost has been increased to Rs 21,600/ha (US$771/ha) for existing areas plus Rs 43,225/ha (US$1,544/ha) for incremental areas.

Water management. The main objective is to make optimum use of rainfall and stored water. To formulate programs, an agricultural planning team (APT) is appointed in each project district. The APT consists of a technical assistant, agricultural instructor (agronomist), and a divisional officer (for institutional aspects). The program is carried out by a tank committee (TC), which will be discussed in a later section. In general, programs perform the following activities:

1. Constructing field channels with control structures.

2. Introducing a rotational water supply (RWS) system where appropriate.

3. Plowing and sowing operations as early in maha as possible.

4. Introducing post-harvest plowing following either maha or *yala* (dry season) crops to keep the soil open for easier rainfall infiltration and plowing early in the following season.

5. Operating the sluice to ensure that stored water is used only to supplement rainfall during maha and yala, with the sluice closed when irrigation requirements can be met by rains.

6. Closing the sluice at night to prevent night irrigation.

7. Introducing a standby rotation system when stored water supplies fall short of normal requirements.

8. Promoting short-duration rice varieties to reduce water requirements and ensure an early harvest.

9. Promoting irrigated upland crops during yala whenever soil moisture permits.

State Intervention in Small Tank Systems in Sri Lanka

The purpose of the VIRP is to increase agricultural production in the Dry Zone. This involves deliberate State intervention to rehabilitate small tank systems and initiate related water management programs. But the cost of such activities exceeds Sri Lanka's budgetary capabilities and State intervention to obtain assistance from donor agencies becomes imperative.

Although attention is mostly concentrated on the Accelerated Mahaweli Program, it has also become the government's responsibility to see that the small-scale farmers who operate small irrigation systems in the Dry Zone have opportunities to improve their living conditions. But problems arose when the government tried to introduce the VIRP through its existing bureaucratic institutions. This is exemplified by the results of VIRP's efforts to increase cropping intensities in the project areas.

The shortage of water is a predominant feature in the Dry Zone, and drought conditions become acute during the dry season from May to August (Abeyratne 1956). There are strong winds, and air and soil temperatures are high (the evaporation rate from a free water surface during the dry season is 6 mm per day). The water shortage is further aggravated by the lack of reliable ground water.

To overcome this shortage of water, farmers in the Dry Zone have adopted their own traditional system of land use through experience. The center of the Dry Zone village is the tank. Historically, the tank systems belonged to the community, and it is the community that managed the water resources for its own benefit. Farmers who lived near tanks adapted their lives to compensate for the lack of physical resources in their environment. Houses are grouped on one or both sides of the tank on relatively high ground beside or below the tank bund, on which drought susceptible fruit and tree crops are grown. Rice is continuously cultivated under irrigation from the tank. In addition, *chena* (slash and burn) in the uplands is utilized to grow pulses, oil seeds, spices, vegetables, and other crops. This type of cropping pattern is ideal for farming in the Dry Zone, showing that farmers have successfully adapted to the natural environment by evolving a tank-based economy.

It is unlikely that VIRP activities to increase cropping intensities in the Dry Zone will yield the results expected by the government without consideration of the problems of water scarcity and the compensating social mechanisms evolved by farmers. Government agencies must consider current research results when setting norms of water use efficiency. If they don't, construction agencies may take the wrong path in designing and remodelling village tanks, and the farmers will face the consequences. For example, according to VIRP documents, a tank in the Dry Zone should have useful water storage of at least 0.91 ha-m/ha (3 ac-ft/ac) in order to be selected for rehabilitation. This emphasizes that the efficiency of water management will be based on utilizing 0.91 ha-m of water per hectare. In order to achieve this, it is necessary to plan various water conserving strategies. However, research done at the Maha Illuppallama Research

Station shows that under reddish brown earth (RBE) -- which is imperfectly drained soil -- a total of 1.057 meters of water is required for short term (3.5 month) rice varieties.

This experiment was done during maha, and effective rainfall was taken into consideration (Nayaka Korala 1983). Thus, the irrigation requirement under RBE during the rainy season for short term rice varieties exceeds 0.91 ha-m/ha.

THE REHABILITATION PROCESS

Large sums of money have been invested in the rehabilitation program of VIRP. Out of a total of about Rs 466 million (US$16.6 million), Rs 383 million (US$13.7 million) has been allocated for physical rehabilitation of existing village schemes. The component for rehabilitation is about 80 percent of the total investment (World Bank 1981:64). In a situation like this, donor agencies as well as the government, have considerable interest in proper planning, monitoring, and evaluating the physical and financial progress of the rehabilitation program, and also in seeing the rehabilitation program completed on time.

As mentioned earlier, the physical rehabilitation program was entrusted to the ID, which is a well-established construction agency of the state. The broad technical guidelines and planning procedures are clearly laid down in the supporting documents of the VIRP Staff Appraisal Report (ibid). The major drawback is that the rehabilitation component and subsequent water management component are conceived of as two separate issues. There is a rigid demarcation of responsibilities laid down in the VIRP Staff Appraisal Report -- the construction program is entrusted to the ID, while implementation of the water management program is the responsibility of DAS. But it is common sense that unless the irrigation system is properly planned and designed, implementation of a water management program will be difficult.

Another important factor is that construction agencies have given low priority to obtaining the cooperation of the farmer/beneficiaries of these rehabilitated schemes. This situation is described by Murray-Rust (1985):

> The majority of irrigation agency personnel in responsible positions have received their training as civil engineers with a natural and inevitable bias towards design and construction of physical infrastructure. Even in developed countries, engineers assigned to undertake tasks of operation or maintenance are regarded as poor cousins, a trend even more marked in most developing countries. Design and construction are the cornerstones of professional recognition by the engineering fraternity and there is every reason for young engineers to gravitate towards these activities for their advancement in an agency as well as for their own job satisfaction.

This attitude tends to increase misunderstandings between construction agencies and farmer/beneficiaries.

From the 1940s, the government's heavy involvement in rehabilitation, with help from external donors, led the farmer/beneficiaries to think that the government owns the village tank and has the primary responsibility to rehabilitate any village scheme that falls into disrepair.

The rehabilitation process under VIRP can be divided into three major stages: pre-construction, construction, and operation and maintenance (O&M).

Pre-construction Stage

A large number of small tanks and anicuts have been rehabilitated by the ID. According to a recent progress report, the ID is expected to complete 718 schemes (both anicuts and tanks) before the end of 1986. They have already completed 418 of these. The DAS has completed 156 schemes and is expected to complete another 306 before the end of 1986. In this discussion, I will only consider the rehabilitation of tanks by the ID under VIRP.

Pre-construction starts with the initial identification (preliminary investigation) of a project for rehabilitation. The procedure for the construction agency is laid down in the "Guidelines for Investigation, Planning, Designing and Estimating Village Irrigation Rehabilitation Works" (World Bank 1981: Annex A). Several criteria were laid down for the selection of the tanks. One of the main criteria is that more than 10 families must benefit. The only official source of this information is the Paddy Lands Register maintained by the Agrarian Services Center but this is often incorrect. The construction agency itself has to ascertain the correct number through field survey and this has proved difficult. There have been instances where one or two owners registered in the Paddy Lands Register their close relatives' as owners of rice fields in order to qualify a tank for rehabilitation.

Because the selection criterion based on 10 farm families is inadequate, criteria based on economic and social conditions must be used. Frequently the affluent class tries to use social and political pressure to place their tank on the rehabilitation list. When that happens, even without the knowledge of the construction agencies, the credibility of the officers involved is lost. It also increases misunderstanding between the bureaucracy and the beneficiaries. What is more, the investment cost cannot be justified because only a few farm families benefit in such a situation.

Unfortunately these selection criteria are imposed from outside the local community and do not encourage farmers to come forward with suggestions about having their tank rehabilitated. If the needs of the community are given due recognition, it tends to want to participate in organizing and implementing future development (Abeyratne and Perera 1985).

After approval is obtained from the competent authority of the ID on the preliminary investigation reports, the proposals are submitted to the local district agricultural committee (DAC) for formal approval. In the DAC, each member wants to know the number of schemes from his constituency that have been earmarked for construction.

Although local departments are also represented, they are much less interested. There have been instances in which, after obtaining DAC approval for specific projects, both the ID and DAS have gone to a particular site to do surveys. This shows that though DAC approval is sought as a formality, the agencies pay little attention to it.

After obtaining DAC approval, the list of proposals is submitted to the VIRP steering committee in Colombo. Again, approving the list of projects is a formality. Yet this approval is necessary in order to have the cost of the rehabilitation program reimbursed by the World Bank. Such formalities are clear instances in which state intervention has penetrated the whole program.

According to the Staff Appraisal Report (World Bank 1981), at the commencement of the full survey and design preparations, a meeting should be arranged with the officers of the DAS and the Department of Agriculture at the site, together with the farmer representative (FR, also called *vel vidane*) and the farmers who would benefit from the scheme. Proposals should then be discussed with the officers and farmer/beneficiaries, and their views obtained.

Although the VIRP envisages that the construction agency will follow the above procedure, this type of consultation was never held prior to the 1983 construction program. As a result, the DAS has undertaken the responsibility for the meeting and arranged for a discussion with the construction agencies and farmer/beneficiaries. Hesitation to have this type of dialogue with the farmer/beneficiaries can be understood considering that the ID is fully responsible for its design and construction work and feels it is unnecessary to obtain the farmers' views regarding its areas of expertise. As a result, it was observed that some of the schemes rehabilitated prior to 1983 have still not been taken over by DAS. DAS officials often complain that these schemes lack enough downstream structures to implement an improved water management program.

As mentioned earlier, meetings to explain the project proposals and to arrange for farmer participation in the project were not held by the construction agencies. Instead, the APT gathered the farmers and invited ID officials to explain their proposals and ratify the decisions made by the ID. At some of these ratification meetings, it was observed that the construction agency was not prepared to alter any plans according to suggestions made by the farmers. When confronted with their failure to involve farmers, the construction agencies tried to cover themselves by saying that they had held ratification meetings. However, just holding meetings does not constitute farmers' involvement unless the construction agency is amenable to farmers' suggestions.

The Construction Stage

After designing a scheme, preparing the estimates, and gaining approval by the competent authorities, the ID must call publicly for tenders and the normal government financial regulations have to be followed in awarding tenders to the lowest bidder. The construction agencies have to work according to a schedule in order to complete the project within a financial year. Thus, the construction agency does not have the power

to award the work to the farmers even if the latter want to take over the contract. The donor agencies, in consultation with the recipient government agency, lay down the conditions that have to be followed in the tender procedure.

The lowest bidder who gets the contract often commences work without employing the local labor available in the village. In many instances, it so happens that the tenderers are complete outsiders to the villages where the tanks are located. The farmers are not given a chance to supervise the work or even to inquire about what is happening to their village tank. This situation may lead to misunderstandings between the farmers and the construction agencies. The net result is that it is difficult to get the farmer to participate when it comes to implementing the water management program. It is often observed that after DAS takes over the rehabilitated scheme from ID, it becomes difficult to get the farmers involved in implementing the water management program (Medagama 1982:10-12).

These procedures, rules, and regulations should be amended in order to allow more farmer participation in rehabilitation. It is interesting to note that some rules and regulations pertaining to tenders were framed during the colonial regime when the British were suspicious of the local administrators. Some financial rules have since become obsolete and should be amended to suit the present context.

Post-construction Stage

Once construction is complete, ID hands over the refurbished scheme to DAS to implement an improved water management program. The process of "handing over" and "taking over" takes place between the two departments and excludes community participation. As such, it appears to the farmers that the rehabilitated schemes belong to the State and not to the community, and, therefore, those living and cultivating under these schemes are merely recipients of government services (Abeyratne 1986:14). In short, the sense of community ownership of the rehabilitated schemes is lost by the time DAS takes over the scheme from ID and tries to introduce water management.

Problems Encountered

Construction agencies and other officials who come to a particular village to work are seldom familiar with such environmental factors as the micro-variations in terrain, stream flows, and catchment areas. Local farmers are the most knowledgeable about their environment. The omission of local knowledge and experience from the design process is a serious drawback. If construction agencies consulted local farmers, many serious mistakes could be avoided. An example is seen in the Badulla District where a tank breached after construction. According to the construction agencies there were two possible causes of which they were unaware: first, when constructing the tank bund, an existing anicut underneath caused the bund to be washed away during heavy rains. Second, a family living upstream might have damaged the bund for fear of having their houses inundated. In another example in Badulla District, the construction agency learned after constructing the scheme that the command area came under a forest reserve, thus

precluding any agricultural activities. Had the construction agencies contacted local farmers, these problems might have been averted.

Tank bed cultivation is a common practice in the Dry Zone. When the farmers are not briefed correctly about the full supply level and high flood level, they continue to cultivate the tank bed even though it is prohibited. After rehabilitation, farmers who do tank bed cultivation realize that their crops will be affected and, in some instances, damage the tank bund and the sluice in order to save their crops. This situation could be avoided by dialogue between the construction agencies and the farmers.

Similarly there are many instances where downstream structures like control gates, farm turnouts, and pipe outlets were damaged by the farmers after they were constructed by ID. The farmers say that those structures do not serve any purpose and even hinder the flow of water to their rice fields. If farmers are briefed correctly, willful damage would be minimal. In other cases, measuring devices which were constructed downstream were often damaged or demolished. A typical example is a rectangular weir that was constructed to measure the discharge from the sluice. This measuring device has a baffle to break the velocity, which is viewed by farmers as an obstruction. With a weir just outside the sluice, farmers think they are unable to utilize the dead-storage in the tank which is normally used by buffaloes and for domestic purposes during dry spells. To prevent such difficulties, any plan that construction agencies intend to introduce should have the concurrence of the farmer/beneficiaries or it may serve no purpose at all.

A study undertaken by the Agrarian Research and Training Institute (ARTI) on behalf of DAS revealed that less than one percent of the farmers said that they were consulted or even kept informed of the design plan or its progress. About 60 percent of the farmers who said that there were problems in the physical works after the rehabilitation program attributed those problems to the fact that ID did not consult the local residents (Abeyratne & Perera 1985:78). A second study conducted by the University of Peradeniya revealed that most farmers indicated that they knew about rehabilitation only after the contractor arrived at the site. It also noted that farmers were very interested in knowing the various aspects identified for the rehabilitation and about the budget set aside for such work (Herath et. al. 1986:9).

The VIRP documents (World Bank 1981) stress that the views of the farmers should be obtained regarding their contribution toward implementing the project. It should be explained, for example, that farmers will be required to dig field channels and drains in accordance with designs specified by DAS in order to facilitate water management and distribution. But, in practice the farmers contribute little mainly because at the start they are not consulted nor are their responsibilities explained. When DAS tried to explain that farmers must contribute by digging field channels, farmers suspected that the item had been included in the estimate, that the contractor had not performed his duties, or that officials were conniving with the contractor to get the job done through the farmers. Such misunderstandings seem inevitable when farmers are not consulted.

The government should not approach the farmers in one way for rehabilitation and in a completely different way for management. This situation was highlighted during the 1986 World Bank Review Mission, which went so far as to say that DAS discriminated against the tanks rehabilitated by ID and gave priority in developing water management programs to tanks modernized by DAS. DAS explained that it was easier to introduce a water management program where they were involved with the farmers from the beginning, and this explanation was accepted by the Mission team.

The tussle between DAS and ID remains to be solved. To help remedy the situation, the Mission recommended to government authorities that a separate block allocation should be given to DAS to rectify defects and attend to urgent repairs after taking over ID schemes. The important issue that arises here is not the tussle between the two government departments but the failure to follow the required procedures and involve farmers.

WATER MANAGEMENT PROGRAM

Program components. All irrigation schemes that are to be rehabilitated by ID are, in principle, considered for the DAS water management program. The major goal of this program under VIRP is to use rainfall and tank-stored water more efficiently than at present and expand command areas by improving the dependability of water supply and allocating water equitably among the farmers. The DAS water management program has three components:

1. Civil works for improving field channels and providing control structures for efficient delivery of water; installing measuring devices to measure seepage and conveyance losses; and providing and upgrading drainage facilities.

2. Improved agricultural practices for dry sowing of rice during maha with early rains; plowing immediately after maha and yala harvests to facilitate early land preparation for the following season; growing subsidiary crops (non-rice) in yala; promoting short duration varieties of rice in both maha and yala; and cultivating on time and adhering to the cultivation calendar.

3. System management for establishing farmer organizations (tank committee and farmer groups) for system O&M and for implementing the water management program; cultivating only part of the command area in periods of water shortage; setting up a rotational water supply system with fixed delivery schedules; allocating water from tail to head; and supplementing irrigation both in maha and yala.

Program organization. The Water Management Division of DAS is responsible for planning and implementing the water management program in the schemes rehabilitated under VIRP. At the national level, coordination is the responsibility of the Deputy Commissioner of the Water Management Division. At the district level, the program is

coordinated by the Assistant Commissioner. The farmer representative (FR) is the lowest link in the DAS hierarchy. Though he is elected from and by the farmer beneficiaries, his responsibilities and obligations are more to the officials rather than to the farmer/beneficiaries. The FR is entitled to a modest remuneration from the cultivators of his area. At the field level, the water management program is carried out by agricultural planning teams (APT).

The World Bank Staff Appraisal Report (1981) has defined the composition of an APT: there should be one technical assistant (TA) from DAS and an agricultural instructor (AI) from the Department of Agriculture, whose services should be obtained on a secondment. In implementing the program, the Water Management Division realized that the presence of an officer to deal with farmer organizations was necessary in the APT. A divisional officer (DO) who is in charge of Agrarian Services Centers under DAS has been appointed to the APT.

Farmer representation in the APT. As seen earlier, the APT is a local unit designed to implement the water management program at the district level. Though the APT is oriented to work closely with farmer beneficiaries, the farmers tend to think of it as an outside organization because they are not represented. DAS has tried to fill this need by appointing an officer to deal with rural institutions for the village farmer but it has had no serious impact. From the official point of view, the DO already fills the need (Abeyratne 1986:16). Adding another office in the APT, even with good intentions, shows that the state would like to consolidate its bureaucratic power over the farmer beneficiaries.

In the VIRP water management program, the local vel vidane or farmer representative (FR) is expected to perform a vital role. He has to operate the sluice and supervise water deliveries based on a predetermined rotation, as well as collect daily rainfall data and function as the chairman of the tank committee. In most cases, the FR does not function as expected. Under the Agrarian Services Law the FR's employment period is not specified and, thus, FR's have been performing their duties for the last seven years under tenuous contract. An amendment regarding this is to be brought before the Parliament. However, when FRs' performance is less than expected, the farmers become reluctant to pay the remuneration, and, in turn the FRs' enthusiasm to perform their duties decreases. Therefore, in practice, the FR system has proven less effective in the small tank schemes.

At first, the VIRP expected the FR to play the key role among the villagers. But with the passage of time, a cultivation officer (CO) was assigned the implementing role of the water management program under small irrigation schemes and began performing as the DAS official agent at the village level. His salary is paid by the State. The CO has become the officer whom the farmers approach to resolve their conflicts. The FR has become the lowest rung of the State mechanism at the village level. In cases where farmers violate government rules and regulations, or fail to clear their channels or maintain them properly, the CO has the legal right to prosecute them. In contrast, the FR can bring only social pressure to bear. Therefore, in practice, the position of the FR, the only farmer representative in the whole program, has become undermined by other positions introduced in the government administrative hierarchy.

The tank committee. According to VIRP proposals, a tank committee should be set up for every scheme earmarked for rehabilitation, consisting of village level government officials, such as the CO, the *krushi vyapthi sevaka* (assistant agricultural instructor), a divisional officer, and a few FRs.

With the formulation of a water management program, the command area of a particular tank is divided into tracts. Groups are formed around one field channel and each group selects a farmer as their leader. All group leaders and the FR of that particular tank, in addition to the above mentioned government officials, become members of the tank committee. The FR is the chairman of the tank committee (World Bank 1981:53).

At the tank committee meeting, formal approval is sought for implementing the water management program formulated by the APT. Issues such as the dates to perform maintenance work on the tank bund, clear scrub jungle, and desilt field channels, and issues connected with the cultivation calendar and water rotations are decided. Supply needs have to be reviewed and where necessary, remedial action taken by the local officials who are in the tank committee.

The ARTI study on VIRP highlighted three major issues regarding the concept of tank committees. First, it argues that the concept of a tank committee was based on the "one tank - one village" system that existed in the Dry Zone. With State penetration into rural areas, many changes have taken place, and this concept is no longer relevant. As village communities are exposed to interaction with agencies, the communities are no longer "closed" and must interact with one-another.

Second, with State penetration in the form of financial investment in village irrigation schemes, a doubt has arisen among farmers about their ownership of the tank. In the ARTI study area, 67 per cent of the farmers were sure that the State owned the irrigation works. This attitude could be the cause for the farmers' reluctance to form tank committees prior to rehabilitation. When they realize that they have no role to play in the pre-construction and construction stages, willingness to organize themselves is minimal.

Third, with population pressure and land fragmentation within the village community, farmers are compelled to look for alternative cash crops and other ways to generate income. In this context, the study questions the functional utility and social validity of instituting a tank committee (Abeyratne & Perera 1985:103-106).

Another basic contradiction in the tank committee system is that, although State penetration into rural areas is high with VIRP, at least on face value, State penetration through tank committees is much less. The tank committees are not backed by legal provisions. Because they are neither statutory bodies nor non-governmental organizations, tank committees could not last long.

DEGREE OF SUCCESS

It is clear that eliciting farmer involvement in the rehabilitation and management

process in VIRP is not a success story. Nevertheless, the need to rehabilitate village irrigation systems justifies the existence of a VIRP. In Sri Lanka, the size of land holdings is low compared to other countries. For example, 90 per cent of the land holdings planted to rice are less than 0.4 ha (one acre). With this land holding pattern, could we expect to increase farmer capacity to undertake rehabilitation programs? Farmers under minor tank commands are subsistence farmers who try their best to make ends meet in a given environment; they are not market-oriented.

Though we treat the village irrigation system as virtually a farmer-managed system, farmers' attitudes towards the system may be quite different. Farmers are used to obtaining services for their agricultural activities from external agencies. It is not only from the agricultural sector that these services are expected, expectations also extend to education, health, and food subsidies. The state provides free education up to university level. The state looks after the health of the people. About 50 per cent of the population is entitled to food subsidies from the state. In this situation, farmers too expect many state services. Therefore, establishing State organizations to assist an irrigation management program would not be something new.

According to the ARTI study, after the introduction of the water management program, 63 per cent of the farmers under tank systems with the water management program indicated that their individual water supply has improved. This is encouraging. It shows that farmers can gain even when the water management program is introduced through a bureaucratic institution.

The study also shows that external institutions have to intervene to resolve farmer conflicts. With the appointment of the CO any conflict that arises among farmers is referred to him, and by imposing irrigation regulations, he helps to overcome problems pertaining to water allocation and distribution. Formerly, violation of irrigation rules was referred to rural courts but with the abolition of rural courts the situation under village irrigation systems has worsened. Many farmers feel that there should be a judicial body to take punitive action against those who violate rules and regulations connected to agricultural activities. Social sanctions may not work due to the social conditions under a village irrigation system.

A study undertaken by the University of Sri Lanka revealed that, on average, the percentage of farmers reporting shortage of water in maha during flowering, tilling, and land preparation declined from 59.6 to 13.3, from 39.2 to 10.3 and from 31.7 to 11.2, respectively. These figures indicate that the water management program achieved remarkable success with regard to the availability and adequacy of water. But it is also important to note that the stored water situation in the tank during the dry period has not improved as expected. It could be assumed that there is a high potential to increase the productivity in maha rather than in yala, provided that institutional factors do not disturb the situation.

It is also interesting to note that with the above state intervention program, the proportion of farmers reporting bad channel maintenance and illegal water tapping

declined significantly, indicating improvement in water management in the rehabilitated schemes. This shows that there should be State agencies to guide farmers on the correct path.

RESEARCH ISSUES

There are many issues which need the attention of researchers in order to guide policy makers and implementing agencies.

1. *The degree of state intervention.* The foregoing discussion explained that there is a need for State intervention in the rehabilitation program, but that a clear cut idea does not exist as to the extent of that intervention. Some important questions could be posed here: Is it possible to get farmers involved in the process of rehabilitation and the water management program? What should be the strategy to elicit farmer involvement in this program? How do we implement the program within the existing institutional framework? What would be the role of the officials and farmer organizations? These issues were not clearly addressed by VIRP.

2. *Rehabilitation process.* Another important area of interest is the rehabilitation process of VIRP. Are the existing criteria applicable within the present day context? Should the rehabilitation procedure elicit any farmer involvement in order to obtain their knowledge of the local environment? How can bureaucratic attitudes be changed? What should be the role of construction agencies?

3. *Understanding the Dry Zone village economy as a whole.* It is also time that researchers tried to understand the Dry Zone village irrigation economy as a totality. Just looking at the Dry Zone economy externally does not give a clear picture of the various activities within the village community. An interdisciplinary approach should be used to diagnose the problems in the Dry Zone. Every activity in the agricultural system is related to the behavior of the village community. An in-depth study of the society might throw new light on problems that exist in the Dry Zone.

4. *Land tenure.* Many social scientists have tried to understand the Dry Zone farmer's behavior in relation to his decision making in managing and mobilizing available resources. It is important to understand the land tenure problems that exist in the Dry Zone economy in order to obtain better results from a project like VIRP. An important and relevant question that should be asked is whether the present day land tenure system produces better results even after introducing a state-involved rehabilitation program. This issue remains to be answered. Is the impediment to agricultural development in the village systems in the Dry Zone due to the mismanagement of their tank systems or to the inherited land fragmentation in the society? An in-depth study has to be undertaken on these issues. If the land tenure system is found to be a constraint, what action is recommended? What could be the role of the state in changing the existing land ownership pattern?

5. *Economic viability*. There is always a great concern among economists whether it is economically viable to launch a heavy investment program like a rehabilitation program with respect to the Dry Zone village system. Would it be possible to produce good results even without the civil works component, where about 80 percent of the total investment is concentrated? Would it be possible to resettle these village communities under the major schemes? Or is it possible to invest just a little money on rehabilitation and go ahead with a systematic water management program to obtain better results? As there is a likelihood of introducing the second phase of VIRP, addressing these issues would facilitate rational and meaningful decisions.

6. *Catchment development and protection.* Only about 50 percent of the existing Dry Zone tanks are in working condition. Why do farmers abandon these tanks? It is seen today that due to population pressure in the Dry Zone, many catchment areas and forest reserves have been cleared by farmers. Some are engaged in chena cultivation in the catchment area. This is really detrimental to the existing tank system. What are the best future policies with regard to protecting these catchments and developing them? It has become a social, economic, and a political problem. Therefore, study is essential before embarking on another foreign funded village irrigation project.

CONCLUSION

State intervention that was initiated during the British colonial period in the 1850s reached its climax in the 1980s with the introduction of VIRP. Before VIRP, there was only indirect intervention and the village community managed the irrigation systems. With the VIRP local capacity and capabilities are indirectly discouraged by the State agency rehabilitation process and the heavy involvement of officers in implementing the water management program. But the time will come when the State will find it difficult to maintain these rehabilitated systems with available state resources. It is still not too late to think of an appropriate and meaningful strategy to involve farmers in the whole process. Ultimately they will have to shoulder the responsibility of sustaining the efficiency of the irrigation system.

NOTES

[1]See Agrarian Services Law Act no. 58 (1979): section 68.

[2]Seventy five percent probability of rainfall expectancy value in the Dry Zone is 750-875 millimeters (30-35 inches) per annum.

[3]See Irrigation Ordinance no. 32 (1946).

[4]The exchange rate in 1986 was US$1.00 = Rs 28.00.

[5]I cannot recollect any instance where the proposals were discussed at the VIRP steering committee. The formalities are requirements of the donor agency's financial and administrative rules and regulations.

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PUBLIC INTERVENTION IN FARMER-MANAGED IRRIGATION SYSTEMS IN NEPAL

S.B. Upadhyay*

INTRODUCTION

Nepal is a rectangularly shaped, land-locked country stretching in an east-west direction for approximately 800 kilometers (km) and varying in width from 140-220 km. The country can be broadly divided into three regions: 1) the mountain and Himalayan zone, which exceeds 3,000 meters in altitude and accounts for 34 percent of the total area but only 5 percent of the total cultivated land; 2) the hill zone, with elevation from 300-3,000 meters, is subtropical and occupies 43 percent of the total land area and contains 30 percent of the cultivated land; and 3) the Tarai zone, lying below 300 meters, forms the southern belt extending along the Indian border and accounts for 23 percent of the total area and 65 percent of the cultivated land.

Agriculture and Food Balance

Agriculture is the mainstay of Nepal's economy, accounting for about 60 percent of the Gross Domestic Product, over 90 percent of all employment, and nearly 80 percent of export earnings. Food grain production is the most important component -- rice, maize, wheat, and millet account for over 90 percent of the total agricultural output. However, in the past five years production of food grains has not shown a significant increase.

Food balance projections up to the year 2000 show that to supply the minimum food and nutritional needs of the rapidly increasing population, cereal production must nearly double from the present level. In the next decade this requires an annual growth rate in food production of about 4 percent. Increased grain production can be attained by increasing the productivity of farmland. This can be done by improving irrigation infrastructure, agriculture extension, input supply, processing and storage, and marketing, and by implementing new irrigation systems.

Irrigation Development

The total cultivable land in Nepal is estimated at 3,000,000 hectares (ha). Much of this land could be irrigated by surface water sources. Portions of the Tarai zone also have potential for increasing the use of groundwater for irrigation.

Public sector irrigation development does not have a long history in Nepal. The Chandra Canal in Saptari District, built in 1923, was the first irrigation scheme built with standard engineering methods. In 1926 an agriculture council was set up to take care of Nepal's

*Executive Director, Water Resources Directorate, Water and Energy Commission Secretariat, Kathmandu, Nepal.

irrigation activities. The second modern irrigation system, Judha Canal in Rautahat District, began operation in 1945.

In 1951, the agriculture council was dissolved and the Irrigation Department established. The Irrigation Department has been reorganized into the Department of Irrigation, Hydrology, and Meteorology and undertakes all major irrigation schemes. Three other agencies -- the Ministry of Panchayat and Local Development, Farm Irrigation and Water Utilization Division of the Department of Agriculture, and the Agriculture Development Bank -- are also involved in irrigation development.

Although public sector irrigation development with respect to modern engineering techniques is relatively new, irrigation development in Nepal has been taking place for centuries. Farmers have built and operated systems on their own, some of which are as much as 400 years old. Of the estimated 690,000 ha of land that is presently irrigated, farmer-managed irrigation accounts for at least 400,000 ha. The percentage of the total irrigated land in the hills and in the Tarai under farmer-managed systems is about 90 and 70, respectively.

Farmers work together to divert water from rivers, and build main and branch canals, and the distribution system. They also maintain and operate the systems. To manage a system they form a *kulo samiti* (canal committee) and choose leaders. In many cases water is distributed on the basis of land holdings but in times of low supply a distribution schedule is used which may or may not be related to landholdings. Repair and maintenance of the diversion and main canal is done collectively, but field channels are maintained by those who use them. The organizational pattern used by those involved in repair and maintenance differs from one system to the other depending on the soil, climate, topography, and social structure of each location.

There are benefits that could be derived from greater involvement of farmers in the development of public sector systems. In the design phase, farmers can assist with information regarding soil conditions and topography; in the construction phase, they can provide labor; and, in the operation phase, they can participate in operation and maintenance (O&M). Similarly, public intervention in farmers' systems could help in several ways. At the macro level, rules and laws that recognize and protect the status and customary rights of the existing farmer-managed systems need to be formulated. At the micro level selective assistance is needed to: 1) strengthen weak user groups to enable them to exercise authority when necessary, 2) improve the physical systems by giving technical and material assistance, 3) improve accounting and administrative skills, and 4) improve water management skills.

PUBLIC INVOLVEMENT IN FARMER-SYSTEMS

Since 1985 the Water and Energy Commission Secretariat (WECS) has been conducting a water use inventory in the Tarai. The inventory has placed emphasis on identifying farmer-managed systems and obtaining information about how they function. The

irrigation status, as compiled from this study for both the private and public sectors, is given in Table 1. In the eight districts where studies have been completed, 836 farmer-managed systems were recorded.

Table 1. Relationship between cultivated and cultivable land area and public and private irrigation coverage (in '000 hectares)

District	Land				Gross Irrigated Area			
	Total area	Culti-vable	Culti-vated	Irrig-able	Farmer systems Season	Farmer systems Year	Public sector*	Total
Jhapa	156.9	136.5	113.5	124.0	66.4	3.0	5.0	74.4
Morang	184.7	142.6	107.3	120.6	25.6	21.1	54.0	100.8
Rauthat	103.7	88.0	58.4	81.3	1.7	6.7	6.0	14.3
Chitwan	219.4	114.1	46.8	87.6	11.1	9.3	5.5	25.8
Nawal Parasi	201.6	104.8	60.2	79.2	14.6	6.3	9.8	30.7
Rupendehi	141.5	114.6	90.4	108.7	10.4	32.7	10.9	53.9
Danddekhu	297.3	113.3	68.4	76.1	18.4	23.2	1.9	43.6
Kaiali	324.8	191.6	69.7	156.5	23.9	7.8	5.0	36.8
	1629.9	1005.5	614.6	833.9	172.0	110.0	98.1	380.2

*Government built systems.

Numerous problems have been observed in the farmer-managed systems. In low-flow periods, disputes and even fights over water sometimes disrupt irrigation activities. In systems that tap water from large rivers, there is no mechanism to control flood-water from depositing silt in the canal and destroying the canal and fields. In such cases there is frequent damage to crops. Many of the farmer-managed canals do not have sufficient control structures and appear to be poorly designed and of irregular size. At times farmers have changed the canal alignment when the original canal was filled with silt, making it difficult to repair. In the hills, farmers have used wooden structures to cross drains and even wooden aqueducts along rock cliffs. Such structures leak and the resulting erosion makes the span larger and more difficult to cross. Landslides frequently destroy canals and they cannot be repaired using local skills and materials. The diversion structures are a difficult problem for the farmers. They are constructed from boulders and brush or even earth and bamboo, but floods wash them away easily. In some systems the diversions must be rebuilt many times in one season. This increases the uncertainty of water delivery.

Public involvement in farmer-managed systems, if done in a way that preserves the organization and management strengths they exhibit, could enhance agricultural development. To evaluate and design better ways for public involvement in farmer-managed systems in the hills, WECS, in collaboration with the Ford Foundation and the

International Irrigation Management Institute (IIMI), have undertaken a study in the Sindhupalchowk District. The study's primary objective is to identify underlying problems of farmer-managed systems which limit their expansion and intensification.

Similarly in the Tarai, investigations should be made to see if there are effective ways to assist farmers in improving their systems. It is essential first to identify clearly the problems faced and the alternatives that could be undertaken. It may be possible in some cases to increase the irrigated area by improved management practices which reduce the consumption of water. In other cases, building semi-permanent diversions and other structures may enhance the performance of systems. Other benefits, such as reducing labor demands for repair and control of silt due to erosion and floods, would also be gained. Many of the farmer-managed systems were found to be seasonal. With improved technology some of these systems can be made perennial. Studies should be undertaken and research carried out to find ways that public intervention in farmer-managed systems can improve their performance and expand the irrigated area.

AN EVALUATION OF IRRIGATION PROJECTS UNDERTAKEN BY AKRSP IN THE GILGIT DISTRICT OF NORTHERN PAKISTAN

Maliha H. Hussein, Hussain Wali Khan, Zahur Alam, and Tariq Husain*

INTRODUCTION

Methodological Approach

The Aga Khan Rural Support Program (AKRSP), an affiliate of the Aga Khan Foundation, initiated a development program in the Northern Areas of Pakistan at the end of 1983. The program's objective was to increase farm household incomes and, in its first three years of operation, its major accomplishment was the establishment of self-sustaining village organizations (VO) in each village using a "productive physical infrastructure" (PPI) as an entry point. A majority of the PPI schemes undertaken involve irrigation channels and, by the end of June, 154 had been identified and 97 completed. This paper will present an interim evaluation of the 154 irrigation schemes. However, before the benefits of these irrigation schemes can be fully realized, the new land which they will help to irrigate must be developed. As such, the costs and benefits of the land development package have been included in this analysis.

This analysis uses a 15 percent discount rate and a planning horizon of 21 years. This period was a convenient choice because of its compatibility with the requirements of the computer software used to conduct the analysis and because it provided the policy planners a sufficiently long term perspective on the impact of the program. Although this period does not strictly represent the economic life of the projects, it will not materially alter their benefit/cost profile.

The data used in this analysis was taken from various sources. Previous AKRSP Monitoring, Evaluation, and Research (MER) division discussion notes were used extensively. AKRSP's wheat surveys provided invaluable information on the local farming systems and enabled an examination of existing cropping patterns and comparisons across villages. Publications covering the United Nations Development Programme/Food and Agriculture Organization (UNDP/FAO) experience in the Northern Areas were used for cross checks on yields and farmer management practices. Detailed discussions with the program senior engineer and program senior agriculturalist provided another valuable source of information. The data was analyzed using the BENCOS computer software package designed for economic analyses in developing countries.

It would not be possible to write this paper without making certain assumptions which will be refined after more information becomes available. All assumptions have been made explicit to place the evaluation in its proper perspective. Therefore, it is best to read this as a first document that will be amended as time goes on.

*The authors are all on the staff of The Aga Khan Rural Support Programme (AKRSP), Aga Khan Foundation, Gilgit, Northern Areas, Pakistan.

Irrigation History of the Area

The Karakoram region of Northern Pakistan falls in a partial rain shadow and does not receive the monsoon rains. The area is arid and cultivation depends on irrigation. There are three rivers in the Gilgit district: Hunza, Gilgit, and Skardu. These rivers lie above most villages and cannot be channelled for cultivation. Irrigation channels, fed by glacial sources, provide a crucial, and in most cases, the only source of water to the small subsistence agricultural communities in the area.

Although there is little documentation on the irrigation history of the area, existing evidence suggests that the first irrigation channels were constructed by people who migrated to the area hundreds of years ago. Typically, the kinds of channels that could be built using the meager resources of the local people were relatively simple and did not require major outside support. These channels were largely fed by glaciers and snowmelt. The water flow has always been highly variable, increasing many fold in summer and becoming a mere trickle in winter; in some areas the capacity flow is 35 times its minimum. This variation put increasing pressure on the people to devise an effective water management system. However, there was a limit to developing additional water sources. Consequently, a greater effort was exerted to increase the efficiency of the existing system.

The next phase in the construction of irrigation channels was undertaken by the traditional rulers. Some systems were more sophisticated than others, depending on the support of their ruler and the degree of internal village cohesion, and the degree of water scarcity and proximity to glacial water sources. The politics of the area also influenced the irrigation system that developed because political support was often rewarded by title to unsettled land and by rights to extended glacial sources. In some areas, the *mirs* and *rajas* (rulers) employed forced labor to construct channels and instituted a system of *malia* (land tax) to extract the benefits of the increased water supply in the form of compulsory taxation on agricultural produce.

This system worked well because it could induce collective development of projects that could not be undertaken individually and because it ensured that, during the initial phase of the project, the people who had been sent to develop new land would be sustained by the members of their families who had stayed behind to cultivate their existing holdings. The villages of Sultanabad, Oshikandas, and Mohammadabad were developed in this fashion by Hunzakuts under the supervision of the Mir of Hunza.

The mirdoms were able to ensure gradual development of new land in areas where people had nearly exceeded their individual capacity to cultivate new land. The mirs helped the collective construction of irrigation channels. Once this was done, most of the remaining potential irrigation channels could not be built with collective endeavor alone. More material support was required to blast through the mountains to reach the water sources. Just prior to the abolition of the mirdom system in 1974, this system reached near capacity and little new land was being brought under cultivation.

Thereafter, the development needs of the area were assigned to different government departments. This was done partly to redress the institutional vacuum created by the abolition of the traditional rulers. The Northern Areas Public Works Department (NAPWD) began constructing about 20 large irrigation schemes, each at an average cost of 1.85 million Pakistani Rupees.[1] Only one of these schemes is still functioning.

These schemes suffered from lack of technical and operational planning. Theoretical formulations provided the main guidelines for planning. The local people, who developed considerable expertise in designing irrigation systems, were not consulted at any stage of construction. The difficult and unstable terrain posed special problems in establishing channel gradients, and village elders should have been consulted on past glacial movements, avalanches, and flood paths. However, the factor singularly responsible for the failure of these schemes was the department's inability to institute a system which would transfer the maintenance of these channels to the farm households who were using them. It is reported that 15 of these 20 schemes failed because of poor maintenance.

The Local Bodies and Rural Development (LB&RD) department was another institution entrusted with the construction of irrigation schemes in the area, and it helped improve some of the irrigation channels. The LB&RD could have achieved a lot more than it did if not for its system of disbursing funds for the channels. Each union council member was given a share of the development funds allocated for the Northern Areas. However, this share was based on the population in each area and not on the development priorities in each *tehsil* (sub-district). This piecemeal method of disbursement did not allow the completion of any scheme and the work done in a previous year often would be completely washed away before the next installment was received. The farmers had neither the capacity nor the incentive to maintain an incomplete channel which offered no economic return.

At the time, current thinking did not subscribe to the view that the people should be given labor payments for a project which was designed ultimately to increase their incomes. Other agencies like UNDP/FAO, which endorsed this view, gave drill machines and other construction implements to aid sporadic self-help efforts. However, people who could be producely employed on their farms or who could seek off-farm employment (construction of government projects or gathering fuelwood for sale) could not be persuaded to work without the promise of wages. The attraction of increasing future incomes by increasing their assets was luring but it did not answer the more immediate needs of survival. This was the situation at the end of 1983.

The Traditional Water Management System

The water management systems devised by the people of this area are extremely sophisticated in the construction and management of channels because water sources were scarce and uncertain. Most of the irrigation channels are fed by glaciers, and villages assert property rights on glacial water. The fate of a village is closely tied to that of

its glacier. Sudden glacial movements have wrought havoc on the tenuous water systems and some villages have "gone dry" due to glacial retreats. Artificial birthing of new glaciers by the mating of male and female glaciers is well entrenched in local tradition. Incredible as it may seem, local inhabitants testify that the Minawer glacier is one example of a successful mating arranged 29 years ago. Recently, the farmers of Sikkanderabad (AKRSP n.d.:72-74) "planted the seeds" of a new glacier to ease their acute water shortage.

In constructing water channels, the local people devised various ways to ensure technical success. In order to ensure that the gradients were built correctly, water was allowed to flow along as the channel was dug. Village elders were always consulted about glacial movements, avalanches, or mudflows to ensure that these would not disrupt the water supply system of a village. Villagers also devised a system of sanctions against those who did not participate in the collective work of a village.

Responsibility for maintaining channels constructed by the people gradually evolved into a functional system. The *jirga*, a body of village elders, often adjudicated village disputes. Initially, the jirga decided water allocations but later its jurisdiction was expanded to maintenance issues. The village divided responsibility for maintenance and entrusted it either to different clans or households with each clan or household responsible for a section of the channel. Also they undertook to issue an early warning in case of impending disaster or to ensure repair in case of danger. In some cases, two or three people were entrusted with the care and maintenance of the channels and were paid in grain donated by each beneficiary household.

The allocation of water and water rights is a complex issue with no single predominant pattern in evidence. In some villages, title to water is not separate from title to land. In areas of acute water shortage, water rights are treated as distinct from the land which it will irrigate. Few of the villages in the area have been officially settled and as such, the villagers rely heavily on the traditional system of distribution enforced by religious and social sanctions. In case of water theft, the miscreants are fined in cash or in-kind. These days the payment is mostly in cash.

The sophistication of the water allocation system depends primarily on scarcity; generally, the more scarce the water, the more well-developed the distribution system and the water rights. Settlement office records indicate that water rights were distributed to existing clans and are passed on through inheritance along with other assets. The basis of the allocation is not clear. In some cases, geographical proximity was considered sufficient.

Distribution is also seasonal. In the Ulter channel, for example, a wooden frame is placed at the head to distribute the water flow. Half goes to the Hamachi and Kiser irrigation channels and half goes to Sammerquand. Subsidiary channels then direct the water to individual fields. In water sharing, the velocity of water and other factors are considered in deciding shares. In Hunza, due to acute shortages, water is given first to wheat fields, then to fodder crops, and finally to trees. Thus, people who want to plant

more trees are restricted not only by the land constraint but also by the water constraint. It is expected that orchard and tree plantations in Hunza will increase due to the increased water supply in that area.

According to the old settlement records of Hainzal, all the cultivated lands could be irrigated, and uncultivated land could get irrigation water once cultivated. If a farmer developed barren land, he was allowed to irrigate it according to his specified water rights. Water from irrigation channels could be diverted to mills provided they did not interfere with the irrigation rights of others. Gardens could not be irrigated. In some villages, irrigation rights were apportioned on the basis of the revenue paid by each household to the government. Forests were generally considered government property and individual households were not given water shares for adjoining forests in settled villages. No person had the right to construct subsidiary channels if there was scarcity of water in the area.

By the end of 1983, the Northern Areas had developed farmer-managed irrigation systems which had, on average, the capacity to irrigate about 70 hectares (ha) of cultivated land in each village. Almost all the irrigated area in the Gilgit district was under the command of a farmer-managed irrigation network. Besides that, the management and maintenance of the system was well established in local social tradition. The sustainability of the system was enhanced by the fact that property rights on water and the new land which it helped to cultivate were very explicit; where they were not, they were fairly easily imputed from past custom. There were few disputes regarding the distribution of rights on water or land within villages; disputes were more likely to be between villages. Due to the difficult terrain and the unstable physical environment, the management focus of the local system was on maintenance issues.

The system had the capacity to maintain and operate the existing network of channels but it lacked the ability to build new channels or extend old ones without outside assistance. Although each village had some marginal land, used primarily for pastures and growing fuel wood, it could not be more productive due to water scarcity. Development entrepreneurs felt that the most substantial increase in overall productivity could be achieved by irrigating presently barren land and by increasing the existing water supply of villages in the Gilgit district (Saunders 1983).

The few new channels that were being constructed by the NAPWD were unable to mobilize the indigenous capacity of the people in planning and maintaining new projects. Moreover, wherever a government project was built, the distribution of the additional resources it helped create was preempted by officials who based their decisions on political considerations. This further exacerbated the maintenance issue and the question of sustaining the project. As such, the system had reached a static phase.

AKRSP's Intervention in the Irrigation System

When AKRSP first came to the Northern Areas in December 1982, it was confronted by this static phase. Its strategy in developing the area required the creation of productive physical infrastructure (PPI) projects; a self-sustaining village organization (VO) which

would oversee construction, management, and maintenance of these projects; and a process for managing and constructing development projects on a continuing basis. One PPI scheme was granted to each village and project identification was left to the villagers. A majority of the villages selected irrigation channels as their priority project. In return for financial aid, AKRSP asked the villagers to form a development-oriented VO. The terms of partnership with the VO included regular savings to build up the VO's equity capital, weekly meetings, participation in extension training programs, and collective land development.

By the end of June 1986, AKRSP and the VO had identified 154 irrigation channels (about 63 per cent of all PPI schemes undertaken by AKRSP). These included construction of 66 new irrigation channels and the extension and modification of 88 old channels. The LB&RD had attempted to rehabilitate several earlier but had not succeeded for one reason or another. Of the 154 irrigation channels 97 were completed. Apart from these, AKRSP also helped to construct lift irrigation, sedimentation tanks to improve water quality, and water storage tanks. This was the largest investment in irrigation schemes ever undertaken in the Gilgit district. The potential land which this water will irrigate is expected to double existing landholdings and, thus, influence the cropping pattern by removing two important constraints; water and land. The increased yields will have both forward and backward linkages on the farm economy with implications for input and factor markets.

An analysis of the part played by VOs in constructing PPI projects indicates some interesting features of the AKRSP approach. In implementing the program, AKRSP follows a diagnostic procedure which entails holding detailed dialogues with a majority of village residents and involving them in each stage: identification, feasibility, and construction.

In the identification stage a project is only chosen if it benefits a majority of village households. To determine the technical feasibility of the projects, village elders, nominated by the villagers, accompany the AKRSP surveyors. The VO is given responsibility for implementing and maintaining the project. But, because of the public nature of meetings, accountability is given to the entire village and not to one or two people. The interaction of local people and AKRSP at each stage ensures that village concerns are considered, participation is ensured, and local expertise is mobilized in support of the project. Villagers have invariably accepted the cost estimates prepared by AKRSP because their representatives are involved in the survey. Payments to compensate for land or other assets affected by the construction is left to the villagers. AKRSP has a strict policy of not interfering with the distribution of benefits from these projects.

Two other important aspects of AKRSP's policy are labor payments as part of the PPI grant and grant disbursements by installment. The former are in keeping with the understanding that the opportunity cost of rural labor is not zero and that it will be difficult to induce people to work on the project without remuneration at subsistence income levels which forces them to be concerned about current levels of consumption. Development agencies that do not pay wages have not adequately considered the fact that the future benefit stream was being discounted heavily by the farmers of this area.

The phasing of the grant in installments performs an important monitoring function by ensuring that a specified part of the project is completed before additional funds are paid to the village. The final installment is given only after a project is completed. This method of implementation helps to avoid having to maintain complicated muster roles. A major drawback of the NAPWD's approach was an excessive concern with muster role monitoring to the detriment of actual progress on the schemes.

FARM INCOME ANALYSIS

Farmer Resource Ownership

At present, the average farm household in the Gilgit district owns about 0.76 ha of cultivated land. This estimate does not include communal pastures and forests but, if these are included, the average landholding per household comes to about one hectare. Table 1 gives aggregate and Table 2 gives individual estimates of land utilization for the Gilgit district.

Table 1. Estimates of land utilization for aggregates for individual and communal lands, Gilgit District, 1985.

	Area (ha)	% of total
Cultivated area	20392	43
Orchards	3874	8
Annual crops	16518	35
Uncultivated area	26612	57
Cultivable waste	6474	14
Uncultivable forest	3672	8
Uncultivable other	16466	35
Total area	47004	100

Source: AKRSP 1985.

These figures are verified by the wheat surveys conducted by AKRSP's MER division in 1983 and 1985. MER prepared a land use profile of the average farmer from the 1985 wheat survey data. These data indicate the present average cropping pattern in the area. On a one hectare farm, about 40 percent is planted to perennial crops, 10 percent to forest, 18 percent to orchards, and 12 percent to alfalfa. Annual crops are grown on 60 percent of the land. Wheat takes a major share (36%); clover, 14 percent; and barley and vegetables, about 5 percent. In the double cropped area, 34 percent of the land is used for maize cultivation, 26 percent for pulses, and 4 percent for vegetables. The cropping intensity is about 134 percent.

Differences between small- and large-scale farmers were examined to draw inferences about how an increase in the amount of land might affect the cropping pattern. It is

Table 2. Estimates of land utilization for individually-operated holdings (n = 26,685 farms), Gilgit District, 1985.

	Area (ha)		% of total
	Total	Per farm	
Cultivated area	20392	0.76	70
Orchards	3874	0.15	14
Annual crops	16518	0.61	56
Uncultivated area	8492	0.32	30
Cultivable waste	6474	0.24	22
Uncultivable area	2018	0.80	8
Total area	28884	1.08	100

Source: AKRSP 1985.

estimated that, on average, each household will be able to irrigate an additional 0.71 ha of new land in villages where an irrigation project was constructed. Based on this, a profile of the average projected land use for new land was prepared (Table 3). These projections reflect AKRSP's understanding of the kind of choices that will be made by farmers in the future. For illustrative purposes, new land has been divided into two stages of 0.5 ha each. These stages can help in illustrating the distinction between small and large beneficiaries of land development as well as highlight the gradual process of land development.

Table 3. Projected land use for new land.

	1st 0.5 ha		2nd 0.5 ha		Total 1 ha		Present use of 1 ha of land (%)
	ha	%	ha	%	ha	%	
Perennial crops	0.25	50	0.35	70	0.60	60	40
Forest	0.09	18	0.13	26	0.22	22	10
Orchard	0.09	18	0.13	26	0.22	22	18
Alfalfa	0.07	14	0.09	18	0.16	16	12
Annual crops	0.25	50	0.15	30	0.40	40	60
Rabi	0.25	50	0.15	30	0.40	40	60
Wheat	0.15		0.07		0.22		36
Barley	0.03		0.03		0.06		5
Vegetable	0.03		0.01		0.04		5
Clover	0.04		0.04		0.08		14
Kharif*	0.14	28	0.08	16	0.22	22	34
Maize	0.09		0.05		0.14		26
Pulse	0.02		0.02		0.04		4
Vegetable	0.03		0.01		0.04		4

*Double crop, villages only.

At the completion of the land development process, perennial crops will form 60 per cent of the total new land, compared to the present 40 percent. Areas planted to forest, orchards, and alfalfa will all increase. In the rabi season, the share of wheat will decline from 60 percent in the old land to 55 percent in the new land. Clover and vegetables might increase their share somewhat. In the kharif season, (double cropping areas only) the share of maize should decrease, leaving proportionately more land for pulses and vegetables than now. Kharif land use, however, is hard to project since relevant data are extremely meager.

The average livestock ownership per household is 18 animals, with about 7 large animals and 11 goats and sheep per household. Meat is a preferred food item but is consumed rarely. The area is deficit in meat and dairy products due to the acute fodder shortage and lack of labor to shepherd animals to the high mountain pastures. Much of the meat is imported. Each household normally slaughters an animal and stores it for consumption during the fierce winter months.

Agroecological Variation

The agriculture of each valley in the Northern Areas depends on the soil quality and type, water availability, and altitude. These factors vary greatly in the Gilgit district. The altitude of villages where cropping is possible varies from about 1,500-3,350 meters, although barley and wheat have also been observed at 3,660 meters At such high altitudes wheat does not mature and is used primarily for fodder. The average lapse rate is about 0.6-0.7 degrees centigrade (with the mean temperature) per 100 meters In single cropped areas generally more land is cultivated than in double cropped areas. Forty-five percent of the villages under study were in double cropped areas, while 55 per cent were in single cropped areas.

All types of soil are present in the region. In the relatively flat lands the soil ranges from silt loams to gravely sandy loams. On the slopes, the soils range from stony loamy sand to gravely sandy loams. There is no distinct zonation of soils in villages. Some old river terraces generally provide better quality soils. Alluvial fans and moraines have highly variable soil quality and the extent of land development required also varies greatly in these areas.

FINANCIAL INVESTMENT ANALYSIS

Estimated Costs

Project costs. The cost of improving the irrigation system of an entire area depends on several factors, the most important of which are: type of irrigation, terrain, design standards, and whether the project is new or the extension and modification of an old channel. The 154 irrigation projects that AKRSP has so far designed in the Gilgit district can all be classified as surface irrigation. Of these, 88 are old irrigation projects and 66 are new channels. The distinction between old and new is somewhat tenuous in AKRSP's

case, as it eclipses the fact that the widening and extension of old channels can often be more costly than the building of new ones. However, the distinction is important because the expected benefit stream of old and new channels is different.

There are direct and indirect costs, and, as much as possible, an attempt will be made to quantify all costs. Those which cannot be presently quantified will be listed. The assumptions made to assist in quantification will be made explicit and where necessary, sensitivity analysis will be made to estimate the effect of assumption changes on the cost profile of projects. An attempt will also be made to trace through the linkage effects of costs on other aspects of the farming system and the regional economy.

Broadly speaking, costs of the irrigation channels have two components: the cost to AKRSP and the cost to the villagers. The cost to AKRSP includes a) the grant for material and labor payments made to the villagers, b) charges for engineering, survey, and research (ESR); and c) implements granted to VOs for land development. The costs of operating a helicopter have been included separately in the cost/benefit analysis as a percentage of the total funds invested in the irrigation projects.

The cost to the VO includes: a) the difference between the estimated cost and the negotiated grant of a project, b) maintenance cost, and c) the VO's extra effort to extend the project beyond the specifications prepared by the engineers. In computing the present cost of maintenance, a discount rate of 15 percent was used with 21 years as the assumed life of the project.

The total costs. The total cost of the 154 irrigation projects initiated by AKRSP up to the end of March 1986 was PRs 39.05 million. AKRSP's share was PRs 21.01 million and the balance was the VOs' share (Table 4).

AKRSP bears a rough average of about 54 percent of the cost of each irrigation channel. The largest factor in AKRSP's costs is labor (51%), with material costs of 33 percent and ESR of about 15 percent. The largest cost to the VO is for maintenance -- about 49 percent of the total costs over the 21-year life of the project -- and pooled labor (both skilled and unskilled) is about 24 percent. The balance (27%) makes up the difference between estimated cost and the negotiated grant. The village is expected to bear the last two costs in the first year of the project.

Unit costs to AKRSP. The cost per cusec of all irrigation channels is PRs 27,105 and the cost per meter is PRs 43. The cost per hectare of newly irrigated land is about PRs 2,067. A study on the economic return to investment in irrigation in India (World Bank 1982) indicates a cost range of Rs 8,000-20,000/ha[2] of surface irrigation projects. The paper reports that the Sixth Plan implies an average capital cost at 1979/80 prices of about Rs 15,000/ha of surface irrigation potential created. Although these figures are not directly comparable with those of Pakistan, they do indicate the cost-effectiveness of these small irrigation schemes. Even if the cost to the VO is included in these figures the average cost per hectare of newly irrigated land is PRs 3,842. When helicopter costs are also included, the costs rises to PRs 4,336.

Table 4. Costs of irrigation projects, March 1986.

	Total (PRs '000)	Average (PRs)
AKRSP cost component		
Negotiated Grant: Material cost	6881	44681
Labor	10778	69987
Engineering, survey & research	3047	19785
Land development implements	300	1948
Village organization cost component		
VO subsidy (estimated cost-negotiated grant)	4786	31078
Maintenance cost*	8850	57468
Village labor subsidy (skilled)**	1232	8000
Village labor subsidy (unskilled)***	3172	20597
Total AKRSP cost component	21006	136401
Total village organization cost component	18040	117143
Grand total	39046	253544

See note 1 for exchange rates. *Calculated at 15% discount rate for 21 years; **average 160 skilled days extra on a project x 50 x 154; ***average 824 unskilled days extra on a project x 25 x 154.

The cost profile over time. All costs increased from 1983 to 1986 (Table 5).

Average estimated costs have increased from PRs 102,849 to PRs 244,199. This near 150 percent increase could be due to the fact that the irrigation canals constructed in 1986 were longer and more complex than earlier ones. However, the average negotiated grant increased from PRs 109,082 to PRs 144,418, only a 32 percent increase. This means that at this stage of the program, the VOs are being called upon to exert greater effort in the construction of PPIs (productive physical infrastructures). As ESR (engineering, survey, and research) is calculated as a percentage of the estimated cost of a project it was expected that with the increase in estimated cost, ESR costs would also increase. However, in percentage terms there is no change in ESR. Average length increased by 16 per cent, although average capacity decreased by about 11 per cent. Cost per cusec has increased by 53 percent, cost per meter by 17 percent, and cost per hectare of newly irrigated land by 38 percent. Figures 1-3 illustrate these costs graphically.

Table 5. Irrigation channels cost profile by year (in Pakistani Rupees).

	1983	1984	1985	1986
All irrigation channels (n)	48	60	37	9
Average estimated costs	102849	143628	159070	244199
Average negotiated costs	109082	114510	115579	144418
Cost per cusec	22634	29574	28721	34603
Cost per foot	12	15	12	14
Cost per ha of new land	1934	2061	2129	2686
Breakdown of costs				
Average material cost	30740	49434	50695	64015
Average labor cost	78359	65077	64895	80402
Average ESR	17566	20708	21075	26601
Average length (feet)	10929	9202	11300	12653
Average capacity (cusecs)	5.76	4.76	5.03	5.10

Percentage changes	1983-84	1984-85	1985-86
Average cost	18	10	53
Average negotiated cost	5	1	25
Cost per cusec	30	2	20
Cost per meter	25	20	17
Cost per ha of new land	6	3	26

Figure 1. Estimated compared to negotiated costs for irrigation channels, 1983-86, Gilgit district.

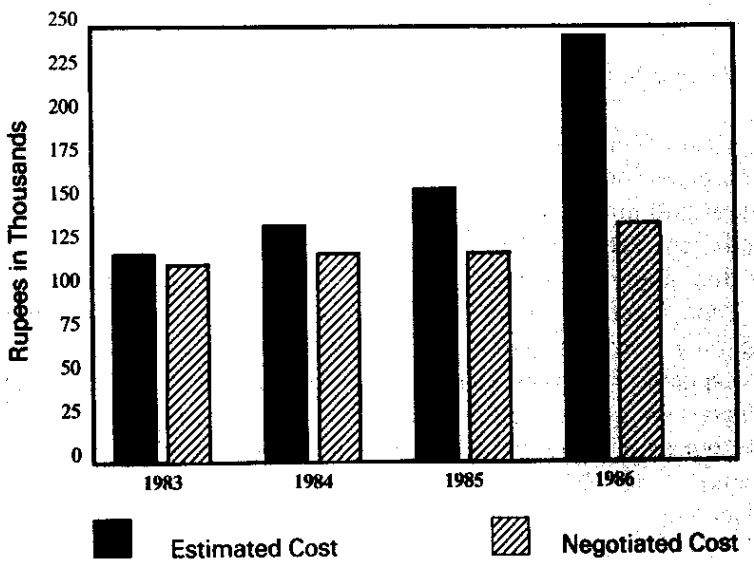


Figure 2. Cost of new land compared to irrigation channel capacity costs, 1983-86, Gilgit district

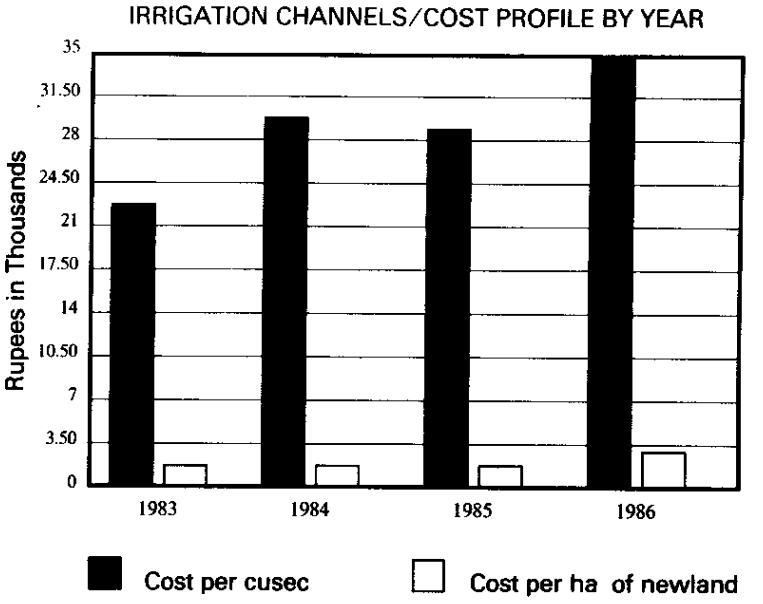
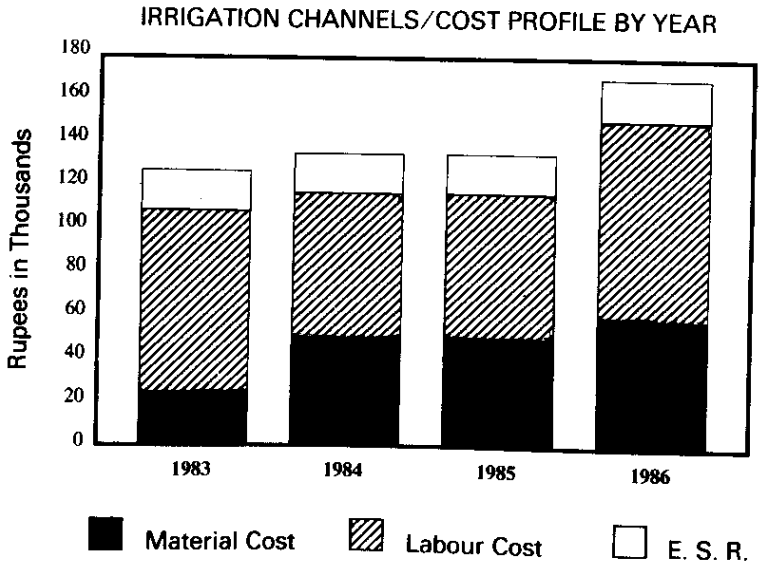


Figure 3. Costs for materials, labor, and ESR (engineering, survey, and research) for irrigation channels, 1983-86, Gilgit district.



Land development costs. The irrigation channels will benefit land which has not yet been developed for cultivation and land which is presently under cultivation. The costs of developing the new land will be considered before presenting a cost-benefit profile of the projects.

There are two costs involved in land development: costs to AKRSP and those to the farm household. Funds are given to the VO as a loan with a five percent service charge. AKRSP received the funds from National Development Finance Corporation (NDFC) as a long-term interest-free loan, and the only cost to AKRSP is an administrative cost which is calculated at 15 percent of loans to be disbursed in the future. The 15 percent also includes costs that will be incurred to assess the land development requirements of a village. Repayment of these loans will be made with the help of elected office-bearers who will be given a commission of 2.5 percent on the recovery of the loan.

The costs to the villagers of developing new land is fairly high, partly due to the difficult terrain involved. According to an ESR estimate, it takes about PRs 900-2,500 to develop 0.05 ha of new land for annual crops. Costs of developing new land for perennial crops is estimated at about PRs 350 per 0.05 ha. Each irrigation project brings an estimated average of 66 ha of new land under cultivation, which means that each farm household brings about 0.71 ha of new land under irrigation. Assuming that the farmer will ultimately grow perennial crops on 60 per cent of this land and annual crops on the balance, the cost of developing this land will be PRs 14,664 per family. The cost of developing new land per village is about PRs 1.36 million. Although this figure is quite large in relation to the resources of a farm household, the cost of development is moderated by the system of labor pooling practiced in the area and the fact that this development will be phased over 8-11 years.

In consultation with ESR, an estimate based on labor requirements was prepared for phasing the land development in an average village. Labor is affected by several factors: First, there is no net migration into the Northern Areas and, assuming this will not change, the substantial amount of labor required suggests that land reclamation will be a long-drawn-out process. Second, the government has a large development allocation for the Northern Areas and can be expected to provide a competing source of off-farm employment. Third, because the terrain and climate do not allow work throughout the year and the average farmer cannot work full time on this development, preparing land for cultivation can take the average family up to 11 years. Five years after the average farmer has begun the land development process he is likely to have developed 50 percent of his new land.

The entire land development effort will require, without any cost overruns, an estimated PRs 217 million and 4.14 million unskilled person-days. If the VOs pool their labor and use family labor, land development will require PRs 117:5 million. Although the total cost to the farm family will remain unchanged, the financial implications will substantially change depending on whether family labor or pooled VO labor is used. Moreover, land development may also be completed somewhat earlier if the VO is used. The earlier

returns will alter the cost-benefit profile and the internal rate of return as examined later.

Production costs. Cultivating new land also entails production costs, which include the additional labor required to manage and cultivate the new lands as well as the inputs. In estimating, input costs were assumed to be constant, substitutability between inputs was assumed unchanged, and government price policy was assumed unchanged. Family labor, farm yard manure, and other nonpurchased inputs were valued at opportunity cost. Where available, market values were used, and where a market price was not explicit, it was imputed from first principles. Production costs were PRs 3.92 million in the first year after project completion. These will gradually rise until they reach a maximum of PRs 70.75 million in the 17th year when all the new land is under full production.

Helicopter costs. The program has a helicopter to expedite visits by management to the villages and ensure quick and regular follow-up by the senior program members based in Gilgit. The costs to AKRSP of the helicopter were estimated at about PRs 30,000 per flying hour, which includes leasing and maintenance expenditures. Helicopter costs make up about 24 percent of the annual AKRSP budget. As such, 24 percent of the amount spent on irrigation channels has been taken as the machinery cost to the irrigation component of the PPI. This amounts to PRs 5.04 million for the 154 irrigation channels under progress.

Financial Benefits

This section presents estimates of direct and indirect benefits to be realized by the farmers in the Gilgit district as a result of the irrigation projects. Within each classification there are tangible and intangible benefits. Quantification of the direct tangible benefits, though difficult, is possible with the use of explicit assumptions. Indirect benefits also require restrictive assumptions. Intangible benefits, on the other hand, can present serious problems of quantification. Consequently, in the present analysis, the direct benefits will be examined more closely.

A combined average profile of benefits from old and new channels was prepared for estimating benefits. A new irrigation channel will help to bring an average of 66 ha of previously undeveloped land under irrigation. The projected cropping pattern on this land was made by relaxing the land constraint and then examining the cropping patterns of large and small farms from the wheat surveys. The analysis assumes present profitability, and the projected cropping pattern does not reflect any changes due to the introduction of new crops. These assumptions may not be realistic but have the advantage of establishing a minimum threshold of profitability.

Expected yields were computed from various sources and cross-checked. The high degree of variation in the soil quality, terrain, and altitude was incorporated into the analysis by preparing an average profile on yields in the project area. Government price policy was assumed constant and yields were multiplied by existing product prices. The effects of the increased production on prices was examined in the sensitivity analysis. All costs and benefits were phased over a 21 year time frame. Particular attention was given to phasing benefits separately for perennial crops. In most cases benefits from perennial

crops have a time lag which was incorporated into the analysis. Annual crops were also phased to reflect the farmers' limited resource ownership and input requirement. Farmer concerns with risk and diversification were incorporated into the cropping pattern used.

The benefits from irrigating new land start in the second year after the completion of the channel, when they total PRs 15.89 million. Third year benefits rise to PRs 27.18 million, a 71 percent increase. Thereafter, the benefits keep increasing and jump to PRs 114 million in the 7th year when fruit production starts. The benefits reach a maximum of PRs 367.52 million in the 17th year when all the new land comes under full production. This benefit profile continues to the 21st year.

In addition to bringing new land under cultivation, the extension and modification of old channels will also increase the water availability on about 100 ha of previously cultivated land per channel with a cropping intensity of 134 percent. The increased water supply will decrease the watering interval from seven to five days (Husain 1985). This will increase the water availability in these villages by approximately 20 percent. The effect of this on crop yields was estimated from yield response factor information (Doorenbos et al. 1979). The yield response for wheat, maize, and barley is understated as the existing *warabandi* (water allocation) system gives priority to these crops. The assumption made here is that even when water is scarce these crops received more water than others. The estimated benefit from increased yields for all the 154 projects is PRs 5.63 million each year, which accrue from the first year after an irrigation project has been completed.

Benefit/Cost Analysis

The discount rate, representing the opportunity cost of capital, used in this analysis was 15 percent. The gross benefit/cost ratio for this analysis is 2.02. The reciprocal of this ratio, often called the cost-effectiveness ratio, is 0.49. This indicates that benefits could fall by 51 percent (i.e., 1-0.49) before the benefit/cost ratio would be driven down to 1. Similarly, costs could rise by 120 percent before this ratio would be driven down to 1. The net benefit/scarce resource cost ratio for these channels is 18.63. For the purposes of this analysis "scarce resource" was defined as the AKRSP funds invested in these channels. This investment measure gives the returns per AKRSP rupee expended. Thus, for each AKRSP rupee spent, the return is about PRs 19. The estimated internal rate of return for these 154 channels is 37 percent. This indicates the rate of return on the money invested in these projects. The ratio of (benefits - production costs) / (operating + capital costs) equals 3.27.

The present value of net benefit is negative for the first five years after project initiation. The benefit stream turns positive in the 6th year,[3] reaching a maximum of PRs 42.46 million in the 11th year when the forest trees begin to yield income from timber. Thereafter, the benefit stream falls somewhat, with the present value of net benefit at PRs 15.99 million in the 21st year.

Sensitivity Analysis

Sensitivity analysis was used to study the impact of changing assumptions on the economic profile of the irrigation projects (Table 6).

Table 6. Impact of assumption changes on the economic profile of the projects.

Assumpt ons:	Gross benefit/ cost ratio	IRR	Net benefit/scarce resource cost ratio
All benefits reduced by 10%	1.82	33.40	15.15
All benefits reduced by 20%	1.62	29.37	11.66
No benefits on previously cultivated land	1.93	33.58	16.94
No benefits on previously cultivated land and benefits on new land reduced by 20%	1.54	26.80	10.31
No benefits on previously cultivated land and benefits on new land reduced by 50%	0.96	14.02	0.36
All benefits delayed one year	1.71	28.24	13.26
Land development delayed one year	1.92	32.96	15.13
Land development delayed two years	1.75	30.10	10.82
All costs increased by 10%	1.84	33.73	15.46
All costs increased by 20%	1.69	30.73	12.82
Failure rate of 10%	2.00	36.30	16.71
Opportunity cost of capital 50%	0.74	37.27	- 0.32

IRR = Internal rate of return.

The analysis indicates that the project's economic profile is not as sensitive to reductions in benefits on old land as it is to benefits on new land. The projects are

sensitive to delays in the land development program after the initial investment in irrigation channels has been made. A delay of one year in implementing land development results in the benefit/cost ratio falling to 1.92 -- a delay of two years makes it fall to 1.75. The internal rate of return (IRR) falls to 33 percent with the one year delay, and to 30 percent with the two year delay. This is illustrative of the returns to investments in the VO and the helicopter, both of which help to speed up land development. At an opportunity cost of capital of 50 percent the projects are not economically viable and the gross benefit/cost ratio falls to 0.74 percent. The interest rate on informal credit in the Northern Areas is not precisely known, however, if it is as high as 50 percent the irrigation projects would not be viable. This is illustrative of the high investment costs in rural areas and provides a partial explanation for the lack of local investment initiatives in these areas.

Comparative Assessment

In this section the AKRSP irrigation channel projects are compared with other irrigation projects in the Northern Areas, and, to the extent information is available, to similar projects in other developing countries.

A comparison of AKRSP channels with those of the Northern Areas Public Works Department (NAPWD) shows very different cost profiles. The AKRSP cost per project is PRs 136,401 and the average cost of a NAPWD channel is PRs 1.85 million. The NAPWD channels are large projects and a better comparative measure might be provided by a unit cost figure. Cost per meter of AKRSP channels is PRs 46 while the NAPWD's cost per meter is PRs 246. AKRSP's cost per cusec is PRs 27,105 while NAPWD's cost per cusec is PRs 125,194. Because only one of the NAPWD projects is presently functioning the benefit/cost ratio and the internal rate of return would show an even greater difference between the AKRSP and NAPWD channels.

An economic analysis of irrigation development in the deltaic regions of Asia in Central Thailand (IRRI 1978) indicate benefit/cost ratios for various phases of the program. The highest among these is 1.56 compared to the 2.02 of the AKRSP irrigation channels. The internal rate of return reported for projects in Thailand ranged from 6.4-18.4 compared to 14.02-37.27 in the AKRSP sensitivity analysis.

SUSTAINABILITY ANALYSIS

Equity

An important issue in discussing the sustainability of a program is the distribution of benefits and responsibilities. Equitable distribution of benefits and obligations ensures the sustainability of the physical and social infrastructure necessary for development. In the case of irrigation channels there are issues of equity in the construction and maintenance of the projects, in the distribution of water rights, and in the division of new land in the command area.

AKRSP has helped to ensure equity during construction by encouraging the entire village to participate. However, the issue is one which is dealt with primarily by the villagers internally. A recent modification in AKRSP's policy which led it to negotiate the estimated labor cost of a project has equity implications. Villagers who decided to work on the irrigation channels for less than the market wage were subsidizing others who would eventually use the project. In Risht village, the VO was aware of the implicit subsidy and fined villagers who did not participate in channel construction. By and large, the VO has paid equal wages for equal work.

The traditional maintenance system of the villages has been reinforced by the presence of a VO. In some villages maintenance responsibility is distributed by clan, in some by geographical proximity, and in some each household assumes responsibility for a certain section. The most common pattern is to appoint one or two *chowkidars* (watchmen) and then to pay them in grain or cash on a monthly or annual basis. The VO has strengthened this system by imposing sanctions itself or by supporting the sanctioning role (*chatorkhand*) of traditional institutions. Thus, each household benefitting from an irrigation channel assumes some responsibility regarding channel maintenance. Similarly, there are well laid out rules for work on a channel destroyed by avalanche or flash floods, and each household is expected to share equally in such work. Exceptions are made in the case of households where there are no males or where the household is too poor to contribute. In such cases, all the village households share the extra work equally.

The two main direct benefits from the irrigation channels are the irrigation water and the new land in the command area which the increased water supply will help irrigate. Generally, water rights are not attached to the land so that people owning large tracts of land do not necessarily benefit more from irrigation. The system of warabundi is based on different criteria in different areas. In villages where there is extreme water scarcity it is common to give priority to those lands used for annual crops. Wheat and maize presently have priority over other crops, and farmers with more area under wheat cultivation have greater access to water. However, the available data (AKRSP 1985) indicate that landholdings are relatively equally distributed with the average developed landholding in a village ranging from 0.41-1.26 ha. Thus, water is also relatively equally distributed as households do not vary much in their cropping decisions within villages.

In accordance with age-old customs new land is divided equally among all existing households. In exceptional cases, landless households also get a share in potentially cultivable land (*shahtote*). As soon as an irrigation channel makes its command area potentially cultivable, villagers divide the land in equal shares among households. In apportioning this land various factors are considered: work required to develop the land, soil quality, accessibility, and potential cropping. Thus, a farmer getting a plot of land that has poor soil will generally get a larger share than a farmer who receives better quality land. To make the system even more fair, lots are drawn to determine who will get which plot. The system is perceived as fair by everybody. There are few disputes over land within villages.

Available data (ibid.) indicate that the distribution of land becomes less skewed when undeveloped land is included in total holdings. The distribution of land per capita is even less skewed and the gap narrows when total land per capita is compared with total land per household. Hence it is reasonable to expect that bringing new land under cultivation will contribute to greater equity in the area.

The equity issue is also important in terms of the manner in which new land will be developed. In principle, villagers have adopted variants of the AKRSP approach. The program policy was formulated with concern about both equity and productivity. Medium and long term development loans were to be advanced to those VOs which resolved to work on the land together. AKRSP felt that this would help farmers take advantage of economies of scale in the use of inputs and obtain savings in transaction costs. In practice, VOs have interpreted collective development to mean different things. Villagers in Khyber use "collective" to mean simultaneous development at several sites; others in Risht and Shahtote use it selectively to apply to land development management and input delivery. VOs in Jaffarabad have developed part of the land as one large farm. In Khyber, the villagers have divided the plots equally but have not yet assigned individual ownership rights in the belief that the collective land development process will be slowed down if people work only on individual holdings. They have plans to assign ownership once the development process is complete. The Shahtote farmers pool their labor and take turns working on each other's land. In Jaffarabad, farmers have collectively planted trees. In part, these interpretations reflect the varying conditions in each village: the extent of social cohesion, individual perceptions about risk and expected profitability, access to markets, and soil and land conditions. As such, it would be unrealistic to expect the same pattern of land development to be successful in each village. However, each of these patterns ensures that land development may not take as long as it would have done without such collective endeavor and that no villager will be left so far behind as to increase inequality.

Productivity

The sustainability of irrigation channels depends on continuing the benefits derived from them. On average, Gilgit farm households will be able to double their incomes by the 11th year after project completion. This assumes present levels of profitability and no other program intervention. By relaxing these constraints, the doubling of incomes can be expected much earlier with AKRSP's intervention in areas such as marketing, introduction of new crops, or improved livestock. The net benefit stream from these projects -- including land development costs -- will, on average, turn positive in the 6th year after completion. The ratio of (benefit - production costs) / (operating costs + capital costs) is 3.27, the gross benefit/cost ratio is 2.02 and the internal rate of return is about 37 percent. These factors indicate the creation of a very productive irrigation system.

Institutional Stability

AKRSP's intervention in a farmer-managed irrigation system has definite implications for the system's future development. AKRSP helped to improve the existing irrigation infrastructure, which almost doubled the existing irrigation capacity in three years. But

it is difficult to sustain this development in an area where the physical environment is so unstable without a social infrastructure to support system operation and maintenance. With this understanding, AKRSP has helped to create the institutional structures required to operate and maintain the system. The VO in each village is expected to undertake the maintenance and development tasks.

The total annual maintenance cost of the 154 irrigation channels is about PRs 1.4 million, which must be borne by the villagers. The VOs have opted to handle maintenance tasks within the existing social institutions. To do so, the authority of the traditional jirga has been strengthened by the VO and carries the force of the entire village behind it. Moreover, the presence of a VO has helped the villagers construct other irrigation channels by themselves. In Risht, they are planning to construct a second irrigation channel which will help to bring additional land under cultivation. Village savings will be a major factor in sustaining the VO's development efforts. By the end of March 1986 the VOs of the Gilgit district had collectively saved PRs 10.06 million.

In most villages, substantial economies of scale have been realized by the collective purchase and delivery of agricultural inputs, such as seeds, saplings, fertilizer, and also obtaining credit. Through the VO farmers have been able to share information and reduce the risk of using new inputs whose characteristics are difficult to determine ex-ante. In the sensitivity analysis it was demonstrated that a delay in land development changes the benefit/cost profile of these channels. The benefit/cost ratio falls from 2.02 to 1.71 and the internal rate of return falls from 37 percent to 33 percent with a year's delay, and the benefit/cost ratio falls to 1.75 and the internal rate of return to 30 percent in case of a two year delay in land development. The increased returns from faster project implementation can be regarded as the returns from collective effort. These factors increase the expected profitability of the irrigation channels and the VOs and will help to make them both more sustainable.

FAILURE ANALYSIS

Analysis of Slow Schemes

An analysis of schemes where work has progressed slowly reveals that the reasons for this can be broadly categorized as 1) technical, 2) financial, 3) program policy, 4) socio-political, and 5) climatic. Of the 154 schemes, 3 percent (Jutal, Oshikandas) have technical problems; 1 percent (Hanuchal, Gawachi) suffer from financial problems; 5 percent (Bodolas, Hakis, Zakirabad, Damas) are slow because of social or political tensions in the village which undermines the role of the VO; and 2 percent (Nasirabad, Broshal Hanono, Holshal) are delayed because they are at an altitude where the work season is very short. AKRSP's ability to handle these different kinds of problems varies greatly. Those schemes which suffered as a result of some aspect of AKRSP's policy are the easiest to remedy by a change in the program policy. Technical faults can sometimes be remedied but when the technical feasibility is fundamentally misguided the only solution might be to abandon the project. One indicator of the strength of the VO is its performance on the PPI. Wherever

the VO is weak or torn by internal dissension the project has suffered. AKRSP can play only a limited role in remedying this situation.

Financial problems arise when the material costs of a project are underestimated. AKRSP has introduced an element of negotiation in the grant given to the VOs for the channels. It is important that in this negotiation the material cost is not compromised. To some extent the people will even pool their resources through the VO to subsidize labor, but the VO will be helpless if the cost of explosives or other materials is not covered. The importance of not negotiating below a certain level on the labor component is reinforced by experience in villages (Shahtote, Hanuchal, Bodolas) where a nearby government project has attracted away all the available labor.

An illustration of how a simple change in program policy impacted the performance on PPIs is provided by the disbursal of the PPI grant. Initially, the PPI grant was given to the VO in four installments. There was an inordinate delay in the progress of some schemes in the final stages and the reasons for this were discovered during a monitoring exercise. The first installment was given before the start of the project. The second installment after the completion of the first 25 percent of the channel. The third installment was paid after the completion of 50 percent of the channel and the final installment was paid only after the work was fully completed. This meant that those who worked on the last 50 percent of the project had to work without wages until the VO received the last installment. It was difficult to persuade people to do so, especially when alternate sources of on- and off-farm employment were available. AKRSP realized this and divided the installments into five equal parts. This considerably eased the burden in the last stages of project completion and improved progress on slow schemes.

In large villages there are problems of coordination which slow down the work. A response to this has been smaller management and maintenance groups divided on some social criterion. Village level problems also include the inexperience of VOs in handling the financial responsibility for the projects. Carried away by their new found prosperity, in a few cases, (Gupis) the VO has given generous wage payments initially and then had problems of adjusting to more realistic wage payments. This has not been a serious problem in any village and the matter is internally solved by the VO. Handling new technology (Qurqundas, Siphon irrigation schemes) which has implied deviating from traditional practices of the village, has not met with much success. It will take time for people to develop the experience to handle these. The importance of local participation in the channels was reinforced by AKRSP's experience in the field. In one or two villages local people were not involved in the feasibility survey. This resulted in a lack of acceptance of the cost estimates prepared by AKRSP.

Analysis of Schemes that Failed

The most common reasons for the failure of schemes, in addition to some of those listed in the preceding section, are 1) ambiguity over the distribution of benefits and 2) maintenance. The case study of Jutal provides a very instructive lesson in the performance of a project when benefits are not clearly defined. The command area of the Jutal irrigation

channel had been allocated by the government to some farmers from Hooper who had to be resettled after the destruction of their lands in a natural disaster. The people of Judai, who laid traditional claim to this land decided in all probability, to reinforce their claim by building an irrigation channel. Although an AKRSP resurvey team informed the villagers that the project was not technically feasible due to insufficient water in the source, the VO insisted that there would be enough water in the channel and eventually persuaded a second survey team to approve the project on technical grounds. This was one of the few villages in which the advice of the local participants proved misguided. The judgement of the people may have been guided by their zeal to insure their claim on disputed land rather than on their assessment of the water sources of the village. The village of Sikkwer, a recently settled village, was also beset by an internal land dispute and progress on the project was seriously undermined until the land dispute was finally settled in a court of law.

The failure of the NAPWD to enlist village participation in the maintenance of the irrigation channels built by them has been the major reason for the failure of all but one of their schemes. The difficult terrain and the unstable physical environment make village participation essential for the success of any scheme to ensure proper maintenance. Some AKRSP schemes have also been victims of maintenance problems. The VO has, in most cases, reinforced the well developed traditional mechanisms for the maintenance of these schemes. Where there are tensions in the organization there is likely to be a higher probability of maintenance issues arising. The public nature of AKRSP's dealings has placed responsibility on each member of the village and made them accountable for its success. This will help to minimize maintenance problems. This is one reason that no irrigation channel built under the AKRSP strategy failed due to maintenance problems.

ECONOMIC LINKAGE ANALYSIS

Integrated Resource Management

A farming systems perspective focuses attention on the agroecological environment in an integrated manner and allows an examination of the secondary and tertiary impact of a program intervention. In this section some of the backward and forward linkages of the irrigation and land development program will be discussed. The landholdings of the farmers in 154 villages will nearly double. This would increase the irrigated area in the district by about 10,000 ha and considerably improve water availability on presently cultivated land. This has implications for labor productivity, land markets, food and fodder production, livestock carrying capacity, factor and product markets, agricultural commodity prices, future incomes, and consumption patterns. It is difficult to trace the effects of all these factors; however, an attempt is made to trace the direction of change.

The labor requirements in the villages under study are likely to double with the increased landholding. In view of the labor constraint in most villages and the lack of net immigration into the area, farmers will need to devise ways to increase the productivity of existing labor to optimize the returns from their increased resource base. Where labor

efficiency cannot be improved, outside labor can help to develop and cultivate new land. In Sherquilla, for example, outside labor was hired by some farmers.

The increase in cultivable land has initiated a limited land market in an area where none existed. Land sales were virtually unknown in the area. Pathan traders who settled in some valleys about 15 or 20 years ago were unable to buy land. The strict local tradition of not selling land to outsiders is being put under increasing pressure by marginal farmers. In Gupis, some Pathan shopkeepers were able to buy land for the first time after the construction of an irrigation channel. Similarly, some villagers in Shahtote wanted to sell land but were persuaded not to do so for the time being. Not all households in the area will have the resources or the inclination to pursue farming, and with the increase in off-farm employment opportunities some are likely to sell their agricultural land.

The increase in annual and perennial crops may have an effect on commodity prices which will depend on both the supply and demand conditions. Input demand is projected to increase. Supply conditions are also improving due to improvements in the communication network and the institutional support to the input delivery system. As such, the final effect on input prices is difficult to determine at present. The projected cropping pattern shows increasing investment in perennial crops. The aggregate supply curve for such agricultural commodities is highly price inelastic in the short run due to the asset fixity of resources employed in agriculture. The investments being made now are based on calculations of present profitability.

The livestock carrying capacity of the area is also expected to increase with the increase in fodder crops. It is estimated that the increased production of fodder crops will support 22,431 additional head of livestock in the villages under study. This means that the population of goats, which is the preferred meat, can be doubled. Meat is presently imported into the area and eaten only on special occasions.

As incomes increase the consumption patterns may also change. With an increase in incomes, the consumption of livestock products can be expected to increase. The demand for fodder crops is also likely to go up. There will be a shift from inferior grains like barley to the more preferred wheat and maize. Consumption of apricot- and mulberry-based products, which form a major portion in the diets of some valleys, may decline. The consumption of oil, sugar, and tea is likely to increase. All these products are imported. Unless production of these goods is initiated locally or consumption patterns shift towards locally produced goods, the terms of trade between the Gilgit District and the importing regions may deteriorate.

The physical stability of the environment will also be affected by the irrigation intervention. To illustrate: the shortage of fodder led to overgrazing in the pasture areas. This contributed to soil erosion and limited the natural potential of the land. Free grazing on the high pasture lands led to considerable strain and weight loss of the animals traveling to and from high mountain pastures. The development of the dairy industry was inhibited because the animals had to stay away from the villages during the summer months. The

preservation of wildlife was endangered in this system because the snow leopards posed a threat to the free grazing animals and had to be killed. The availability of fodder in the villages, if it encourages stall feeding, will sustain the entire system.

Projected Agricultural Trend Assessment

The present analysis was conducted with the assumption of unchanging profitability. Greater access to markets and the introduction of new crops are changing the economic potential of most crops. Wheat, the staple food grain in the area, was grown rather than imported at subsidized rates because of the food security it provided to a region cut off from the rest of the country. As the communication network improves, the subsistence economy will invest in enterprises in which it has a comparative advantage and trade for what it is not profitable to grow in a market economy where exchange is possible. A few enterprises which have been identified as having a future in the area are seed potatoes, fodder cultivation, livestock production, agroforestry, and new crops like saffron and mushrooms. There is a great shortage of fuel in the area and unlike the European experience where alternate energy sources quickly replaced the use of wood, in the Northern Areas fuel cropping has to be kept as an integral part of the farming systems until other energy sources are developed.

NOTES

[1]The exchange rates for US$1.00 were PRs 15.36 (1984) and PRs 17.15 (1986).

[2]*Editor's note*: The authors do not indicate if these are Indian or Pakistani rupees. We assume they are Indian at an average 1982 exchange rate of US$1.00=Rs 9.455.

[3]This does not reflect the cash flow of the farmer as family labor and other nonpurchased inputs were costed.

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USE OF RESEARCH RESULTS TO IMPROVE AGENCY PROGRAMS

GOVERNMENT INTERVENTION IN FARMER-MANAGED IRRIGATION SYSTEMS IN THE PHILIPPINES: HOW RESEARCH CONTRIBUTED TO IMPROVING THE PROCESS

Benjamin U. Bagadion*

INTRODUCTION

Irrigation systems in the Philippines cover about 1.35 million hectares (ha) of land. Of this, about 500,000 ha are in national systems managed by the government's National Irrigation Administration (NIA), 600,000 ha are in communal systems managed by farmers' irrigation associations, and 250,000 ha are in private systems managed by individual farmers. Thus, 63 percent of the total irrigated area is served by irrigation systems managed by farmers either indiviually or through their irrigation associations. Furthermore, in the national irrigation systems, the tertiary level system following NIA policy has to be managed by farmer associations or groups while the main system is managed by the NIA. From 1983, NIA has been turning over the management of small national systems and substantial parts above the tertiary level in medium-sized national systems to organized irrigation associations. This further increases the area of farmer-managed irrigation systems.

Construction and management of irrigation systems by farmers in the Philippines antedate Spanish colonization. Government activities to develop irrigation started in 1910 under the Americans. These activities included the construction of new irrigation systems that were eventually managed by the government as national systems which charged irrigation fees to users. Before 1950, government intervention on existing farmer-managed systems was negligible except for the Irrigation Act of 1912 which prescribed a system for claiming prescriptive water rights for existing systems.

GOVERNMENT INTERVENTIONS AND PROBLEMS EXPERIENCED

In the early 1950s, a nationwide irrigation development plan was launched to enhance food production and resulted in two types of intervention in farmer-managed systems. With Type 1, groups of small farmer-managed (communal) systems were improved, consolidated, and expanded into government-managed (national) systems. With Type 2, other communal systems were improved and expanded by the government without any obligation on the part of the farmers to pay for construction costs but with the responsibility for management of the system remaining with the farmer irrigation association.

Type 1 Interventions

The first form of intervention was usually employed whenever a communal system or group of such systems could be expanded to cover a contiguous irrigable area of at least

*Irrigation Management Consultant and former Assistant Administrator for Operations, National Irrigation Administration, Quezon City, Philippines.

1,000 ha. Where such a scheme was considered economically feasible and politically desirable the government posted notices in public places within the proposed service area informing the public that an irrigation system would be built by the government to serve the locality, for which irrigation fees would be charged to the landowners within the service area. The notice further advised people to file their opposition to the project with the government on or before a specified date. When there was no opposition (or no more opposition), construction was started.

Construction always featured permanent concrete structures to replace the temporary ones reconstructed or repaired by farmers every irrigation season. The new structures were usually not located in sites where the temporary ones were situated. When several small communal systems were consolidated into one and expanded to cover a larger area, a single permanent diversion weir usually replaced several temporary weirs and a new canal network was constructed which, depending on the judgment of the design engineer, did or did not utilize the existing distribution system. The government constructed the irrigation system down to the turnout or structure that delivered water to an area of about 20-50 ha. All construction was undertaken without participation of the farmer beneficiaries. The land that was used as sites for the facilities was paid for by the government according to prescribed rules.

Beyond the turnout the farmers were expected to construct farm ditches and apportion the water among themselves. When after many years it was observed that the farmers did not undertake farm ditch construction to the desired standards, the government changed its policy and decided to undertake such construction with farmer participation in the form of giving the ditch right-of-way without payment. In all cases the farmers were expected to operate and maintain the farm level system.

Upon completion of construction, the government posted another notice in public places informing that:

1. The irrigation system would be formally opened on a specified date.

2. The operation and maintenance (O&M) of the main system would be undertaken by the government, and at the farm level by the farmers' groups.

3. Farmers should organize an irrigation association to coordinate with the government in matters pertaining to system O&M.

4. Irrigation fees would be charged at the rate of a certain amount per hectare on the landowners served by the system.

5. Irrigation fees would be levied first on the land irrigated and then on the crops raised, and in case of failure to pay the charges thereon, the land, upon judgment of a court of law, would be seized by the government and sold for satisfaction of the amount due.

Foremost among the many problems with Type 1 interventions was the disintegration of the organizations that maintained farmer-constructed systems. These organizations were structured around the network of canals and changes in canal locations in the new systems destroyed the existing organizational arrangements. Efforts to start new organizations failed. When the government took over responsibility for O&M, farmers lost their initiative and began to depend on the government to maintain the irrigation system.

The personnel operating and maintaining the irrigation system were responsible not to the farmers but to the government irrigation agency. Whether or not farmers paid irrigation fees, the system's personnel received their pay. The absence of an organization that could effectively represent the farmers and the non-responsibility of the system's personnel to its clientele resulted in a situation where farmers had no voice in important decision making processes. Consequently, many turnouts constructed by the government were not used by the farmers. Instead, farmers often installed small pipes underneath canal embankments to draw water in violation of NIA schedules. Maldistribution of water was often prevalent; farmers in the upstream part of the canal received much more water than those downstream.

Farmers in the defunct communal systems maintained their temporary weirs and canals through labor contributions of members in accordance with the rules of their association. The government-managed system that absorbed the communal systems required payment of irrigation fees. Farmers were not accustomed to this as they did not pay irrigation fees earlier. Moreover, the government could not impose swift sanctions on violators of the system's rules as the procedures prescribed were long and tedious. As a result, the majority of the farmers did not pay irrigation fees.

Whatever fees were collected went to the central government treasury and the requirements for system O&M were provided by annual appropriations authorized by the Philippine legislative body. Invariably the appropriations were insufficient to provide an adequate level of O&M. The result was progressive deterioration of the national systems.

Type 2 Interventions

The second type of intervention was usually employed when the service area of the communal irrigation system, including its expansion, was less than 1,000 ha. It started with an appropriation in the annual Public Works Act of the Philippine Congress for improving a specific communal irrigation system. The practice was a "reward" in appreciation of votes cast in favor of a member of congress or to fulfil an election promise made by him. As such there was no repayment from the farmers and management remained with the farmers. Project implementors were required to have an irrigation association duly organized and registered with the Securities and Exchange Commission (SEC) before starting any construction.

As in the communal systems that were converted or absorbed into national systems, these irrigation schemes had temporary diversion works and earthen canals that were repaired and maintained by farmers every cropping season. Farmers' organizations were

informal and unregistered with the government. To facilitate compliance with construction prerequisites, a standard set of articles of incorporation and by-laws for irrigation associations were framed by the government irrigation agency. To expedite the start of construction, engineers enlisted the municipal or village heads to complete the documents necessary for expeditious registration rather than organize an association that would effectively manage the irrigation system after its improvement.

The appropriation for these projects was usually small as it would not be repaid. Consequently, only piecemeal improvements could be made in any one year and it usually took several appropriations over a number of years to improve a system fully. The improvements often consisted of permanent diversion weirs and other structures replacing temporary ones and some canals for expanding the irrigable area. Sometimes additional diversion weirs were constructed on other sources to increase the water supply of an existing system. In most cases, new structures and additional canals were built that required substantial maintenance efforts from the farmers. But as the improvements were free and the government did all the work without farmer participation, dependency on the government was fostered. The irrigation agency expected that the farmers would maintain the new facilities, but farmers sensed that the government would repair what farmers failed to maintain. Hence, many of these irrigation systems fell into disrepair and the government had to appropriate funds again and undertake restoration.

Modifying the Mode of Intervention

The two types of intervention were carried over into the NIA after it was created in 1964 to take over the responsibility of irrigation development from the Bureau of Public Works. During the NIA's first 10 years these types remained unchanged and problems increased. In the early 1970s, the NIA gave attention to research showing that indigenous Philippine irrigation systems continued to function satisfactorily over many decades with little or no government assistance. The research suggested that ownership of a system and investment of labor and time in its construction developed commitment to its continued maintenance.

In 1974 the mode of intervention for communal systems was modified by an amendment to the NIA charter. Influenced partly by research on indigenous irrigation systems, a policy requiring repayment of construction or improvement costs was promulgated, the repayment to accrue to a fund for communal irrigation development. The new policy was adopted to instill a sense of ownership among beneficiaries, and to provide supplemental funding that would show farmer commitment and help justify increased government appropriations for expanding communal irrigation development. To implement the policy, agreements between NIA and the irrigation associations stipulated the repayment of construction costs without interest over a period not to exceed 50 years. In addition, the farmer beneficiaries pledged 10 percent of the project's direct costs in the form of labor, materials, and land for canal right-of-way. The implementation of the new policy added repayment and farmers' participation to problems already facing the NIA. The need to develop strong communal irrigation associations became increasingly urgent.

In its search for better irrigation associations the NIA contracted with the Farm Systems Development Corporation (FSDC) to organize farmers in communal irrigation systems that were being constructed or improved. In the resulting arrangement, the NIA undertook to plan and construct the projects and the FSDC organized the farmers. This did not work as expected. The institutional organizers were directed by FSDC officials and the agreement with NIA to organize farmers was only one of their many activities. NIA engineers constantly complained that FSDC organizers were always taking credit for the projects and were telling farmers that these were FSDC projects contracted out to NIA for planning and construction. Poor field coordination resulted in many irrigation associations refusing to accept the system improvements because of misunderstandings over the amount to be repaid by the association and claims that the new facilities were not functional.

After two years of the NIA-FSDC arrangement NIA decided to develop its own method of organizing irrigation associations. The search involved a learning process anchored on action research. To promote further the growth of irrigation associations, appropriate provisions were included in a Philippine Water Code that consolidated and improved all water laws.

USING RESEARCH FOR PLANNING IMPROVED INTERVENTIONS

NIA's search for a more effective way to organize irrigation associations started with a series of research reports on Philippine indigenous irrigation systems that caught the attention of NIA top management. The research showed the following:

1. The irrigation systems were constructed by farmers with very little help (and often, none at all) from the government. The systems were small-scale, with earthen canals, and temporary diversion weirs of logs, rocks, and brush.

2. The systems were operated and maintained by the farmers. They had rules for allocating and distributing water, maintaining canals and repairing the temporary weir, penalizing violators, and settling conflicts.

3. The associations were strong. Leadership was dedicated and knowledgeable about their irrigation systems. Each member knew his obligations, did the work expected of him under the rules of the association, and was penalized for failure to do so.

4. In contrast with the irrigation systems constructed solely by the government, the farmers who constructed their own irrigation systems continued to maintain the systems.

Nevertheless, it was evident to the NIA that farmers' resources alone were insufficient to build communal irrigation systems with permanent facilities and it would be necessary for the government to intervene to assist in construction or improvement. On the other hand, drawing from the research, it was equally necessary to emphasize farmer ownership of the system and maximize farmer participation in the planning and construction, in anticipation of the problems of O&M of the improved irrigation system. The problem,

however, was that while a policy was already established on farmer ownership of communal irrigation systems, there was no process within the NIA for maximizing farmers' participation in the planning and construction of irrigation systems. The process had to be developed through action research.

USING ACTION RESEARCH FOR IMPROVING INTERVENTIONS

NIA top management wanted answers to the following questions: 1) How can farmer participation be maximized in planning, constructing, and managing an irrigation system? And, 2) does farmer participation result in more viable irrigation associations with greater capability for system O&M? If so, how can the processes be developed for broad application throughout the NIA?

To find the answers, NIA decided to use two pilot communal irrigation improvement projects with conditions and resources that could be foreseeably sustained as "learning laboratories" for developing an appropriate participatory approach for involving farmer beneficiaries. The pilot projects were in Laur, Nueva Ecija. Six community organizers (COs) trained in the social sciences and experienced in working with rural and urban poor were hired under an experienced coordinator. The COs were carefully selected on the basis of their ability to communicate and long term commitment to organizing farmers through maximized farmer participation. The COs lived in the villages, interacted with the farming communities, and mobilized the farmers to participate in planning and construction. An interdisciplinary committee was established with membership from NIA, Institute of Philippine Culture (IPC), Asian Institute of Management (AIM), Ford Foundation, International Rice Research Institute (IRRI), and the University of the Philippines at Los Banos (UPLB). The committee, known as the Communal Irrigation Committee (CIC) had expertise in irrigation engineering, agriculture, institutional management, sociology, anthropology, economics, and training. Flexible funding assistance was made available by a grant from the Ford Foundation.

The COs stayed with the projects for about 3 years, at least 10 months of which were spent interacting with the communities, and organizing the irrigation associations and guiding their activities prior to construction. The objective was to develop grass-roots capability for: 1) decision making within an association, 2) planning improvements and expansion of the irrigation system, 3) securing water rights and right-of-way for new canals, 4) constructing irrigation facilities, and 5) controlling construction costs.

Committees were organized by the farmers, with guidance from the COs, for surveys, right-of-way acquisition, revision of by-laws, registration with the SEC, labor mobilization, materials checking, water permit, and repayment of construction costs. With assistance from the COs and NIA technical staff these committees successfully undertook the tasks they were organized for. Before construction, farmers prepared a map of the proposed service area and indicated where they would like the canals to pass. They subdivided the area into sectors and conducted sectoral meetings for revising and ratifying their by-laws. During construction, the sectors mobilized labor, much of which was volunteered as the

contribution of the association. Various committees checked the use of construction equipment, the consumption of fuel, the quality and quantity of construction materials, and the procurement costs of the materials. Farmer committees assisted in locating canals and negotiated for canal and road right-of-way.

The two pilot projects were established as learning laboratories to develop a process of maximizing farmers' participation. The smaller project, which was about 600 ha, proceeded smoothly. The larger one, which was over 1,000 ha but treated as a communal project, had slower progress due to internal conflicts which frustrated grass-roots participation for over a year. Both provided lessons to NIA, and the CIC arranged to document the activities. A documenter regularly visited the projects, and stayed for several days during each visit interviewing organizers, engineers, farmers, and leaders of the associations on the processes and procedures that were being followed, the problems that were being faced, and the solutions that were developed. Every month the documenter submitted a report which was discussed by the CIC for lessons to be learned, implications on future activities, and improvements on the procedures being employed with a view to using them in future projects. The documentation was studied to identify training needs of COs, engineers, technical staff, and the irrigation association leaders and members. Among the lessons learned were:

1. Enough lead time should be given the COs for organizing farmers prior to construction. In the 600-ha pilot project this required 10 months.

2. Engineers and other technical staff should be trained to develop flexibility in their attitude towards farmers and to gain a basic understanding of the processes being used by the COs.

3. Engineers and COs should work together closely and integrate the technical and organizing activities into one process.

4. Agency policies and procedures that inhibit farmers' participation should be revised.

5. Farmers participate extensively in planning and construction when given opportunities to participate in activities they find beneficial.

6. Farmers' participation when properly harnessed has potential for improving planning of the system and reducing costs of construction to the government.

The action research in the Laur pilot projects succeeded in developing the basic processes for inducing farmers' participation in planning and constructing NIA communal irrigation projects, but the CIC did not regard it as conclusive. Furthermore, it noted some weaknesses that had to be improved before replication on a larger scale.

In April 1979, NIA started two more pilot projects in the province of Camarines Sur where the general conditions and characteristics of the farmers were different from those

in Nueva Ecija. To avoid the problems experienced in the bigger Laur pilot system, a project selection process was introduced wherein technical and institutional information on several proposed projects was analyzed and discussed in a workshop attended by engineers, community organizers, and members of the CIC. Two projects were selected, one with about 400 ha and another with 200 ha. The project selection process was subsequently developed further and adopted as standard procedure in the communal irrigation program. Improvements made on the process during the implementation of the Camarines Sur pilot projects were:

1. To integrate technical and institutional activities, a flow chart was developed synchronizing the various elements of both over 8-9 months of organizing activities and technical preparation prior to construction.

2. Problem areas that needed improvement to promote farmers' participation were identified. Among these were procurement and contracting procedures, preparation of paddy elevation maps, and funding procedures that would enable better preparatory technical and institutional work.

3. A manual on financial management for the associations was developed in consultation with the farmers. A water management manual for the associations was likewise developed.

By the end of 1979 enough experience had been generated in the Camarines Sur pilot projects to expand the action research to the 12 regions of the country. The regional irrigation directors of the NIA were gathered in a conference initiated by the CIC. The program for establishing regional pilot projects based on maximum farmers' participation was discussed and agreed upon, and a pilot project for each region was launched. These projects were used as NIA learning laboratories for developing understanding and capability for promoting farmers' participation and were based on processes developed in the pilot projects in Nueva Ecija and Camarines Sur. The following year two more pilot projects were started in each region in provinces other than those of the first regional pilot project.

In mid-1981 a World Bank team appraised a proposed project for assistance to the Philippine Government on the development of communal irrigation systems. The team reviewed and evaluated the effectiveness of the farmers' participation program and recommended its adoption in all the communal irrigation projects to be funded with World Bank assistance. Since 1982 the participatory approach has been standard procedure in all communal irrigation projects of the NIA.

Action research for improving government intervention was also extended to the national irrigation systems, where for many years NIA had been organizing farmers with little success for operating and maintaining farm level facilities. Again, as in the communal systems, research studies were used in identifying solutions to be developed through action research. Research reports from various sources suggested that irrigation associations at the tertiary level in national systems could not become viable for lack of

motivation and incentive. An action research program was therefore designed to find a process that would generate sufficient motivation and incentive. In the implementation of the program the participatory approach developed in the communal systems was applied with modifications.

Community organizers were fielded in December 1980 in the Buhi-Lalo Irrigation Project in Camarines Sur, which was to be improved and expanded from 1,000 ha to 3,000 ha. The COs lived in the villages of the farming communities. For one month they interacted with the farmers and then began ground work on mobilization. In the existing portion of the system to be improved, farmers reviewed the proposed layout of terminal facilities, walked through the farm ditch locations with engineers, discussed changes in canal locations, and undertook construction of canals that were suitable for manual labor. The service area to be improved was divided into 12 zones, each zone was subdivided into small groups of farmers by turnout service area, and each small group constituted a construction unit with a group leader. Depending on their capabilities, these units were awarded construction contracts for canals and small structures by NIA. Thus the farmers worked together, developed cooperative and decision making skills, and identified capable leaders. As construction ended, the COs motivated the small groups to organize into associations by zones in order to negotiate with NIA the manner of sharing O&M responsibilities in the system and the consequent sharing of the proceeds of irrigation fee collections between NIA and the associations.

In July 1982, when the improvements in the existing systems were nearing completion, three zone associations covering over 1,000 ha negotiated with and entered into an agreement with NIA for O&M in their respective zones and collecting irrigation fees from the farmers. Pending completion of the expansion area of 2,000 ha where farmers were also being organized, NIA maintained and operated the diversion weir and the first 1.5 kilometers (km) of the main canal. A system of sharing the irrigation fee collections between NIA and the associations was agreed upon which proved to be beneficial to both. As in the communal systems, the processes in the Buhi-Lalo action research were documented and used for improving the processes for replication in other national systems.

The success of the Buhi-Lalo processes was of great significance to NIA. Theretofore NIA staff had been organizing and exhorting farmers in national systems to undertake O&M of farm level facilities with negligible results. In the Buhi-Lalo, however, it was the farmers who proposed to NIA that they take over O&M responsibilities on three zones covering over 1,000 ha. This led to a decision in NIA to replicate the processes in some national irrigation systems which were under rehabilitation and improvement under a World Bank loan and in the pump irrigation systems which were eventually turned over by NIA to farmer irrigation associations. As of the middle of 1986, the program covered about 35,000 ha in 37 national irrigation systems. Nine of these systems have been fully turned over to farmers' irrigation associations. The rest are jointly operated by NIA and the farmers' associations with NIA undertaking the O&M of the diversion weir and part of the main canal, and the irrigation associations taking care of the rest of the system. Observations on the results of these arrangements were:

1. In terms of O&M the systems have become financially viable. Collections of irrigation fees have increased and the share of NIA now exceeds its expenses on O&M. The irrigation associations likewise have been able to accumulate funds from their share of the collections.

2. Canal maintenance greatly improved and the area irrigated increased.

3. Farm ditches constructed were not tampered with by farmers in contrast with previous projects (without farmers' participation) where farmers complained about farm ditch locations and eventually moved the ditches.

4. Relations between NIA and the farmers improved.

Soon after the participatory approach to organizing irrigation associations was developed in the first set of pilot projects, NIA began to look for appropriate ways to train irrigation associations in financial and irrigation systems management. Again research on indigenous systems was found helpful when designing the structure and contents of the training programs. The methods of recording used by indigenous systems, for example, were helpful for framing a simplified process of bookkeeping. Rather than give them ready-made plans, a training approach was adopted that allowed the associations to develop their own management plans. Areas where the associations developed their own plans included: 1) cropping calendar; 2) normal and crisis water distribution plans; 3) conflict management plan; 4) maintenance plan; 5) farm level facilities plan; and 6) duties and responsibilities of members, officers, and system personnel.

LESSONS FROM ACTION RESEARCH ON FARMERS' PARTICIPATION

Action research is still going on in the NIA. From time to time members of the CIC assist as needed, although not as intensively as during the first five years of the program, as NIA staff have gained much capability. Many more lessons from action research will be learnt, and much has already been learned -- for instance:

1. Farmers' participation in planning and construction or improvement of their irrigation system strengthens their irrigation association and increases the potential for successful O&M.

2. An effective way of organizing farmers for participation is through a catalyst (such as a community organizer) with a high degree of commitment who should live in the farming community, and furnish guidance and assistance, but leave the decision making to the farmers themselves.

3. For developing a participatory approach, irrigation agency policy should fully support farmers' participation. Any policy that tends to inhibit such participation should be discarded or amended. Strong support should be given from the highest level of the agency.

4. The irrigation agency should have the capability to respond positively to farmers' participation. Agency personnel should be properly trained to develop this capability.

5. In implementing projects with farmers' participation, engineers, technical staff, and community organizers should work together closely with a jointly prepared integrated work plan. Thus it is advisable that the organizers are also from the irrigation agency undertaking the project.

6. Lead time should be allowed for organizing work before construction. Depending on whether the project is rehabilitation or new construction, the lead time for organizing work is about 6-9 months.

Among the reasons for the success of action research in support of the farmers' participation program in the NIA are:

1. There were appropriate NIA policies and leadership.

2. The interdisciplinary committee was composed of researchers and specialists from various institutions and key NIA officials worked together for developing and improving the program.

3. The areas of action research were live problems meaningful to NIA.

4. Participants in the action research were strongly committed on a long-term basis to the program.

5. The action research used a learning process approach.

PROBLEMS AND STRATEGIES IN MANAGEMENT OF COMMUNAL IRRIGATION SYSTEMS: THE EXPERIENCE IN JOINT DECISION-MAKING BY FARMERS AND AGENCIES

Uraivan Tan-Kim-Yong*

INTRODUCTION

Several thousand communal irrigation systems co-exist with large-scale government-managed irrigation systems in northern Thailand. Due to a growing concern over the capabilities of local people to perform irrigation development, management-intensive strategies and the integration of farmers into the process of irrigation development have become the policy of the Thai government in the last few years. However, because many of those committed to a large bureaucracy with highly trained personnel do not believe that the interests of farmers and farmers' organizations should take precedence in development activities, the attempt to encourage farmers' participation has dwindled in practice, and projects which attempt to integrate farmers meet with minimal success. Although northern Thailand is widely known for its active communal irrigation organizations (CIO), there is no specific policy to link these existing groups formally into the government development schemes.

Research that describes farmer-managed irrigation systems is available. That knowledge, however, has had little impact on current irrigation projects in Thailand. There is a need to sensitize government to the potential of this research and encourage cooperation among all parties if rational change is to occur in irrigation management. Difficulties in transferring knowledge into practice lie primarily in a lack of effective communication among agency staff (policy makers and developers), researchers, and farmers.

This paper has three objectives. First, to describe CIOs in northern Thailand. Second, to present the problem-solving method used in meetings between agency staff, researchers, and farmers to identify problems and strategies. Third, to show how this method can help the government to involve and sustain farmer participation in irrigation management.

COMMUNAL IRRIGATION SYSTEMS IN THAILAND

To most researchers, and some planners, the presence of a CIO is a precondition for good management. Many researchers (Moerman 1968, Calavan 1974, Potter 1975, Ishii 1978, Surarek et al. 1980, Tanabe 1981, Sirivongs 1982, and Tan-Kim-Yong 1983) have described the structural arrangement and management of CIO's in northern Thailand.

*Assistant Professor, Faculty of Social Sciences, Chiang Mai University, Thailand.

Over time, some CIOs have successfully incorporated changes and retained effective management, while others have not. The parameters involved in communal irrigation systems in northern Thailand are defined below.

System Description

Communal irrigation systems are diversion dams with canal networks primarily supporting rice farming, and vary greatly. The systems can be found in both highlands and lowlands ranging in area from less than 2 hectares (ha) to more than 2,400 ha. Farmers from one or many villages may cultivate irrigated land in a single system. The system is constructed, operated, and maintained collectively by farmer members. Because temporary structures are involved, one or two cycles of major maintenance are required every year. Although this appears a heavy investment, the system structure depends mostly on local labor, local materials, and simple techniques.

Organization

A CIO is an organization of farmers that shares as a single community the water provided by an irrigation system and manages its own investments and services. Within the organization an individual's water rights are guaranteed through customary laws. As a result, all farmers identify the irrigation system as their own, and this sense of ownership is important in promoting farmers' participation.

Administrative functions and membership. Farmers control the management of the scheme. A group of elected leaders takes responsibility for operation, maintenance, and managerial work such as planning, financing, and accounting. Members are able to take turns in leadership roles. Where the system draws direct payment from members for administrative services, performance is good and organizational power is maintained.[1]

Managing activities. Managing and coordinating communal task forces for routine, emergency, and special projects are complex tasks involving the mobilization of groups of farmers. Communal task forces are generally organized at system and canal management levels and coordinated to fit the cultivation schedule of farmers. Regularizing such activities and involving farmers in group tasks reinforce the sense of collective ownership and group cohesiveness.

Planning and decision making. Participatory decision making is an integral element of communal irrigation systems. The democratic election of leaders plays a vital role in promoting members' commitment. Decisions regarding such problems as disputes and conflicts over water allocations during peak times are based entirely on mutual agreement among members within the CIO. Long-term rehabilitation plans are made when necessary.

Communication. Good management of CIOs requires effective communication between leaders and members, and among members. Seasonal meetings, home visits, and messenger announcements keep members informed of on going activities and future projects.

Finance. In most cases, CIOs manage water fee and fine collections, direct cost sharing, and other fund raising activities. Water fees help pay for administrative services while fines help cover routine maintenance costs. Because traditional irrigation systems primarily serve rice farming, a fixed rate per unit of cultivated land is commonly used. In areas of diversified cropping and where crops are grown intensively, the same water rate is used but farmers who grow rice pay in-kind and those who grow cash crops pay in cash. Additional funds for maintenance and rehabilitation are contributed by farmers.[2]

Legal action. CIO members exercise the authority of customary law when their leaders perform poorly in their jobs. When a leader fails in his duties, he has to pay a fine or face termination of office. Similarly, members are judged under customary law and fined for such offences as theft.

Payment to a leader. CIO leaders are not paid at fixed rates but at variable rates according to performance. Usually, each member pays directly to the leaders. If a farmer/member is dissatisfied with a leader's performance -- perhaps his cultivation fails because of a wrong decision on water delivery -- he may withhold his payment.

Skills and Knowledge in Management

Although farmers' acquired skills and traditional knowledge appear to be effective for operating simple irrigation systems, improved irrigation technology and new cropping techniques may require specialization that automatically eliminates the participation of most farmers.

IRRIGATION DEVELOPMENT AND CIOs

At present, irrigation development in northern Thailand is applied to management problems in: 1) large-scale irrigation systems; 2) small-scale, traditional irrigation systems; 3) system rehabilitations; and 4) upstream reservoirs.

Large-scale Irrigation Systems

Large-scale irrigation systems, which include the complete canal system and all major and minor services, are the government's responsibility. Activities, including design, implementation, distribution, and maintenance, are allocated to the national and regional offices of the Royal Irrigation Department (RID). Frequently the command area of a large-scale system includes irrigated land operated by several CIOs, and integration into such government-controlled systems often brings dramatic changes to irrigation groups accustomed to traditional operating methods. Unfortunately, in practice, the government irrigation administration often works without satisfactory participation from local farmers despite many new irrigation groups being formed to control water and share maintenance duties. Integrating farmers and supporting local irrigation groups is a critical management objective that the government should address.

Small-scale, Traditional Irrigation Systems

Development of small-scale traditional irrigation systems is carried out independently by local communities, and presently there are a large number of such systems operating. Identifying methods that develop local capabilities fully and encourage cooperation among farmers should be a serious concern of the government. Policy makers should ask how, when, and to what extent the government should intervene in traditional systems to promote these objectives.

In addition to small-scale systems constructed by local communities, the government has recently constructed several hundred small-scale irrigation systems that are presently operating in the north. The local communities are being encouraged to take responsibility for irrigation system operation and maintenance (O&M) after construction. Organizing beneficiaries into groups is an important step in achieving effective O&M. However, because concentrating a large number of new small-scale irrigation systems along a particular river or tributary increases population density, new problems involving inter-system relationships, water-user rights, and O&M responsibilities must be addressed.

System Rehabilitation

The government's rehabilitation of traditional communal irrigation systems aims to improve irrigation efficiency and management performance by changing designs or adding new structures to existing systems. In such cases, the existing communal groups continue their responsibilities for O&M. However, this can involve an adjustment or reorientation of activities within the communal groups and the government should be aware of this possibility.

Upstream Reservoirs

The last type of irrigation development consists of constructing upstream[3] reservoirs without major changes in downstream system design. After completion, a small RID crew manages the reservoir while the CIOs manage the canal systems, thus keeping the government's intervention to a minimum. These rehabilitations aim to sustain wet-season irrigation capacities and to increase dry-season capacities.

THE MEETINGS

Strategies and methods that address irrigation management problems and serve different irrigation requirements need commitment and concerted action from three parties -- agency staff, researchers, and farmers. To meet these requirements, a series of meetings was held in Chiang Mai, northern Thailand.

The meetings provided an opportunity for the three parties to exchange experience and knowledge, and to integrate their ideas on "participatory action planning." One objective was to produce an action plan for developing small-scale irrigation in the communal

irrigation systems and government rehabilitation schemes in Chiang Mai and other areas of northern Thailand.

The first meeting was held in September 1985. There were several on-site workshops sessions where researchers worked with communal irrigation groups to investigate irrigation problems and strategies for solving those problems. An action plan for development activities and research gradually evolved from these sessions. Researchers and agency staff also went on field trips together. A final meeting, scheduled for April 1987 in Chiang Mai, will discuss and plan a research and development pilot project.

Objectives

The 1985 meetings had four major objectives:

1) To encourage interaction among participants to find alternative solutions to irrigation management problems in northern Thailand.

2) To suggest strategies and methodologies for improving irrigation management and applying relevant research to CIO activities.

3) To generate locally-relevant policy guidelines for government assistance programs and for cooperation with CIOs.

4) To develop closer collaboration between national and regional government irrigation agencies and university researchers.

Methods and Procedures

Preliminary consulting meeting. This was a brainstorming session among RID authorities, researchers from Chiang Mai University, developers from local non-governmental organizations (NGOs), regional committees of small-scale irrigation projects, and leaders and members of the *muang fai*[4] CIOs (see Appendix 1). The meeting encouraged participants to define current problems and future needs of irrigation development. It emphasized the active participation of farmers or CIOs from five traditional irrigation systems of Chiang Mai. The participants identified possible means of integrating local capabilities into the irrigation development process and the need for research in this area.

Project design activities. Following the preliminary meeting, participants worked to design an activity plan for research, training, study tours, and researchers' consultancy services. In doing so, agency staff and farmers interacted and gradually gained confidence and commitment, while researchers facilitated and studied the process. Additionally, the field workshop sessions proved an efficient tool to improve problem-solving capabilities and to sensitize RID officials and researchers to local needs. This process strengthened linkages between the government and the CIOs, and built confidence in CIOs and their continuing involvement in management.

Workshop. The final stage was a workshop to discuss the draft of the proposed activity plan. The participants focused on launching a joint pilot project between Chiang Mai University and RID. Unfortunately, the pilot project was postponed due to changes in the government and RID management. Also, the pilot project has yet to be submitted to a donor agency. Post-meeting activities will encourage informal discussions to provide CIOs with access to available information as soon as possible, including contact with RID and the Provincial Committee on Small-scale Irrigation (PCSSI).

AN OBSERVATION ON ACTUAL INTERACTION AMONG THE THREE PARTIES

The farmers from CIOs initially expressed more interest in meeting RID authorities than vice versa. However, as the discussions progressed, this attitude changed. The interaction between farmers and RID authorities was more active during the first session. Farmers who had more experience in interacting with government authorities led discussions. However, in the second session interaction between the more- and less-experienced farmers increased: communication among those who shared similar interests and experience proved effective as a learning process.

RID authorities who were trained in engineering and confident in technical design raised questions about inappropriate irrigation management by local groups, while farmers who had confidence in the management-intensive systems of CIOs raised questions about technical errors. Thus there was a failure to understand the potentials and limitations of the other party, and the need for continuing interaction between farmers and RID officials was confirmed.

Some CIO leaders expressed misgivings about the government's development scheme. Less-experienced leaders tended to accept the need for development but requested more government assistance to construct technically advanced weirs similar to those of their neighbors. However, such government interventions require the involvement of CIOs if they are to succeed. The researchers maintained a low profile at the meetings and performed best as facilitators of the dicussions.

GOVERNMENT'S STRATEGIES IN FIVE IRRIGATION DEVELOPMENT PROJECTS

Mae Taeng Project

Begun as early as 1955, the Mae Taeng Project was designed to boost multiple cropping in the Chiang Mai-Lampun Valley; construction was completed in 1973. The project has a large-scale diversion dam with a 75 kilometer (km) main canal, 23 secondary canals, and 38 tertiary canals, all with concrete lining. The total area irrigated is 24,000 ha. Almost 100 villages and several hundred communal irrigation systems lie within the command area. The project services the full command area during the wet season but about 40 percent in the dry season. The RID staff and project engineer administer the system down to the secondary canal level, and leave the tertiary and farm-level canals to the farmers.

Following project completion, government intervened to restructure some of the traditional irrigation groups. Because the farmers were not asked to participate in this process, the restructuring became a threat to both the existing leadership and the members. Despite conflicts among farmers and other problems, some success has been reported. In the new groups, leaders are elected and earn their income from water-users as in traditional systems. They are responsible for adjusting water supply to satisfy demand among the members of their group, and for mobilizing labor for maintenance.

Khun Kong Project

Khun Kong is one of 11 traditional irrigation systems on the Mae Wang River. The project covers about 1,280 ha and more than 10 villages. Evidence indicates several decades of irrigation development through communal effort with external assistance. Therefore, traditional weirs and canals have been rehabilitated over time. In recent decades, this area has become a highly intensive cropping region, with triple- and double-cropping commonly practiced. Increased cropping intensity results in a need for improved irrigation performance to achieve timely and equitable water distribution.

Government strategy has involved replacing traditional weirs with concrete weirs in several development schemes constructed by different government agencies. Complex inter-system management problems have caused tension and conflict among both upstream and downstream water-users during the dry season. Such situations demonstrate that complex problems are sometimes created by too many projects, too many agencies, and probably too much government intervention. To solve these problems, the government must focus on a management-intensive policy to strengthen CIOs and link them effectively with related agencies. In the Khun Kong Project, the management at all levels has been left to the CIOs.

Muang Mai Project

This project is one of four traditional irrigation schemes along the Mae Klang River. The Muang Mai Project covers 1,600 ha of cultivated land, with more than 10 villages. All weirs have been replaced by concrete weirs. Though expansion of irrigated land and cropping intensity have increased rapidly, Muang Mai's CIO has effectively performed the irrigation activities to sustain production. Leadership is good, and resources are efficiently mobilized for routine tasks and new development projects. So far, the system has a low record of disputes and conflict, and the CIO has been able to manage those that did occur.

Local farmers requested government assistance to construct the concrete weirs because of a shortage of local construction materials. After the weir was built, the CIO continued in full control at all levels. But problems of recurring silt required increasing maintenance. Whether this was a result of poor weir design or of inefficient O&M needs careful study. If evidence of poor O&M is found, it may be due to the farmers' inexperience with new irrigation technology.

Nong Plaman Project

This project is a small-scale traditional irrigation system covering 176 ha, and a single village. Weir construction was an initiative of local farmers and approved through the Sub-district Council under the national Job Creation Program[6]. Small-scale irrigation of all types is a priority of the program and, each year, several hundred weirs are constructed in villages. After construction, full control at all levels is left to the existing CIOs or the newly established water-users groups. Again, CIOs should be involved directly in planning and decision making of small-scale irrigation development.

Mae On Project

Mae On is a mini-basin RID reservoir construction project to solve the problem of water deficiency in existing communal irrigation systems. The project, when completed, will increase the dry season irrigation capacity of more than 10 small-scale systems on the Mae On River. The reservoir is designed to store water and divert it back to the natural river. In this way the project mainly provides more reliable and continuous water supply for the existing systems which will continue to be under CIO management.

Mae On is the most recent RID irrigation project in the north and direct intervention is minimized. However, when completed, there must be cooperation between RID staff who manage the reservoir and the CIOs along the river. This will be a new experience for CIOs. A CIO-RID linkage has to be developed in the early stages of the project. However, some difficulties are expected in coordinating three different RID teams -- survey and design, construction, and O&M -- and this may weaken the CIO-RID linkage without support from the RID extension service to promote post-project activities.

A SET OF PROBLEMS

The preliminary meeting pointed out the following management problems in the five different cases of irrigation development:

1. Construction is emphasized and management performance is given low priority.

2. Interaction between agencies and CIOs is not encouraged.

3. RID and implementing agency personnel have not yet recognized the local irrigation management capabilities of active CIOs.

4. The irrigation project staff generally encourages farmers' involvement only at the O&M stage and not during the planning and design stages.

5. There is insufficient government staff to help CIOs to solve recurring irrigation management problems.

6. Engineers believe many irrigation schemes involve only simple technology, but farmers find almost all new schemes to be technologically sophisticated.

7. Management becomes more complex as cropping intensity and diversification increase. In many cases such complexity is beyond the capabilities of CIOs.

8. Conflict and corruption among the water authorities and CIO leaders, and complex operations, may result from increasing the numbers of new members -- and especially if they are big land owners and upstream orchard operators.

9. Economic resources of farmers are overemphasized; farmers' knowledge and skill tend to be ignored. CIOs should be encouraged to improve opportunities for exchanging knowledge.

10. Assistance to weak and uncompetitive CIOs should aim to strengthen management capability and appropriate organizational arrangements.

11. Some inexperienced CIOs are unable to cope with the problems of inter-system cooperation to manage irrigation. In some cases, larger associations might attract more experienced farmers and manage water distribution better.

12. Many attempts to promote farmers' participation have been superficial. There is no formal channel for CIOs to communicate their problems and needs to agencies. Agencies do not understand CIOs and lack interest in them.

THE NEED FOR RESEARCH AND DEVELOPMENT

Research

1) *Irrigation development and its effects on the local irrigation community.* Research is needed to investigate the social, cultural, and ecological influences of large- and small-scale irrigation construction.

2) *Relationships among cropping intensity and diversification, irrigation management requirements, and irrigation performance.* The research should be carried out on farmers' fields in areas of highly intensive and diverse cropping. Operations under various actual management and decision making conditions should be studied.

3) *Identifying the factors that cause management deficiencies and successes among CIOs.* Knowing these factors will facilitate training of RID and CIO personnel, and strengthen irrigation performance.

4) *Irrigation bureaucracies and legal action.* The influence of these on organizational linkages between RID and CIOs needs to be better understood. Frequently, new irrigation projects introduce modern technology without consideration for traditional mechanisms. Departmentalization in the Thai administrative structure can retard this understanding.

5) *Government intervention strategies*. What should be the government's intervention strategy? When and to what extent should the government intervene in CIO activities?

6) *Other research*. Exploratory studies are needed on irrigation management schemes and management problems, and performance evaluations of pre-project and post-project activities. RID and CIO staff should take part in such studies together.

Training and Consultancies

Training activities and consultancy services should be emphasized to strengthen CIO and RID strategies. Farmer-to-farmer training is economically feasible and socially desirable. Also, mobile teams of professionals and consultancy services play an important role by supporting the exchange of information.

Public intervention in farmer-managed irrigation systems.

a) The government should minimize intervention in communal irrigation development and provide assistance through policies that are responsive to farmers' needs. This will provide an environment in which CIOs are able to work.

b) The government should attempt to involve CIOs directly in decision making regarding irrigation tasks through all stages of rehabilitation. Communication and feedback linkages between RID and the CIOs must be established. There is a need to have mobile teams of RID to organize and regularly schedule field workshops with CIOs.

c) RID should train CIO members so they will be familiar with the new technology for irrigation development.

d) An emphasis on a management-intensive system and a participatory irrigation development requires a new orientation and training for RID personnel. RID personnel should be trained and given knowledge and skills to work cooperatively with CIOs.

e) RID should have complete up-to-date information about CIOs and their irrigation systems, and work with CIOs to gather data, such as making an inventory of all watersheds, to facilitate decision making.

f) To avoid duplication and excessive effort among the 16 government agencies now involved in water resource development, a master plan for water resource and watershed development should be prepared.

g) Irrigation development planning should include a social science component. Local educational institutes can provide this component and have the resources to manage relevant research, training, and monitoring of irrigation development.

h) RID should emphasize problem-solving or rehabilitation of communal systems rather than creating new construction projects.

i) The problems of watershed destruction and resulting water shortages are critical in many areas of Thailand. Irrigation development must be integrated with forestry, watershed, and land development.

Strengthening CIOs

Four tools are suggested to strengthen CIOs, as well as to create an effective linkage between RID and local groups.

Policy and plan dialogue. This method allows agency personnel to exchange ideas on problems, strategies, and plans with local communal irrigators at various stages of development. This should be a continuing process and part of the regular activities of RID personnel at local levels. The method has a two-way effect: the agency is able to communicate government policy to the people, and in return they can communicate problems and ideas to the government for adjustment of future development policies and plans. The responsibility in this task should be with the mobile team. Through this method, linkages are strengthened and real participation is achieved.

Inventory. The recording of new developments and emerging problems in the systems can best be done by the CIOs because they are on-site. A CIO could obtain data and information through an inventory. The inventory has several advantages: a) it provides low-cost, efficient, up-to-date data; b) the method provides a continuous process of two-way communication; c) it will make farmers feel more confident and involved in the development process; d) it will integrate farmers' problems and ideas into the planning process; and e) it promotes a participatory attitude and strengthens the relationship between farmers and agencies. The inventory form, designed by university researchers before the project starts, must be simple and workable. Training CIO and agency staff to use the form correctly is necessary. Recording the inventory could be designed as a routine activity and the results could be kept at the CIO offices. Feedback to RID could be made when the mobile team visits the CIOs as part of the policy dialogue described above.

Community/leader network. The plan for irrigation development should motivate links among the CIOs. An attempt should be made to encourage meetings and visits to share ideas and promote self-help capabilities. Inter-CIO assistance should occur in two ways: first, the more-experienced CIOs can provide consultations to help the less-experienced CIOs solve specific urgent problems; second, the more-experienced CIOs can transfer their knowledge about problem-solving on modern technology, and management practices to the less-experienced groups in a regular program of assistance.

Federation of CIOs. It is evident that problems in irrigation are getting more complex as agricultural intensity increases and diversification is encouraged. Furthermore, increased population, more diverse agricultural activities, and natural resource scarcity and related

problems mean greater complexities in irrigation planning and problem-solving. Greater cooperation is needed among farmers, as well as between farmers and agencies.

CONCLUSION

The action plan described in this paper has been discussed with farmers and agencies (RID and many NGOs). It will be presented at the meeting in April 1987 to be discussed and developed further. Preparations for the final workshop are underway. After the meeting, the plan will be submitted to donor agencies which will be asked to consider funding the pilot project.

NOTES

[1]However, communal irrigation schemes may eventually turn into a mixed control system of farmers and agencies when government intervenes. In contrast to CIOs, government agencies control major structures at system and canal levels and leave control at the tertiary level to farmers in all large-scale and some medium-scale irrigation systems. Medium-scale systems projects are those with costs of over 4 million baht (US$152,497), and construction time of more than one year. (The exchange rate in 1987 was US$1.00 = 26.23 baht).

[2]Because most farmer-managed irrigation schemes are management- and labor-intensive, they are appropriate for low cash-generating communities of rural farmers. Undoubtedly, where capital-intensive systems are introduced, water users have no incentive to participate and lack the ability to finance the system even partially.

[3]That is, upstream of small river basins to store and divert water back to the natural rivers which feed the existing irrigation systems.

[4]See Coward and Levine's paper in this volume for a discussion of the muang fai of northern Thailand.

[5]This was because the forest land surrounding the irrigated region was declared a national park.

[6]There are more than five government agencies involved with small-scale irrigation projects under the Job Creation Program. RID is responsible for roughly 30 percent. Besides this agency, private agencies, including NGOs and private contractors, are involved.

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APPENDIX 1. Communal irrigation system and government's rehabilitation scheme, Chiang Mai.

Communal irrigation system	Irrigated area (ha)	Government rehabilitation scheme*
Mae Klang River		
Huey Kang Bok Fai	400	
Fai Muang Mai	1600	RID[a] (1982)
Fai Muang Luang	1440	Sub-district Council[b]
Fai Mokala	320	RID
Mae Rim River		
Fai Mae Rim	n/a	
Fai Chao Pu	576	
Fai Huey Sai	424	
Fai Nong Plaman	176	RID (1985)
Fai Sai Moon	219	
Mae Wang River		
Fai Non	40	RID (1986)
Fai Nong Yen	2880	
Fai Huey Pueng	240	
Fai Khun Kong	1280	ARD[c] (1983)
Fai Na Sai	304	ARD
Fai Ta Kam Pa	576	
Fai Ta Sa	80	RID (1982)
Fai Don Pin	96	
Fai Sri Boon Rueng	136	RID (1982)
Fai Kam Pilo	80	
Fai Pu Loh	80	RID (1983)
Mae On River		
Pha Lad	60	
Pang Ma Takien	120	RID, (1980)

Appendix 1 (cont.)

Communal irrigation system	Irrigated area (ha)	Government rehabilitation scheme*
Pana Sak	42	
Mae Na Guen	72	
Hua Ta-ad	88	
Pha Plu	88	
Ko Kok	32	RID, (1979)
Fai Luang	92	ARD
Huey Sai	96	
Mae Len	112	
Ku Bia	400	RID, (1980)
Muang Ho	544	
Muang Pao	640	RID, (1980)
San Ko-ong	400	
Sai Mun	480	
Muang Luek	480	
Muang Pao	480	
Muang Mai	815	
Pa Pao	11	
Buak Kang	106	
Kao Lung	6	
Len Long Halao	3	
Sri Suk	3	
Phaya Kam	13	
Pha Tan	32	
Pha Kaem	48	
Nai Nuan	5	
Yai Pai	192	
Ton Bong	64	RID, (1983)

*All projects listed involved the construction of concrete weirs; n/a = not available; [a]Royal Irrigation Department; [b]*Sapha tambon*; [c]Office of Accelerated Rural Development.

MAKING RESEARCH RELEVANT TO ACTION: A SOCIAL LEARNING PERSPECTIVE

Frances F. Korten*

INTRODUCTION

Development programs of today are reaching an ever wider spectrum of people in ever more varied ways. As program implementors struggle to understand how to shape programs that will actually be helpful to diverse and dispersed peoples, they are increasingly turning to researchers for help. And researchers, eager to contribute to the development process, are increasingly aiming their research efforts at improving action programs.

One of the most common approaches to applying research to action is to evaluate the impact of an action program; that is, assessing what happened in the field against some set of objectives. After assessing production gains, interviewing beneficiaries, and examining structures built under a project, researchers write up their findings and often make recommendations. These are forwarded to people responsible for the action program through a report, a seminar, or both, in the hope that the research will contribute to improve programs.

But often researchers and implementors alike come away from this process with an uncomfortable feeling that somehow it does not really help. In many cases nothing much changes as a result of the research. One commonly hears complaints from researchers, such as: "No one in the implementing agencies listens to us," or "Our reports just go on the shelf," or "The government is too sensitive to criticism." The implementors complain, "Academics are too theoretical," and "The researchers just criticize without giving constructive suggestions," and "The recommendations aren't realistic; they don't take into account our constraints."

What is the problem here? Why do we so often find researchers and implementors talking past each other? In understanding this impasse, we need to distinguish between two types of policy arenas and two types of planning traditions which shape the very nature of a research process. By using these distinctions, we can match the appropriate set of assumptions and methods to the appropriate policy arena, and thus increase the likelihood that the research conducted will be relevant to the action intended.

MACROPOLICY AND MICROPOLICY

Applied researchers in the development field generally expect their research to be relevant to policy change. But *policy* refers to a great range of possible changes. Korten (1986) has noted that it is useful to divide these into two basic arenas: the macropolicy

*Program Officer, Ford Foundation, Jakarta.

and the micropolicy arenas. The macropolicy arena covers problems calling for a single decision which can be accomplished with a "stroke of the pen" by the appropriate political or administrative authority. These decisions are ones for which major questions of implementation do not exist, either because implementation is not inherently important to the decisions or because methods of implementation are already well known. *Do* or *don't* questions and *how much* questions are often of this type. Common macropolicy decisions involve matters of pricing, subsidy, and trade.

But there are many other problems which fall into the micropolicy arena. Often these focus on the *how* questions, such as how a program should be carried out at the field level and how an agency's capacity can be developed for implementing it effectively. These are issues which cannot simply be mandated by a central authority. When the reform involves a reorientation of approach -- such as from a centrally directed decision making style to one more responsive to the needs of local people -- the changes needed relate to many different organizational characteristics. Implementing personnel may need to develop new skills, attitudes, and assumptions. Evaluation, monitoring, and incentive systems may need to change. The organization's approach to supervision may need restructuring. These are in the arena of micropolicy reform.

POLICY ANALYSIS PERSPECTIVE AND SOCIAL LEARNING PERSPECTIVE

A second important distinction is made by Friedmann (forthcoming). In tracing the intellectual roots of planning theory, he distinguishes the policy analysis tradition from the social learning tradition. While both are approaches to planned change, they have different intellectual heritages and rely on different assumptions and methodologies. These traditions have strongly influenced the perspectives from which researchers view their research and their role in relation to a process of planned change.

The policy analysis tradition derives from economics and public administration.[1] The perspective is based on an assumption that there is some kind of single, powerful, and rational decision maker, who, if provided high quality information and analysis will respond with appropriate decisions which will then automatically set off a chain of events which will remedy the problem under analysis. The process by which those changes come about is not inherently of interest to the policy analysis perspective because it is assumed to be automatic although it may be hampered by a "resistant" bureaucracy (see Allison 1971).

From this perspective the researcher's task is to determine the macrorecommendations that should be provided to a powerful decision maker. To ensure that the answers provided are correct, the researcher focuses on data which can be objectively verified and which allow precise calculation. Organizational issues related to carrying out the recommendations are viewed as details which are better left to the implementors.

The social learning tradition, in contrast, finds its roots in management and social psychology. It assumes that in making change there are many decision makers important

to the change process, and whose decisions are based on many factors -- only one of which is precise, quantitative data. Other important factors include their own experience, their relationships with others, organizational norms, incentive systems, and political considerations. From the social learning perspective, planning issues cannot be separated from implementation. These two blend in interactive sequences, and are inextricably linked. The critical task becomes one of linking multiple decision makers to a continuous flow of information, and building in feedback loops so they all have an improved basis for action.[3]

From the social learning perspective, a researcher's task is to contribute to that flow of new ideas and data either directly, by gathering information that the implementors otherwise may not have, or by helping create tools that will allow them to routinely capture and analyze needed information. The data may or may not be quantitative, and are often geared to elucidate problems and options rather than support a recommendation.

MAKING RESEARCH RELEVANT TO ACTION

The above descriptions reveal the inherent match between each policy arena and each planning tradition. As illustrated in Figure 1, a match occurs when the assumption and methods of the policy analysis tradition are applied to the needs of the macropolicy arena, and when those of the social learning tradition are applied to the micropolicy arena. The impasse between researchers and implementors arises when there is a mismatch -- when we find ourselves in Cell B trying to address micropolicy needs from a policy analysis perspective or, conversely, in Cell C trying to meet macropolicy needs from a social learning perspective.

Figure 1. Matching research to policy.

		POLICY ARENA: Macro	POLICY ARENA: Micro
RESEARCH PERSPECTIVE: Policy analysis		A match	B mismatch
RESEARCH PERSPECTIVE: Social learning		C mismatch	D match

For any type of program there are both macro- and micropolicy questions. In the macro-arena there are basic *do or don't* questions regarding whether government (or others) should invest in a given activity. The main consideration here is effectiveness. For example, does potable water reduce mortality? Does irrigation raise yields? Does nonformal education increase literacy? Research deriving from the policy analysis tradition is suited to providing answers to these questions. The goal is to provide an answer to some central decision maker who is trying to determine whether or how much to invest in such a program.

But if the basic questions relate to *how* a program is carried out -- How can a community manage a potable water system to make it last? How can water be delivered reliably throughout the main canal of an irrigation system? How can adult interest in reading be sustained once a nonformal education program is over? -- then we are in the micropolicy arena and the appropriate research response comes from the social learning tradition.

Paradoxically, a macroquestion cannot be tested effectively until the microprocess has occurred. Thus, the question of whether a potable water system reduces mortality cannot be reasonably tested until there are a fair number of communities which have maintained effective potable water systems long enough for an effect to be observed. And to create a program that can achieve a sufficiently widespread and sustained effect requires careful program development, evolving through a microreform process; that is, through helping an implementing agency figure out how to do its job better.

Implementors are generally working from the micropolicy arena. They are not determining whether a program should be done or even how much is to be spent on it, but rather are shaping how things are done. They need tools, training materials, new procedures, innovative methods -- needs best met through a social learning approach.

But researchers are much more often working from the policy analysis perspective. Their backgrounds usually provide them little exposure to the social learning tradition, which has a fuller history of application in management and private industry. Consequently their attempts to improve programs focus on macrorecommendations. Implicit in their approach is the assumption that the process of implementing these recommendations is relatively automatic or at least sufficiently straightforward so that it does not need their attention. But because this is often not the case, the Cell B mismatch (Figure 1) is common, resulting in frustration for researchers and implementors alike.[4] To contribute fruitfully to the micropolicy arena, researchers need to understand the assumptions and methods of the social learning perspective.

APPLICATION TO ISSUES OF FARMER-MANAGED IRRIGATION

Our workshop is entitled "Public Intervention in Farmer-managed Irrigation Systems." To discover how to make research relevant to action in this field we must first ask what research perspective is most appropriate. Do the key issues fall in the macropolicy arena -- *do or don't* or *how much* questions requiring one-time decisions by a single decision-maker -- or are they *how* questions, involving multiple decisions over many points in time by a variety of different people?

One macropolicy issue would be: "Should the government assist farmer-managed systems or not?" If the answer is "no," then this is indeed a "stroke of the pen" decision suited to the policy analysis research perspective. But if the answer is "yes" and appropriate implementation capacity is well in place and simply needs funding, the decision remains in the macropolicy arena and the major focus of attention would be on how much funding. Or, if the answer is "yes," but the implementation capacity is not in place

methods have been institutionalized as the standard approach to all of the agency's communal irrigation work, including much of its work on larger national systems.[8] In Indonesia, efforts to use participatory methods began in 1982 and are gradually being used more widely.[9]

Researchers have played a critical role in these efforts. In working from a social learning perspective, they have found that both the types of research they carry out and the roles they play have shifted markedly from their more conventional research experiences.

TYPES OF RESEARCH IN A SOCIAL LEARNING PROCESS

In contrast to policy analysis research which is often aimed at generalized findings and macrorecommendations, research based on a social learning perspective is aimed at microreform. The research issues range from the general to the detailed, focusing on what is directly of concern to the implementing agency's program. The research is often not quantitative, although there may be situations calling for quantitative work. It is generally not oriented to providing proof of its findings but rather to exposing the details of how things are done, and with a rough sense of the consequences so that positive experiences can be replicated and negative ones avoided.

Research in the Philippines and Indonesia has focused on three different needs: 1) documenting proven practices in irrigation management, 2) developing the agency's differential response capacity (i.e., the capacity to respond differently to different situations), and 3) documenting agency intervention for micropolicy reform. The research carried out to meet these needs illustrates the types of research relevant to a social learning process.

Documenting Proven Practices in Irrigation Management

When a program is trying to determine what works, an important need is to document what has already been discovered. In a field such as farmer-managed irrigation, a natural experimentation process has been going on for centuries, carried out by the people most strongly motivated to manage water -- the farmers themselves. It is important to exploit this history of experimentation by documenting the management mechanisms that have evolved, and sift through the findings to determine what needs to be disseminated to other sites, what needs to be bolstered by outside intervention, and what needs to be changed.

Case studies are often best suited for this task. For example, in the Philippines in 1977, the NIA and the Ford Foundation funded a major case study program which documented the ways in which farmers in 51 communal systems in different parts of the country managed their irrigation systems (de los Reyes 1980). Valuable lessons were drawn from this work which were later used in training NIA community organizers and engineers.[10] Case studies of the record keeping systems of four communals that were particularly adept at financial management were used as the basis for shaping the financial management systems that NIA taught to hundreds of communals throughout the country.[11] An intensive

or needs reform, then the issues move to the micropolicy arena and appropriately designed research must shift to the social learning perspective.

For example, a reform commonly advocated regarding government construction assistance to farmer-managed irrigation is that such assistance be done in ways that fully involve the farmers. But this is not a decision that can be mandated. In an agency accustomed to more top-down approaches, evoking farmers' participation involves too many changes in the implementing agency's procedures, incentive systems, norms, and personnel skills to be a simple "stroke of the pen" decision.[5]

Because the social learning perspective is suited to many of the issues of interest to this workshop, but is generally unfamiliar to development professionals, the remainder of this paper will examine some examples of applying this approach to issues of government assistance to farmer-managed irrigation in Southeast Asia.

GOVERNMENT ASSISTANCE TO FARMER-MANAGED SYSTEMS IN THE PHILIPPINES AND INDONESIA

As in many other countries, both Indonesia and the Philippines have experienced crash irrigation development programs in the last two decades. These were designed to help the national economy become self-sufficient in rice. Major funding has been provided by international lending agencies, and the projects have been implemented primarily by public works agencies, which have viewed their task mainly in technical engineering terms.

As large-scale irrigation systems have been developed, attention has turned increasingly to smaller scale systems. Developing small-scale systems often involves expanding or improving farmer-constructed and managed systems. But assistance to these systems has generally included no meaningful farmer involvement. While these construction projects have improved some structures and often expanded irrigated area, other structures built have been poorly adapted to the local topography and traditions and, in many cases, after the construction, farmers feel a weakened sense of responsibility for operating and maintaining their system.[6] In Indonesia, government construction projects have commonly resulted in dam and main canal management being transferred from the farmers to the government.[7]

Concerns about some of the negative effects of government efforts have been widespread both inside and outside the relevant implementing agencies in both countries; but actually making the needed changes represents an immense task. The situation is well-suited to the social learning perspective; the issues are rich with *how* questions and a focus on building new capacities within the implementing agencies is needed.

In both the Philippines and Indonesia the Ford Foundation has been supporting the implementing agencies' processes of change. Efforts in the Philippines began on a small scale in 1976. Gradually the social learning process has transformed the way the National Irrigation Administration (NIA) assists communal irrigation systems. Now participatory

In pilot projects in the Philippines and Indonesia, a form of research called process documentation has been developed which provides a detailed record of the pilot projects' field level activities. These reports, provided monthly, have allowed agency staff and others to understand what is happening in the field and to determine its implications for micropolicy reform in the agency.[14] In this context the researchers' role is to gather data aimed at enriching the feedback loop from the field to decision makers and other advisors who assist with improving the agency's approach. Regular monthly reports allow the data to flow into the agency, feeding into a reform process as opportunities arise.

In carrying out process documentation a researcher needs to look in two directions: while attending to what is happening in the village a researcher must also be alert to the factors which affect the implementing agency's actions. For researchers to help with the micropolicy reform process, they must understand how the current procedures work and how these procedures can guide them in selecting field level issues to document. Researchers may need to be attuned to questions such as: How does the budgeting process work -- what funds come from what sources and with what constraints? What are the personnel's job descriptions? How do they view their roles? What are the terms of their evaluations and the basis for their promotions? What about the legal issues of asset transfer, water rights, responsibility for materials? An understanding of the issues contained in such questions may help explain certain problems that are encountered in the field. The documentation of those issues can then lead to appropriate micropolicy reforms.

These three research needs are not the only ones appropriate to a social learning perspective, but they are illustrative and reveal some methodologies responsive to these needs. All are focused on issues relevant to some aspect of agency intervention. Often the original idea for the research springs from trying to grapple with some particular problem in the action program. In this context, the implications flow directly from the research, and implementors are not left wondering: "What does all this have to do with me?"

RESEARCHERS' ROLES IN A SOCIAL LEARNING PROCESS

Researchers involved in a social learning process find that not only are the types of research they carry out different from conventional research, but also the roles they play are different. Two important differences are: their relationship with the implementing agency, and the variety of functions that they are called upon to carry out.

Relationship with the Implementing Agency

While researchers working from a policy analysis perspective usually meet with implementors at the beginning and end of a research project, researchers working from a social learning perspective interact much more frequently with agency personnel. Decision making is seen as an ongoing process, requiring that research results flow in on a a regular basis.

case study of the water management practices of an indigenous communal with particularly sophisticated approaches to water rotation became part of the NIA's water management training for other communals (Angeles et al. 1983). In that training, farmers were provided examples of different approaches to water management practices used by other communal irrigation associations as a basis for determining their own association's approach to water management.[12]

In Indonesia case studies have helped reveal farmer traditions of water allocation which have contributed to understanding the appropriate design of water division structures in rehabilitation projects (Sutawan et al. 1984 and Rachman et al. 1986). They have revealed issues about the division of operation and maintenance responsibility between farmers and the government, and of coordination among systems along a river. These case studies then led to action projects currently underway which try to operationalize the studies' implications (Sutawan et al. 1986).

Developing the Agency's Differential Response Capacity

An important key to effective implementation of a program that relates to people in diverse environments is the ability to respond appropriately to each situation. Each farmer-managed irrigation system is unique and requires carefully tailored interventions. Fortunately, the key dimensions on which the systems vary are not unique. With sufficient experience it is possible to specify guidelines for routinely assessing the key characteristics of a given system as a basis for planning appropriate interventions.

In both the Philippines and Indonesia social scientists working together with engineers have helped develop instruments for making such assessments.[13] The approach involves using a structured set of guidelines (not a questionnaire) to observe the existing physical situation (canals, structures, crops) and to interview key informants about topics such as the history of irrigation in the area, use of the water source by other users, desires regarding government assistance, the existence of different (possibly conflicting) irrigation-related groups in the area, the existence and functions of irrigation-related organizations and leaders in the area, and cropping patterns both existing and desired. The output is a site-specific description geared to the decision making needs of an agency that plans to assist that system. In this context the researchers' primary role is to develop an instrument and a process by which the agency itself can gather and use this type of data on a routine basis for each of the sites in which it intervenes.

Documenting Agency Intervention for Micropolicy Reform

Whether an agency is developing a completely new program or reforming an existing one, an important set of issues involves the exact nature of the intervention needed and the agency support systems required to carry out that intervention. Pilot projects are often carried out to try to determine the former, but attention to the latter is often inadequate with the result that later efforts to replicate the pilot project fail.

In several situations, working groups have been formed of researchers and implementors to provide a clear structure for such interactions. The group meets regularly to discuss findings emerging from the research and their potential relevance to the action agency's program. For example, in the Philippines, researchers from several different organizations met with officials from the NIA at least once a month over a period of six years to help bring about the transformation of the NIA's approach to communal irrigation assistance.[16] Thus by the time a final report is written, its contents are already known by the key implementors and sometimes many of the recommendations have already been built into the agency's program.

To help encourage a strong working relationship between the researchers and the agency, the Ford Foundation has channeled funding for this type of research primarily through the action agency, which then contracts for specific research work. This approach to funding university-based researchers has the disadvantage of being bureaucratically cumbersome, but it has several important advantages. It has helped agency personnel feel a strong sense of owning the research -- in other words, being involved in shaping its form, monitoring its progress, and using its results. And it has helped the researchers become more responsive to the needs of the agency.[17]

Response to Emerging Needs

In a social learning process, a researcher's role broadens as the researcher interacts with the agency and tries to respond creatively to the emerging needs. When such a process works well, the sharp role distinctions between researcher, trainer, and consultant inevitably fade.

For example in West Sumatra, after the Andalas University team had developed a good methodology for inventorying a river system (see Ambler 1985a and b), the natural next step was to train government personnel to do this themselves so that a much larger number of river systems could be inventoried. This activity shifted the university team's role from researcher to trainer. Once the inventory data are collected, the research team plans to help the implementing agency with analysis, shifting the team's role to that of consultant.

Similarly, social scientists from the Institute of Philippine Culture not only developed the approach to doing socio-technical profiles of small-scale irrigation systems, but also trained agency personnel to collect such data routinely. In addition, they took on a consulting role by taking part in workshops to analyze the profiles, and by helping develop the agency personnel's capacity to determine the profile's action implications (see de los Reyes, n.d.).

In a social learning process researchers must be willing to let go of rigid definitions of the researchers' role and search for the varied ways in which they can use their talents to enhance the capacity of the agency. This is not to say that researchers should take on line responsibility in the organization. In a social learning process line responsibilities should remain at all times with the action agency. The goal is to enhance the agency's ability to

implement a program which cannot be achieved by taking over the task. But the researchers do need to be flexible and creative in thinking through the implications of their research findings for the action agency and helping develop the new capacities as needed.

For some researchers taking on such new roles seems difficult as such tasks to build direct capacity seem to threaten their sense of objectivity. Sometimes it is difficult institutionally as the researchers' organization may define its task narrowly, or may assign training or consulting to a different division. A research team involved in a social learning process may find their more conventional colleagues wondering why they are always involved in workshops and meetings at the agency. Or they may find themselves criticized for using nonquantitative methods and for focusing excessively on details.

But for those involved, the social learning approach is often highly motivating. The agency people find that they know more about what is going on in their program than ever before. The researchers find that their research results are listened to and applied. And both gain the satisfaction of creating a program more responsive to the people's needs.

NOTES

[1]Friedmann uses the term *policy analysis* to refer to a broad tradition of thinking about planned change. I use the term as he does, in contrast to the use made by the recently developed policy analysis schools in public administration which fit the broad tradition but define their approach more specifically.

[2]Friedmann (forthcoming) cites Kurt Lewin, Warren Bennis, Chris Argeris, Paul Lawrence, and Jay W. Lorsch among others as representing the social learning tradition.

[3]Steinbrunner (1974) elaborates on this in his discussion of the cybernetic versus analytic perspectives.

[4]There are numerous research reports that have examined the village level effects of a rural development program and then recommended that the implementing agency exercise greater flexibility to be better able to meet the needs of the people. In my experience, however, the implementors are often painfully aware of the need for flexibility but unable to figure out how to achieve it within the constraints of their agency. In these cases the *how* question represents the major challenge, and research which does not address this question is often of little practical value.

[5]An Asian Development Bank funded irrigation project in Bali, Indonesia, illustrates how participation cannot simply be mandated. The loan that provides funds for improving the structures of the famed farmer-managed *subak* irrigation systems specifies that the farmers are to be consulted about all work to be done. However, the reality was often quite different. An Udayana University team has documented how, in some cases, concrete structures built with the farmers' own money and labor were destroyed and replaced by structures viewed by farmers as inferior and less functional. Although farmers protested -- and many agency personnel sympathized with their protests -- the agency procedures were simply not geared to respond to farmer concerns (see Sutawan et al., 1984).

[6]A variety of different case studies have revealed such an effect. For examples see Usman and Rachman (1984), Zein et al. (1986), Siy (1986).

[7]This take-over of management responsibility by government occurs in Indonesia for a variety of reasons. One of them is a general rule that the government manages main canals, while the farmers manage tertiary canals. Because this rule is made without reference to the size of the system, once government assistance is provided to

systems of any size, the main canal generally becomes the responsibility of the government. For a fuller discussion of this and related issues, see Korten (1986).

[8]For a discussion of the process of transformation in the National Irrigation Administration, see Bagadion and Korten (1985). A more complete discussion of this process will be available soon (see Siy and Korten, in preparation).

[9]The participatory irrigation projects in Indonesia have been documented by a number of researchers. Some of the key documents include: Robinson (1985), Masa (1985), Morfit and Poffenberger (1985), and Institute for Socio-Economic Research, Training and Information (1985). These papers all document results of attempts to reform what Coward (this volume) refers to as the "direct" method of assisting small scale irrigation systems. It should be noted that Indonesia has also used "indirect" methods of assistance to farmer-managed systems which are more participatory, although the scale of the rehabilitation carried out in these indirect investment projects is much more limited. For a study documenting the indirect approach, see Hafid and Hayami (1974).

[10]A manual used by the NIA for training community organizers incorporates many of the findings from the de los Reyes study (see Sylvia Jopillo, 1983).

[11]A detailed description of the financial systems of one particular communal is found in Veneracion (1983a). A more general discussion of financial systems in communals is found in Veneracion (1983b). Findings from this study were incorporated in the NIA financial management manual (see Margallo, 1983).

[12]For a fuller description of the "workshop" approach to water management training for farmers on communal irrigation systems, see Communal Irrigation Committee (1983).

[13]For a description of the data gathering instrument used in the Philippines, its development and use, see de los Reyes (1984). In Indonesia this same approach has been applied to small-scale irrigation in North Sumatra and South Sumatra (see NIA Consult, 1985, and Rachman et al., 1985).

[14]For an analysis of nature of process documentation and its uses see: de los Reyes (n.d.). A description of the field-level view of process documentation by a researcher who carried out process documentation for three years is found in Volante (n.d.). For summary reports on process documentation on three different irrigation systems see: Frances et. al (1983), Veneracion (1985), Frances et. al. (1984). In Indonesia, process documentation has been carried out on the Madiun pilot project since 1983 by Satya Wacana University, Salatiga, Indonesia.

[15]De los Reyes (n.d.) provides examples relating field level problems to administrative procedures.

[16]Institutions in the NIA's Communal Irrigation Committee which met regularly over six years included The Institute of Philippines Culture, the Asian Institute of Management, the International Rice Research Institute, and the Ford Foundation, in addition to the NIA itself. For an analysis of the activities of the Communal Irrigation Committee, see Bagadion and Korten (1985).

[17]The Ford Foundation, in some cases, also made complementary grants directly to the universities involved for activities aimed at strengthening the institution's research capacity in the area of concern. But the research intended to be directly responsive to the action agency's needs was generally funded through the action agency.

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LIST OF PARTICIPANTS

Bangladesh

Mowla Bakhsh
Deputy Director of Irrigation Management Project
Bangladesh Rural Development Board
Pali Bhavan
5 Kawran Bazzar
Dhaka

Abdul Momin
Research Associate
Center on Integrated Rural Development for Asia and the Pacific (CIRDAP)
GPO Box 2883
Dhaka

M.A.S. Mandal
Assistant Professor
Department of Agricultural Economics
Bangladesh Agricultural University
Mymensingh

India

U.C. Pande
Administrative Officer and Reader
Water and Land Management Institute (WALMI,
Canal Colony, Okhla
New Delhi 110025

R. Sakthivadivel
Director
Centre for Water Resources
Anna University
Madras 600025

N.R. Banerjee
Program Officer
United States Agency for International Development (USAID)
Room no. 1542, Ashoka Hotel Annexe, 5th Floor
New Delhi

Indonesia

Frances F. Korten
Program Officer
Ford Foundation
Southeast Asian Regional Office
Jalan Taman Kebon Sirih 1/4
Jakarta

Soeseno Sosrodimoeljo
Head of Section for Operation and Maintenance
Directorate of Irrigation
Ministry of Public Works
PO Box 205
Kebayoran Baru
Jakarta

Nyoman Sutawan
Assistant Professor
Department of Socio-economics
Faculty of Agriculture
Udayana University
Denpasar, Bali

Morocco

R.M. Abdellaoui
Maître de Conférence
Institute Agronomique et Vétérinaire Hassan II
BP 6202
Rabat

Nepal

Nasiruddin Ansari
Deputy Director General
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Kathmandu

C.D. Bhatt
Director General
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Kathmandu

Anis Dani
Social Scientist
International Centre for Integrated Mountain Development (ICIMOD)
Kathmandu

Brian Fawcett
Irrigation Planning Advisor
Water and Energy Resources Development Project
PO Box 1340
Kathmandu

Upendra Gautam
Lecturer
Public Administration Campus
Kathmandu

Paul Gurung
Project Engineer
Irrigation Management Project
United States Agency for International Development (USAID)
Kathmandu

Rajendra Kahatri
Legal Officer
Water and Energy Commission Secretariat (WECS)
Kathmandu

Mohan Karki
Director
Western Regional Directorate
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Pokhara

Bhuban Man Kayastha
Joint Secretary
Ministry of Panchayat and Local Development
Kathmandu

Ratneshwar Lal Kayastha
Director
Central Regional Directorate
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Kathmandu

Jyoti Lohani
Agricultural Projects Services Centre
Kathmandu

B.K. Pradhan
Executive Secretary
Water and Energy Commission Secretariat (WECS)
Kathmandu

Sekhar Pradhan
Deputy General Manager
Agricultural Development Bank, Nepal (ADBN)
Kathmandu

Chandraman Pradhan
Division Chief
Agricultural Development Bank, Nepal (ADBN)
Kathmandu

Lisa Rush
Publications
International Centre for Integrated Mountain Development (ICIMOD)
Kathmandu

Prachanda Raj Rajbhandari
Engineering Campus
Pulchwok, Patan
Kathmandu

Chandra Kant Sharma
Executive Director
Water and Energy Commission Secretariat (WECS)
Kathmandu

Shiva Nath Sharma
Executive Director
Water and Energy Commission Secretariat (WECS)
Kathmandu

J. Ram Sharma
Executive Engineer
Feasibility Study Division
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Kathmandu

Mahesh Man Shrestha
Chief
Farm Irrigation and Water Utilization Division
Department of Agriculture
Ministry of Agriculture
Kathmandu

Hari Man Shrestha
Executive Director
Water and Energy Commission Secretariat (WECS)
Kathmandu

Ashutosh Shukla
Lecturer
Institute of Agriculture and Animal Science
Rampur, Chitwan

G.N. Thakur
Project Manager
Irrigation Management Project
Department of Irrigation, Hydrology, and Meteorology (DIHM)
Kathmandu

S.B. Upadhyay
Executive Director
Water Resources Directorate
Water and Energy Commission Secretariat (WECS)
Kathmandu

Dirghanidhi N Tiwari
Engineer
Development Research Group (DRG)
PO Box 32
Kathmandu

IIMI
PO Box 3975
Kathmandu

Mahesh Pant
Researcher

Prachanda Pradhan
Social Scientist

Ujjwal Pradhan
Research Fellow

Robert Yoder
Resident Scientist/Agricultural Engineer

Niger

Talabe Chaibou
Agricultural Engineer
Director of Infrastructures Division
ONAHA
BP 10697
Niamey

Pakistan

Hussain Wali Khan
Deputy General Manager
Aga Khan Rural Support Programme (AKRSP)
Babar Road
PO Box 506
Gilgit, Northern Areas

Philippines

Honorato L. Angeles
Associate Professor and Dean
College of Engineering
Central Luzon State University
Munoz, Nueva Ecija 2320

Benjamin U. Bagadion
Irrigation Management Consultant
Block 17, Lot 19 Axtell Street
North Fairview, Quezon City

Sylvia Ma. G. Jopillo
Research Associate
Institute of Philippine Culture
Ateneo De Manila University
Loyola Heights, Quezon City

Robert Y. Siy, Jr.
Management Scientist
Asian Institute of Management
123 Paseo de Roxas
Makati, Metro Manila

Senegal

Arona Fall
Directeur General Adjoint
Societe d'Amenagement et d'Exploitation des Terres du Delta du Fleuve Senegal (SAED)
BP 74
St Louis

Sri Lanka

Jaliya Medagama
Deputy Commissioner
Department of Agrarian Services
42 Marcus Fernando Mawatha
Colombo 7

Jayantha Perera
Deputy Director
Agrarian Research and Training Institute (ARTI)
114 Wijerama Mawatha
Colombo 7

IIMI
Digana Village via Kandy

Shyamala Abeyratne
Research Fellow

Jennifer Cramer
Conference Coordinator

Russ Cramer
Research Fellow

David Groenfeldt
Economic Anthropologist

Edward Martin
Agricultural Economist

Poh-Kok Ng
Agricultural Engineer

C.R. Panabokke
Agricultural Scientist

Leslie Small
Agricultural Economist

Thomas Wickham
Director General

Thailand

Boonyok Vadhanaphuti
Director
Project Planning Division
Royal Irrigation Department
911 Samsen Road
Bangkok 10300

Sacha Sethaputra
Associate Professor
Water Resources and Environment Institute
Khon Kaen University
Khon Kaen 40002

Uraivan Tan-Kim-Yong
Assistant Professor
Faculty of Social Sciences
Chiang Mai University
Chiang Mai 50002

United States

John Ambler
Sociologist
Department of Rural Sociology
Cornell University
Ithaca, New York 14853

Ruth Yabes
Graduate Student
Department of City and Regional Planning
Cornell University
Ithaca, New York 14853

West Germany

Hans Walker
Agricultural Economist
Uhland Strasse 15
7447 Aichtal