Report No. R-80

SOCIAL ORGANIZATION FOR IMPROVED SYSTEM MANAGEMENT AND SUSTAINABLE IRRIGATED AGRICULTURE IN SMALL DAMS

AN ACTION RESEARCH PROGRAM

FUNDED BY THE DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID), UK

FINAL REPORT

Ralf Starkloff
D. Jayatissa Bandaragoda
M. Asghar Cheema
M. Akhtar Bhatti

April 1999
Pakistan Program
International Water Management Institute
Lahore

Report No.	Title	Author	Year
R-70	**Sindh Waterlogging and Salinity Management**		
R-70.1	Volume I: Irrigated Landscape: Resource Availability across the Hydrological Divides:	Gauhar Rehman Asghar Hussain Abdul Hamid Amjad Siddique Almas Mehmooda Tabassum Muhammad Anas Nomani Kamaran Yousaf	Dec 1998
R-70.1a	Supplement I.A: Improved Water Management Practices for the Rice-Wheat Cropping Systems in Sindh Province, Pakistan	Muhammad Aslam	Dec 1998
R-70.1b	Supplement I.B: Improved Water Management and O&M Practices for the Rice-Wheat Cropping System	M. Akhtar Bhatti	Dec 1998
R-70.1c	Supplement I.C: Drainage in the LBOD Project: Operational Concerns and Quality of Pumped Effluent	Shafqat Ijaz	Dec 1998
R-70.1d	Supplement I.D: Drainage in the LBOD Project: Impact Assesment	Rubina Butt Nausheen Munir Muhammad Iftikhar Bhatti Amjad Siddique Almas Gauhar Rehman Asghar Hussain M. Tariq Soomro Mehmooda Tabassum Kamaran Yousaf	Dec 1998
R-70.2	Volume II: The Farming System: Potential for Investments and Returns	Waqar A. Jehangir	Dec 1998
R-70.3	Volume III: Strategy for Resource Allocations and Management across the Hydrological Divides	Abdul Rehman	Dec 1998
R-71	Characteristics and Implications of Leadership Choice of the Water Users Organizations: A Synthesis of Lessons Learned at Pilot Distributaries in Pakistan	Mehmood ul Hassan Yameen Memon	Dec 1998
R-72	Short Term Impacts of Farmers Participation at the Hakra 4-R Distributary	Waheed-uz-Zaman Khalid Rashid	Dec 1998
R-73	Socio-technical Aspects of Achieving Equitable Water Distributation at the Hakra 4-R Distributary	Whaheed-uz-Zaman Gaylord V. Skgogerboe	Dec 1998
R-74	Operational and Maintenance Issues and Physical Characteristics of Harkra 4-R Distributary	Waheed-uz-Zaman	Dec 1998
R-75	Developing a Canal Operation Management Information System in Malik Sub-Division	Paul Willem Vehmeyer Raza ur Rehman Abbasi Mushtaq A. Khan	Dec 1998
R-76	Using a Hydraulic Simulation Model for Prioritizing Maintenance in an Alluvial Irrigation Channel	Raza ur Rehman Abbasi Paul Willem Vehmeyer	Dec 1998
R-77	Water Level Fluctuations and Discharge Variability in Mirpur Khas Sub-Division, Jamrao Canal, Nara Circle, Sindh Province, Pakistan	Abdul Hakeem Khan Bakhshal Lashari	Dec 1998
R-78	Operation of Jamrao Canal System, Nara Circle, Sindh Province, Pakistan	Abdul Hakeem Khan Bakhshal Lashari Muhammad Ali Khuwaja Zahid Hussain Jalbani	Dec 1998
R-79	Proceeding of the National Workshop on Coordinated Services for Irrigated Agriculture in Pakistan	Tissa Bandaragoda Parchanda Pradhan Mehmood Ul Hassan	Dec 1998
R-80	Outlines for Irrigation Extension	M.S. Shafique Asghar Nadeem Gill	Dec 1998

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FOREWORD

The topography of the area between the Jhelum and Indus Rivers in the Pothwar area of Pakistan is undulating with gradual sloping from the Northeast to the Southwest, and deep incised river valleys. This has facilitated the construction of 31 small dams between 1962 and 1995. Farmers, for centuries practicing rainfed agriculture in these areas, had no organized behavior among them. They were unaware of the coordinated efforts required among them and with the irrigation department, which would have increased the irrigated command area and the agricultural productivity of the area. The Water Resources Research Institute of Pakistan (WRRI), International Irrigation Management Institute (IIMI) and the Overseas Development Authority (ODA) of the United Kingdom recognized this deficiency in 1996. The ODA then committed to sponsor an action-research program titled "Social Organization for Improved System Management and Sustainable Irrigated Agriculture". IIMI and WRRI carried out this study.

Intermediary reports from this study have been consulted by donor agencies such as the Asian Development Bank. This final report documents the lessons learned by researchers, social organizers, agency personnel and farmers. The project has demonstrated the willingness and ability of farmers and agency personnel to manage the land and water resources of the area jointly. Our view is that the small dams offer an excellent opportunity for the promotion of reforms in the irrigation sector. IIMI recommends that farmers in areas around the small dams are mobilized and federated into Farmers' Organizations (FOs). Collectively, the farmers' organizations and the Small Dams Organization may consider forming an institution equivalent to that of an Area Water Board, as presented by the PIDA Act (1997).

Finally, I would like to recognize Prof. G.V. Skogerboe (IIMI), D.J. Bandaragoda (IIMI) and Dr. Shahid Ahmad (WRRI) for their foresight in conceptualizing this study. My sincere appreciation is due to Dr. Ralf Starkloff who joined IIMI in January 1999, understood the project concepts quickly and finalized this report. Drs. Cheema and Bhatti are recognized for their contributions to this study during the past three years. Our thanks are also due to ODA, UK, for sponsoring this valuable action-research.

S.A. Prathapar
Director, IWMI Pakistan Program

ACKNOWLEDGEMENTS

This project has been made possible by a grant from the UK Department for International Development (DFID) under the Competitive Research Facility (CRF) (formerly known as the Holdback Facility), which supports collaborative work between international agricultural research centers, UK and national research organizations. The views expressed are not necessarily those of DFID.

The authors wish to express their appreciation for the valuable suggestions made by Dr. S.A. Prathapar, Director, and Prof. G. Skogerboe, former Director of IWMI Pakistan. Mr. Manzoor Hussain of IWMI provided excellent secretarial services. Thanks are due to Ms. Verenia Duke for a marvelous editing job.

We would like to thank the IWMI Field Team comprising Mr. Muhammad Akram, Team Leader, Mr. Shabir Ahmad and Mr. Wahid Ahmad, Social Organizers, and Mr. Abdul Razzaq, Field Assistant for their valuable participation in this project.

Finally, we wish to acknowledge the cooperation of the farmers of the Shahpur, Mirwal and Kot Raja areas, of the Project Director and officers of the Small Dams Organization in Fateh Jang and Islamabad, of the Director and staff at the Water Resources Research Institute in Islamabad, as well as of the Agency for Barani Area Development, the On-Farm Water Management Directorate, the Agricultural Extension Directorate, the Soil Conservation Directorate, the Rapid Soil Fertility and Soil Testing Directorate, the Wheat Program of the National Agricultural Research Center, ActionAid, and the Agricultural Development Bank of Pakistan. Without the valuable contributions of these people and organizations, this project would not have been realized.

Ralf Starkloff
Management Specialist

SUMMARY

The International Water Management Institute's Pakistan Program, in collaboration with the Water Resources Research Institute (WRRI) of the National Agricultural Research Center of Pakistan and the Small Dams Organization (SDO) of the Punjab Irrigation and Power Department, conducted an action research program on 'Social Organization for Improved System Management and Sustainable Irrigated Agriculture in Small Dams' from April 1996 to March 1999. The Department for International Development (formerly ODA) of the UK funded the project. The program aimed to test the potential for improved irrigation systems management and command area development at small dams in the Punjab Province through the involvement of water users organizations (WUOs) at three pilot-sites.

Opportunities for irrigated agriculture are limited in the so-called Barani (rainfed) areas of Pakistan, as their elevation and hilly topography prevents access to the Indus Basin Irrigation System. Reliable crop irrigation could only be achieved by constructing small dams to collect rainfall run-off and seasonal stream flow in small size reservoirs. From 1972, the Small Dams Organization of the Punjab Irrigation and Power Department, with partial financial support by foreign donors, constructed a total of 31 dams in the Pothwar area located in the Rawalpindi Division.

IWMI's small dams project was motivated by two considerations. First, several significant constraints of irrigated agriculture in the small dams area were identified. After construction of the dams and irrigation channels, no further physical improvement, command area development or institutional development activities were carried out. SDO merely operated the dams and released water to the channels. Farmers were not sufficiently adopting adequate irrigation practices. A system of rules for the coordinated allocation and distribution of water was not developed. Less than 30 percent of the total command area are irrigated. Erosion in the catchment area causes deteriorating storage capacity of the reservoirs due to heavy sediment loads. Second, Pakistan currently seeks to implement a comprehensive institutional reform of the irrigation and drainage sector, involving Participatory Irrigation Management through Farmer Organizations and Area Water Boards regulated by Provincial Irrigation and Drainage Authorities. The small dams systems were identified as suitable pilot sites to test of new institutional arrangements in a limited and relatively independent context, before transferring larger subsystems of the Indus Basin Irrigation System to water users organizations.

The action research program formulated five project objectives to test whether reformed irrigation institutions would be able to deal with the constraints outlined:

1. Identify the extent of current problems related to the system of management and command area development at selected small dams.
2. Facilitate the formation of an appropriate water users organization in each of the selected small dam pilot areas.
3. Assist the organization to become as functional as possible in the management of operation and maintenance, as well as command area development, with an emphasis on improved irrigated agricultural practices.
4. Develop methodologies for water users organizations under the given technical, socio-economic and institutional conditions.
5. Assess the viability of these chosen social organization strategies and their short-term effects on the operation and maintenance of small dam systems and on their command area development.

The expectation of the project was that the establishment of farmer-run mechanisms for deliberation and conflict resolution would reduce the incidence of water- and land-related disputes. The promotion of command area development by the water users organization's would increase the area

under irrigation. The training of farmers on irrigated agricultural practices would lead to improved practices, including the use of new crops and high yielding varieties as well as of fertilizers, and thereby, to higher yields. Furthermore, assistance to water users organizations in the development of clear water rights and allocation rules would improve equity in water distribution. Finally, attendance to O&M by the WUO would increase the reliability of irrigation and reduce government expenditures.

The project emphasized the collaboration between IWMI and national partners as a key to sustainable outcomes. IWMI's tasks were to train social organizers and volunteers; to develop and implement the social organizing process; to provide training to water users on social organization and irrigation operation and maintenance; and to document the action research process. WRRI carried out a technical diagnostic survey of two pilot sites and provided training on irrigated agricultural practices to farmers. SDO supported the social organization and command area development process by working closely with the new water users organizations. To provide support services in agricultural development and credit, IWMI sought the collaboration of several other governmental and non-governmental organizations that are active in the *barani* area. The On–Farm Water Management Directorate assumed the primary responsibility for the social organization of a WUO in one of the three pilot sites.

Three project sites for pilot testing were selected at the Shahpur, Mirwal and Kot Raja Dams located in the Attock and Jhelum Districts of the Punjab Province.

The analysis of the physical, social, agricultural and technical characteristics of the project sites indicated several key constraints and challenges at the time of the project inception. These include the need for land leveling and for alternative techniques of command area development; the paucity of infrastructure services, such as communication, transport and banking; the dominance of influential and powerful large landowners; the lack of experience with irrigated agriculture among farmers; caste divisions and low levels of education; the absence of a culture of organized action for the management of natural resources; low yields and cropping intensities; limited actual command areas; the lack of support services from government personnel; and deficient design, construction, operation and maintenance of the small dams irrigation systems.

The process of social organization involved four distinct phases. First, in support mobilization the collaboration of partner organizations is solicited to develop institutional arrangements to support the project activities. The small dams project mobilized the support of SDO, WRRI, the Agency for Barani Area Development, OFWM, the Agricultural Extension and Soil Conservation Directorates, the Agricultural Development Bank of Pakistan, the Department of Fisheries, the National Agricultural Research Centre, the Soil Testing Laboratory (Attock) and ActionAid.

Second, a comprehensive diagnostic analysis needs to be carried out to collect detailed socio-economic and technical information about the project sites. The project team and WRRI carried out baseline surveys, walk-throughs, open-ended semi-structured interviews, informal meetings and discussions with cultivators and governmental service providers in the pilot areas.

Third, the organizational development phase proceeds through five steps from familiarization and rapport building meetings, through consultation and selection meetings to the official formation of water users organizations. With the cooperation of community-based social organization volunteers, IWMI's social organizers involved increasing numbers of irrigators in the pilot command areas in the deliberation of organizational structures, roles and tasks. Eventually, a governance structure based on village representation was established, office bearers were selected and the water users

organizations were registered with the OFWM Directorate under the On-Farm Water Management and Water Users Association Ordinance of 1981.

Fourth, in the organizational action phase, several collaborative activities between WUOs and governmental partners are carried out. At the small dams these included joint operation and maintenance activities and the resolution of conflict over the inequitable distribution of irrigation water, as well as various training sessions on improved agricultural and irrigation practices.

The pilot project experiences indicate that the mobilization of collaborative support services is essential for the sustainable implementation of institutional reform. Joint planning and implementation of O&M, provision of training, as well as persistent informal contacts and rapport building forged strong cooperative relationships between farmer leaders, agency personnel and IWMI staff. However, the support mobilization arrangements were unable to overcome current social and legal constraints sufficiently to achieve officially sanctioned and sustained participatory irrigation management.

The diagnostic analysis proved to be an indispensable tool for both, the generation of a solid knowledge base and the participatory learning process among the target groups. Water users and agency personnel learned to take a more analytical perspective of their own socio-technical environments, and thereby strengthened their ability to manage their resource systems.

The organizational development process resulted in the successful establishment of three water users organizations at the pilot sites. Trust and confidence, motivation and capacity among farmers were developed as they identified, discussed and tackled their pressing concerns and problems. Rapport between farmers and social organization staff was established despite the farmers' initial suspicion and reluctance. Cooperative relations between farmers and personnel of the SDO and other government agencies were forged. The stress on open debate and consultation and the mutually recognized value of consensus among the water users avoided adversarial relations in decision making, and instead, institutionalized broad representation. Alliances between potentially antagonistic local actors from different social groups of cultivators, i.e. different strata of landowners and different castes, were built. The village-based selection of representatives ensured the participation of most caste and kinship groups. Representation of small, midsize and large landowners was achieved. Larger landowners agreed to surrender privileged access to irrigation water in the interest of equity. The project fostered the recognition that individual gain is interdependent with the welfare of the community, because all irrigators in the command area depend on the effective and prudent management of a common resource.

The pilot testing of organizational action through collaborative activities demonstrated that participatory irrigation management has the potential of reducing O&M costs through farmers' labor contributions and transparent handling of funds. The WUOs were able to plan and implement measures for improved O&M and command area development. The technical infrastructure of the pilot systems was repaired and is maintained. In the process, farmers and SDO staff demonstrated their capacity for cooperation. At the same time, it was learned that organized farmers who maintain well-functioning relations with government actors seek to hold these accountable and insist on receiving professional services. The *warabandi* schedules were redesigned after discussion, and the foundation of equitable water distribution is in place. However, the implementation of revised *warabandi* is still incomplete and requires further negotiation among farmers until a solid irrigation culture evolves. The actual irrigated command area has been increased and farmers demonstrated their willingness to adopt cash crops in combination with subsistence crops. The yield of the 1997/98 wheat crop showed an increase of 34 percent over the previous season, which is an encouraging trend. The WUOs were able to amicably resolve 26 out of 39 water-related conflicts

recorded in IWMI's process documentation, among which was an intense confrontation between villagers in the command areas of two minors at Shahpur Dam. Farmers and irrigation personnel recognized that the WUOs provided a valuable mechanism to hear and address conflicts.

A number of significant constraints remain despite the efforts of all collaborating partners. The WUO members themselves do not judge their organizations to be sustainable as yet, and request the continuation of IWMI's involvement. An important function of IWMI, besides the facilitation of organization building, was advocacy in the interest of the water users. Thereby, farmers have become dependent on the services of IWMI staff. Water users required advocacy in their dealings with government personnel on account of the absence of a reliable legal framework, which entitles irrigators to jointly manage their irrigation systems, and on account of the absence of sufficient motivation among government actors to support participatory irrigation management. Management turnover has not taken place in Pakistan so far, and therefore, farmers are still unable to adequately develop and test their capacity for participatory irrigation management. The small dams action research program, nevertheless, has demonstrated that farmers are highly motivated and prepared to do so.

1. INTRODUCTION

The International Water Management Institute's Pakistan Program, in collaboration with the Water Resources Research Institute of the National Agricultural Research Center of Pakistan and the Small Dams Organization of the Punjab Irrigation and Power Department, conducted an action research program on 'Social Organization for Improved System Management and Sustainable Irrigated Agriculture in Small Dams' from April 1996 to March 1999. The project was funded with Pounds Sterling 148,420 by the Department for International Development (formerly ODA) of the UK through its Competitive Research Facility (formerly Holdback Facility). The program aimed to test the potential for improved irrigation systems management and command area development at small dams in the Punjab Province through the involvement of water users organizations at three pilot-sites [1].

This final report documents the project implementation process, discusses its results and impacts, and makes recommendations for interventions in the future. The introduction provides information about the project background, as well as the objectives, concepts and assumptions, key actors and the approach of the program at the time of its inception. Chapter 2 describes the project setting by highlighting the selected pilot project sites' main geo-physical, social, agricultural and technical characteristics. Central problems relating to the management of the small dams irrigation systems and the development of their command areas are pointed out. Chapter 3 discusses the process of building water users organizations at the project sites. The methodology and practice of the organization building process, in particular, collaborative activities undertaken to improve the management of the irrigation system and to develop irrigated agriculture in the command area, are discussed. Chapter 4 assesses the impact of the project interventions in the pilot sites, with particular reference to the viability of the social organization strategies and their impact on O&M and command area development. The conclusion raises problems arising from the closure of the project, assesses the sustainability of the farmers organizations and makes recommendations for possible future projects.

1.1. Project Background

Irrigated agriculture is of central importance to the economy of Pakistan and the livelihoods of its growing population. Agricultural production accounts for 24.6 percent of the country's GDP, employs 50 percent of its labor force, and provides about 70 percent of export earnings, including processed agricultural exports (Government of Pakistan 1998). Pakistan's extensive irrigation system supports approximately 17 million hectares of cultivated land. The Punjab Province contains about 70 percent, or 14.8 million hectares, of Pakistan's total cultivated area. Of these, 12.6 million hectares are irrigated; 8.3 million hectares through the Indus Basin Irrigation System. Part of the remainder is irrigated by decentralized small dams irrigation systems located in the so-called *barani* (rainfed) tract of the Punjab Province (IIMI 1996).

Here, crops are rain-fed, as their elevation and hilly topography prevents access to the contiguous Indus Basin Irrigation System. In this area, groundwater resources are limited and the majority of streams are seasonal. Therefore, reliable crop irrigation could only be achieved by constructing small dams to collect rainfall run-off and seasonal stream flow in small-sized reservoirs. In order to improve agricultural productivity in *barani* lands, the Punjab Irrigation and Power Department, with

[1] In this report, the entity organized by farmers for the purpose of participation in irrigation management at the level of small dams is referred to as a Water Users Organization (WUO). The term Water Users Association (WUA) generally refers to watercourse level organizations in the Indus Basin Irrigation System, and the term Farmers Organization (FO) to federated WUAs. So far, the legal status of small dam level entities is unclear, as the existing legal framework does not provide for the formation of Farmer Organizations at the small dams.

partial financial support from foreign donors, constructed a total of 31 dams in the Pothwar area located in the Rawalpindi Division. This Small Dams Project was targeted to provide 14,500 hectares of land with irrigation water and, to date, cost Rs. 7811.2 million, with a foreign aid component of Rs. 220.43 million. These small dams were designed and constructed by, and are now operated under, the Small Dams Organization (SDO), which has been a section of the Punjab Irrigation and Power Department since 1972, and is headed by a Project Director at the rank of a Superintending Engineer (Shahid and Ashraf, 1998; Iqbal and Khan 1991).

Besides the SDO, two other important agencies are engaged in the project area. The Agency for Barani Area Development (ABAD) currently administers the Second Barani Area Development Project (SBADP), which aims at improving agriculture, economic production and human wellbeing in the *barani* area. The Water Resources Research Institute (WRRI) maintains a field station near the town of Fateh Jang and undertakes research on water resource issues to support farmers through the SBADP.

1.2. Project Inception

IWMI's social organization program in the small dams area was motivated by two considerations. First, the 31 small dams systems in the Punjab Province experience significant constraints, which impede the successful establishment of irrigated agriculture in the *barani* tract.

- After the construction of the dams and irrigation channels, further physical improvement, command area development or institutional development activities were not carried out. SDO merely operated the dams and released water to the channels.
- Farmers were not sufficiently adopting adequate irrigation practices.
- A system of rules for the coordinated allocation and distribution of water was not developed.
- Less than 30 percent of the total command area are irrigated.
- Erosion in the catchment area causes deteriorating storage capacity of the reservoirs due to heavy sediment loads.

Second, Pakistan currently seeks to implement a comprehensive institutional reform of the irrigation and drainage sector, and the small dams systems were identified as suitable pilot sites to test new institutional arrangements.

Pakistan's irrigation sector is characterized by a persistently low return on investments (World Bank 1994). The deterioration of physical infrastructure, environmental decline, an unfavorable ratio of costs to revenues, and unreliable, inefficient water delivery are considered typical problems. As in the case of the small dams, the performance of irrigation systems generally remains low, despite major technical development efforts. Therefore, the causes for such performance deficits are identified as institutional in nature. For that reason, solutions are sought through institutional reforms.

The participatory management of water resources is a central component of globally tested reform models, where rights and responsibilities for the management of local water supply subsystems are transferred to organized water users. Participatory irrigation management is being promoted by irrigation management experts, research institutes and non-governmental organizations worldwide, and has been adopted by several countries in their institutional reforms. The major objectives are to

ensure cost-efficiency and effective, equitable irrigation services through user involvement and control.

With the enactment of the Punjab Irrigation and Drainage Authority Act, policy makers and government actors in the Punjab Province have also made a commitment to institutional reform. However, as knowledge about appropriate mechanisms for institutional change and its impact on agricultural performance is scarce, considerable skepticism prevails and reform implementation is slow.

To facilitate the process of reform by contributing new knowledge and potential models for reform implementation, IWMI Pakistan proposed to carry out action research programs. These aim to develop and test a new approach to institution building and to assess the impact of reformed institutions on the performance of irrigated agriculture. The small dams area was considered a particularly suitable target for the pilot projects, because experiments with new institutional structures could be tested in a limited and relatively independent context before transferring larger subsystems of the Indus Basin Irrigation System to water users. IWMI and WRRI agreed to collaborate on the design and implementation of the action research program in the small dams area and initiated the project in April 1996.

Three project sites were initially selected at the Shahpur, Mirwal and Bhughtal small dams. The first represents an irrigation system, which was considered highly dysfunctional. The second is moderately functional, and the third is more or less fully operational. IWMI undertook social organization activities at the Mirwal and Shahpur sites during its first and second years. During the third year, OFWM requested that the pilot site for the third project be changed to the Kot Raja dam. Here, OFWM acted as the project implementation agency in order to ensure the continuation of the project after the closure of the DFID-supported action research program, while IWMI provided technical support.

1.3. Objectives

At the point of the program inception, the constraints experienced in the Small Dams Project indicated above, provoked the following basic research questions (IIMI 1996):

- What are the causes of the present low levels of management of the small dams in the Punjab Province of Pakistan?
- Can this situation be remedied and the performance improved by organizing water users so that they would assume greater responsibility for the operation and maintenance of the small dams systems?
- To what extent can this strategy improve agricultural production in small dams' command areas?
- What is the most appropriate method of organizing water users under the conditions prevailing in the small dams area?

Following the conceptual logic of action research, these key research questions were translated into five specific project objectives, the implementation of which would yield comprehensive data to answer the key research questions. These objectives were as follows:

1. Identify the extent of current problems related to the system of management and command area development at selected small dams.

2. Facilitate the formation of an appropriate water users organization in each of the selected small dam pilot areas.
3. Assist the organizations to become as functional as possible in the management of operation and maintenance, as well as command area development, with an emphasis on improved irrigated agricultural practices.
4. Develop methodologies for water users organizations under the given technical, socio-economic and institutional conditions.
5. Assess the viability of these chosen social organization strategies and their short-term effects on the operation and maintenance of small dams systems and on their command area development.

These objectives were translated into time bound targets and project outputs as described in the program Inception Report. The expected impacts of interventions formulated in the Inception Report were as follows:

- The establishment of farmer-run mechanisms for deliberation and conflict resolution would reduce the incidence of water and land related disputes.
- The promotion of command area development by water users organizations would increase the area under irrigation.
- Training farmers on irrigated agricultural practices would lead to improved practices, including the use of new crops and high yielding varieties as well as of fertilizers, and thereby, to higher yields.
- Assistance to water users organizations in the development of clear water rights and allocation rules would improve equity in water distribution.
- Attendance to O&M by the WUO would increase the reliability of irrigation and reduce government expenditures.

1.4. Realization of Project Objectives

IWMI's action research program realized the objectives of the project through the following activities:

Re objective 1: Research to 'identify the current problems related to the system management and command area development in selected small dams' was carried out during the diagnostic phase of the social organization process. IWMI Pakistan Report # R-38 (Cheema and Bandaragoda 1997) and WRRI's report (1997) on 'Initial Technical Diagnostic Surveys for Mirwal and Shahpur Dams in the Pothwar Plateau' present the central findings. Chapter 2 of this Final Report synthesizes the data in the context of a description of the project setting and analyzes the central problems, which are summarized in Section 2.5.

Re objective 2: To 'facilitate the formation of an appropriate water users organization in each of the selected small dam pilot areas', IWMI carried out social organization programs in 2 pilot sites at Mirwal and Shahpur Dams. Farmer water users in the command areas were mobilized and established water users organizations. In a third pilot site at Kot Raja Dam, IWMI assisted OFWM staff to facilitate the establishment of another water users organization. The Yearly Progress Report of April 1998, submitted by IWMI Pakistan to DFID, the Project Inception Report by IWMI Pakistan (1996) and Chapter 3 of this Final Report describe and analyze the social mobilization process.

Re objective 3: To 'assist the [farmer] organizations to be as functional as possible in the management of O&M and command area development', IWMI staff mobilized organizational links between WUOs and government agencies, conducted participatory needs assessment and planning exercises, organized training, and supported collaborative activities between irrigators and government partners in O&M and command area development. The IWMI Pakistan Report on 'Maintenance and Operational Activities at the Shahpur and Mirwal Small Dams' (Bhatti, Cheema and Skogerboe, 1999) provides a detailed review of these activities. Chapter 3 of this Final Report synthesizes the results and provides further information on command area development.

Re objective 4: 'Methodologies for establishing water users organizations under the given technical, socio-economic and institutional conditions' have been developed in the process of the action research program. 'Guidelines for Social Organization in Irrigated Agriculture at Small Dams, Punjab, Pakistan', by Cheema and Bandaragoda, are forthcoming. The methodologies evolved are discussed in this Final Report in Chapter 3.

Re objective 5: An assessment of 'the viability of the chosen social organization strategies and their short-term effects on operation and maintenance of small dams systems and on their command area development' is provided in Chapter 4 of this Final Report.

1.5. Concepts and Assumptions

The program was guided by a number of key concepts and assumptions, which entail certain fundamental values and dispositions. They comprise a conceptual framework, which by implication also underwent field-testing through the action research conducted.

Obviously, the social organization of water users places emphasis on and connects high expectations with collective action. Collective action is assumed to accomplish attitudinal changes among participants, the recognition of common goods as a matter of common concern, as well as the simultaneous facilitation of individuals' capacity for participation and restraint of action within socially accepted behavioral boundaries. Of particular significance here is the negative sanctioning of free riders and community members who seek to maximize access to common goods at the expense of others. In this context, the program stressed the significance of consultation among organized water users with the aim of reaching consensus regarding important decisions. The assumption was that consensus-based decisions would galvanize the groups around a common set of objectives and help overcome divisions grounded in the social cleavages endemic to the communities involved.

The program from the outset was concerned with the sustainability of organized collective action. It recognized that this would depend on the involvement of significant local and national actors and agencies with access to various local social groups and authorities. IWMI staff was expected to play the role of a catalyst, which mobilizes local people, community-based opinion leaders, national institutes and local agencies to share in the organizing effort. At the same time, it was emphasized that the delivery of technical services, extension packages and cost-sharing mechanisms are insufficient to sustain the collective action of water users. It was postulated that 'continuous engagement in productive activity by water users' would by itself be an incentive for persistent organized activity.

Finally, the program specifically favored participatory irrigation management over privatization. While the latter transfers government assets to the private sector, the former is defined as 'processes by which legitimate interests in a project or activity influence or take part in decisions that affect them' (IIMI 1996). The concept of joint management currently used by Pakistan's policy makers and agency personnel in discussions on irrigation reform may capture this understanding.

The Inception Report also mentions 'uncertainties and doubts' regarding the resource capacity of farmers to carry out O&M tasks. These would include financial and human resources, in particular farmers' decision-making capacity to identify and assume a set of functions to undertake.

1.6. Key Actors

The key organizations involved in the implementation of the action research program were IWMI, WRRI and SDO. IWMI's role was to facilitate organization and capacity building among farmers in order to mobilize resources from within the farming communities, as well as resources available from SDO and other local agencies. WRRI agreed to provide support in the form of research and development advice. SDO's task was to support IWMI's and WRRI's field activities and to seek ways and means of involving water users in O&M and command area development at the small dams. The emphasis on facilitation implied that IWMI and WRRI themselves would provide minimum financial resources and physical inputs to carry out project work. The expectation was that the 'irrigation partners', namely WUOs and SDO, would take on such tasks and responsibilities.

IWMI's main tasks were identified as that of training social organizers, social organization volunteers and water user groups; developing and implementing the organizing process; training organized water users; maintaining process documentation; and assessing short-term impacts of WUOs on O&M and command area development. Altogether, IWMI stationed three social organizers in the field, supported and guided by an irrigation institutional specialist and a sociologist. IWMI irrigation engineers provided technical support for O&M activities and trained farmers and IWMI field staff throughout 1998.

WRRI carried out a technical diagnostic survey of the Mirwal and Shahpur Dams and supplied maps of the pilot sites. It provided training on irrigated agricultural practices to farmers. SDO provided support services through its project director and field level staff, including sub-divisional officers, sub-engineers and patwaris.

1.7. Approach

The approach of the IWMI project team to the task of the social organization of water users at the small dams entails five salient components.

- The organizing process itself is participatory, as the water users themselves decide on the form, structure and functions of their organizations. All decisions regarding activities are to be taken by the members. IWMI and other collaborating partners act as facilitators and advisors.
- The process of organization needs to be slow and follow a series of steps in order to establish rapport between farmers and facilitators. Farmers tend to be suspicious of outside interventions as a result of difficult experiences with government agency personnel and previous development projects. The step-wise iterative process strives to develop mutual trust, information exchange, consultation for consensus, development of options, and implementation of an appropriate organizational design.
- The tasks of facilitation of organization building, data collection and farmer training are to be carried out by a small field team of three social organizers and a field assistant. These organizers require thorough training in all social and technical aspects pertinent to the situation in the pilot sites.
- The involvement of community-based social organization volunteers, selected from among key informants during the initial rapport-building and data collection phase, are to be utilized

to carry out a series of dialogues with the community, which would eventually lead to the establishment of water users organizations.

- The incentives for social organization would be primarily non-physical and non-monetary. Project experiences in the past show that monetary or material incentives are merely temporary and fail to generate sustained organizational efforts among project beneficiaries. The action research approach seeks to motivate farmer participation by convincing them of the benefits of organized collective action, such as improved water delivery, equitable distribution, improved agriculture, and empowerment.

In addition, IWMI's staff anticipated developing an institutional arrangement for the provision of irrigated agriculture advisory services that can provide support to WUOs on an ongoing open-ended basis.

Finally, throughout the entire program, data collection on the initial socio-economic, agricultural and technical characteristics of the pilot sites, as well as on the process of project implementation, needs to be undertaken. A combination of research tools can serve this purpose, including walk-through, participatory mapping, semi-structured interviews, process documentation, secondary data collection from government agencies, as well as socio-economic and technical baseline surveys.

2. PROJECT SETTING

This chapter discusses the geo-physical, social, agricultural and technical characteristics of the small dams project area and the central problems affecting irrigation management and command area development at the time of the project inception.

2.1. Geo-Physical Characteristics

The geo-physical characteristics of the small dam area constitute the ecological context with both, factors enabling and limiting agriculture in the Pothwar Plateau.

2.1.1. The Pothwar Plateau

The so-called Pothwar Plateau is located in the Rawalpindi Division and is located in the rain-fed (*barani*) area of the Punjab Province. Twenty-seven percent of the province's population resides in the *barani* area, where 28 percent of its cropped lands are located (ABAD 1986). Agriculture in the *barani* area is characterized by low productivity, uneven distribution of rainfall, losses of rainfall due to rapid rainfall run-off, small size of land holdings and use of limited technology. Crop production is dependent mainly on rainfall, as only 5 percent of the cultivated area are under irrigation through wells, tubewells and storage dams. In the absence of assured irrigation water supplies, the use of complementary inputs is restricted, which ultimately results in lower crop yields.

The main *Rabi* (winter) crops in the *barani* area are wheat, gram and oilseed, while maize, jowar, bajra and groundnuts are the principal *Kharif* (summer) crops. Wheat is the dominant crop of the *barani* tract. In 1985-86, the *barani* area accounted for about 16 percent of the total area sown under wheat in the Punjab Province and produced 9 percent of the total wheat output from this province. The Rawalpindi division produced 6 percent of the Punjab Province's total wheat output and 68 percent of its *barani* tract wheat output (Government of Punjab, 1986).

Rainfall is the most critical factor in the *barani* environment. Approximately 30 to 35 million acre-feet of annual rainfall are received in the *barani* area of the Punjab Province, but rainfall is not fully utilized by crops and plants because of rapid rainfall run-off (Awan, 1979).

Rainfall data for 1983-96 collected at the WRRI-NARC field station (Table 1) indicate that the mean annual rainfall is about 930 mm with seasonal means of 328 mm and 602 mm, respectively, for the *Rabi* and *Kharif* seasons. However, the rainfall probability analysis indicates that rainfall at 20 percent probability is sufficient to raise *Kharif* crops, while a successful *Rabi* crop would depend on supplementary irrigation. Furthermore, inter-annual variation of rainfall, which ranges between 146 and 588 mm in the *Rabi* season and 208 mm and 769 during the *Kharif* season, indicates a considerable fluctuation in water availability, even if reservoirs are utilized to capture run-off. Streamflow in many of the rivers of the Pothwar Plateau is seasonal and, therefore, its potential contribution to reservoir storage is limited. The reservoirs in the *barani* tract, therefore, depend mainly on rainfall run-off from limited catchments.

Table 1. Seasonal Rainfall (mm) at Selected Probability Levels for the WRRI-Field Station, Mauza Mangial, Fatehjang

Season	Lowest Rainfall	Probability (%)			Highest Rainfall
		20	50	80	
Rabi	146	168	297	363	588
Kharif	208	430	528	672	769
Annual	582	818	866	1103	1393

Source: WRRI, 1997.

The topography of the area poses further problems for irrigated agriculture. Its elevation and undulating rolling hills prevent access to the Indus Basin Irrigation System and make the construction of independent irrigation systems costly. Thus, only comparatively small areas can be reached by the small dams systems and expensive land leveling efforts are required.

While most of the small dams were intended to provide irrigation water to cultivators, they have in fact multiple uses, such as the supply of domestic and livestock needs and fisheries. Raised sub-soil water levels due to the impounding of reservoirs afford the added opportunity for groundwater exploitation with tubewells.

2.1.2. Shahpur Small Dam

The Shahpur Small Dam is situated in the Kala Chitta Range at about 47 km from Rawalpindi / Islamabad. The dam site is about 8 km North of the town of Fateh Jang in the Attock District. It is at 72° Longitude East and 33° Latitude North. The climate of the area falls under the tropical semi-arid zone with an annual temperature above 24°C and dry winters. The highest daytime temperatures have been recorded in May and June when the uninterrupted hot weather remains with mean daily maximum temperatures above 45°C. The months of April to June are usually dry. The cold season starts in the middle of December and is characterized by fine weather, low humidity and great variation in the range of temperature. Rainfall is about 737 millimeters in an average year. The elevation of the area, including the watershed, ranges from 1,392 feet (424 m) to 1,772 feet (540 m). The command area is terraced, ranging from 1,451 feet (442 m) to 1,390 feet (424 m) (SDO, 1997a).

2.1.3. Mirwal Small Dam

The Mirwal Small Dam is located near the village of Mirwal, about 42 km to the West of Fateh Jang on the Fateh Jang - Kohat Road in the Attock District. This dam is situated at 72° Longitude East and 33° Latitude North. The climate is the same as at the Shahpur Dam. The elevation of the area, including the watershed, ranges from 1,245 ft. (379.5 m) to 1,629 ft. (496.65 m). The command area is terraced, ranging from 1,298 ft. (396 m) to 1,270 ft. (387 m) (SDO, 1997b).

2.1.4. Kot Raja Dam

The dam site is near the village of Kot Raja, about 24 km South-East of the town of Chakwal. The site is located at Longitude East 72° and Latitude North 32°. The elevation of the area including the watershed ranges from 1,650 ft. to 2,034 ft. and the command area is terraced. The climate is similar to that at the Shahpur Dam (SDO, 1997c).

2.2. Social Characteristics

The social characteristics of the pilot sites constitute some of the central parameters of and also chief challenges for IWMI's social mobilization activities. This section discusses the basic social

infrastructure, property relations, caste, employment, education and organizational behavior. The information provided was collected through the project team's baseline survey and other data collection exercises.

The sample villages include the following: Mirwal, Kisran, Nathein and Kamalpur Sherjang, with a total population of approximately 10,000 living in 1,225 households at Mirwal Dam; Amir Khan, Kareema, Shahpur and Dhok Baluch with a total population of 7,000 in 807 households at Shahpur Dam; and Kot Raja and Sohawa with about 6,800 inhabitants and 850 households at Kot Raja Dam. The baseline survey sample collected data from farming households residing in the culturable command areas of the small dam irrigation systems. Approximately 75 percent of the sample households are irrigators, while the remainder cultivates rainfed land in the CCA (Cheema and Bandaragoda, 1997), due to the lack of access to irrigation channels.

2.2.1. Social Infrastructure

Generally, the infrastructure of basic facilities such as education, health care, access to safe drinking water, transport, communications, markets, etc. in the village communities located in the pilot command areas can be characterized as limited. Some villages are quite remote and, therefore, lack essential services. Most villages offer only primary education. With the exception of the Kot Raja area villages and Kisran village at Mirwal Dam, no medical and veterinary services are available. All villages, except two, do not have access to safe drinking water and none are provided with sewerage systems. Transport is restricted, as only 4 out of the 10 villages are connected to bus services, although 'farm to market' roads have been constructed in recent years. Only one village has marketing facilities. While most villages do not have access to telephones, all villages have postal services as well as electricity. Banks are non-existent in all but one village (Tables 2, 3 and 4).

Table 2. Social Infrastructure of Communities in the Mirwal Small Dam Area

Facilities	Village Name			
	Mirwal	Kisran	Nathein	Kamalpur/ Sherjang
Hospital/Dispensary	No	Yes	No	No
Veterinary Hospital	No	Yes	No	No
School (Males)	Primary	Middle	Primary	Primary
School (Females)	Primary	High	Primary	Primary
Farm to Market Road	Yes	No	Yes	Yes
Electricity	Yes	Yes	Yes	Yes
Telephone	No	No	No	No
Safe Drinking Water	Yes	No	No	No
Post Office	Yes	Yes	Yes	Yes
Marketing Facilities	No	No	No	No
Bus Station	Yes	No	Yes	No
Bank	No	No	No	No
Cooperative Society				
a. Formal	Yes	No	No	Yes
b. Informal	Yes	No	No	Yes
Sewerage System	No	No	No	No
Total Households	225	700	150	150
Total Population	1800	6000	1200	1000
Panchayat System	Yes	No	No	Yes

Source: Cheema and Bandaragoda, 1997.

Table 3. Social Infrastructure of Communities in the Shahpur Small Dam Area

Facilities	Villages Name			
	Amir Khan	Kareema	Shahpur	Dhok Balouch
Hospital/Dispensary	No	No	No	No
Veterinary Hospital	No	No	No	No
School (Males)	Primary	Middle	Primary	Primary
School (Females)	Primary	Primary	Primary	Primary
Farm to Market Road	Yes	Yes	No	No
Electricity	Yes	Yes	Yes	Yes
Telephone	Yes	Yes	No	No
Safe Drinking Water	Yes	No	No	No
Post Office	Yes	Yes	Yes	Yes
Marketing Facilities	No	No	No	No
Bus Station	Yes	No	No	No
Bank	No	No	No	No
Cooperative Society				
a. Formal	No	Yes	No	No
b. Informal	No	Yes	No	No
Sewerage System	No	No	No	No
Total Households	400	150	135	122
Total Population	3500	1300	1050	1300
Panchayat System	No	Yes	Yes	Yes

Source: Cheema and Bandaragoda, 1997.

Table 4. Social Infrastructure of Communities in the Kot Raja Small Dam Area

Facilities	Village Name	
	Sohawa	Kot Raja
Hospital/Dispensary	Yes	Yes
Veterinary Hospital	No	Yes
Schools (Males)	Primary	High
School (Females)	Primary	Middle
Farm to Market Road	Yes	Yes
Electricity	Yes	Yes
Telephone	No	Yes
Safe Drinking Water	No	No
Post Office	Yes	Yes
Marketing Facilities	No	Yes
Bus Station	Yes	No
Bank	No	Yes
Cooperative Society		
a. Formal	No	Yes
b. Informal	No	Yes
Sewerage System	No	No
Total Households	700	150
Total Population	6000	800
Panchayat System	Yes	Yes

Source: Cheema et al, forthcoming.

This situation indicates that some services essential to organizational activity, such as communication, transport and banking, are restricted. The absence of marketing facilities places a significant constraint on the local agricultural economy, and farmers are dependent on private transport services to towns. The restricted availability of education would limit farmers' cognitive capacities and, therefore, may pose obstacles to social organization.

2.2.2. Property Relations

This category involves the distribution of land and the tenurial status of cultivators. Generally, landholdings in the Pothwar area are relatively small when compared to the Lower Punjab and Sindh Provinces. A fairly high percentage of large (11.6 percent: 250 acres and above) and midsize (34.9 percent: 25 to 250 acres) landowners reside at Mirwal Dam. Large landowners are absent at Shahpur and Kot Raja Dams, and the midsize group is quite small (7.9 and 4.6 percent, respectively). More than 75 percent of landholdings are 12.5 acres or less at both sites (Table 5).

Table 5. Land Distribution (Percent)

Land Holdings (acres)	Mirwal (N=43)	Shahpur (N=128)	Kot Raja (N=87)
Up to 5 acres	7.0	41.7	41.4
5.1 to 12.5 acres	25.6	33.9	35.6
12.6 to 25 acres	20.9	16.9	18.4
25.1 to 250 acres	34.9	7.9	4.6
250 acres and over	11.6	-	--

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

Land tenure is characterized by the predominance of owner-cultivation. Only at Mirwal Dam do tenants and lessees roughly comprise 29 percent of cultivator households. Large and midsize landowning households generally employ laborers, some of whom they have maintained service relationships with over generations (Table 6).

Table 6. Tenurial Status of Farmers (Percent)

Tenurial Status	Mirwal (N=59)	Shahpur (N=135)	Kot Raja (N=87)
Owners (Absentee)	5.1	-	-
Owner-Cultivators	71.2	94.0	97.7
Tenants	13.6	04.4	02.3
Lessees	15.2	01.6	--

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

The potential dominance of influential and powerful larger landowners in water users organizations is a typical and justified concern, which IWMI project staff were well aware of. Traditionally, these community-members are well-placed to control material resources, information flow and local politics. Small farmers in the project areas complained about the privileged access of some 'influentials' to irrigation water as one cause of the disregard for allocated water shares (*warabandi*) and, thus, of inequity. Another complaint was that machinery used for land leveling, a prerequisite for irrigation in the *barani* area, was tied up by 'influentials' who secure preferential services from government personnel.

Another concern was the lack of interest in collective action among some large landowners, some of whom never participated in WUO meetings. Their ability to obtain more than an equitable share of resources by individual means and the fact that much of their land was located outside the command areas of the irrigation systems would account for this attitude.

Finally, some writers assume that there is a direct correlation between the size of landholdings and the willingness to adopt so-called progressive farming practices (Lionberger 1961; Cheema et al, 1992). Consequently, it was expected that the combination of a predominance of small-holdings and the lack of experience with cash cropping under irrigated systems would cause difficulties to motivating the majority of farmers to modify their cultivation practices.

2.2.3. Caste

Castes and *baraderies* (kinship groups) (the distinction between both is often imprecise in Pakistan's social discourse) are primary reference groups demanding loyalty and defining identities in all aspects of social life. Conversely the may be primary closure mechanisms with respect to social interaction and control of, or access to land and other resources. Thus, they can be sources of adversarial conduct between different kinship groups.

The Awan/Malik and Rajput castes are among the most prevalent in all sites, although Raja and Syed are strong in the Kot Raja Dam villages as well. Members of the Kathar and Pathan castes are significant minorities in the Shahpur and Mirwal areas (Table 7). The IWMI field team became keenly aware of the fact that members of 'higher' castes were reluctant to meet in the settlements and houses of those considered 'lower'. The divide between these groups affected their capacity to communicate and seek amicable solutions to water-related disputes.

Table 7. Caste Structure (Percent)

Caste	Mirwal (N=59)	Shahpur (N=135)	Kot Raja (N=87)
Pathan	-	11.9	1.1
Kathar	8.5	16.3	-
Maliar	1.7	5.2	-
Rajput	40.7	5.2	24.2
Awan/Malik	37.3	37.0	13.8
Syed	-	-	11.5
Gakhar	-	-	21.8
Mughal	-	-	11.0
Raja	-	-	6.9
Others	11.9	24.4	9.7

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

2.2.4. Education

The most common assumption among critics of farmer involvement in irrigation management is that their comparatively low level of education would prevent them from grasping technical concepts relevant to engineering issues and, thus, jeopardize adequate standards of irrigation management.

Indeed, educational attainment is relatively low, given that at the three dam sites 20, 39 and 49 percent of sample household heads, respectively, are illiterate and another 15 to 25 percent have primary education only. The average level of education is the highest in Kot Raja and the lowest in Shahpur. However, more than 20 percent have attained the matriculation level or higher (Table 8).

Consequently, the challenge for social organization was to secure the involvement of the least educated, while tapping the cognitive resources of the more educated, and thereby, to ensure that representation in water users organizations would be both, equitable and conducive to effective management.

Table 8. Educational Attainment (Percent)

Education	Mirwal (N=59)	Shahpur (N=135)	Kot Raja (N=87)
Illiterate	39.0	48.9	20.17
Primary	15.3	15.6	25.3
Middle	15.3	11.9	26.4
Matriculation	11.9	14.8	18.4
F.A./F.Sc	8.5	3.7	5.7
B.A/B.Sc.	8.5	4.4	2.3
M.A./M.Sc	--	--	1.1
Other	1.7	0.7	--

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

2.2.5. Organizational Behavior

Studying the level of participation in community-based organizations can help assess the existent capacity for organized collective action at the time of the inception of the action research program. Of the three existent organizations in the villages, two are dedicated to the management of religious activities, i.e. *Masjid* and *Zakat* Committees. Cooperative societies exist in all of the project sites and are mostly concerned with the provision of credit. Frequently, these are initiatives for the benefit of a few families only and remain, by and large, 'paper organizations'. *Panchayats*, councils of elders, function in a majority of villages to resolve local level conflicts.

Among the sample households, the highest level of participation of the wider community occurred in the maintenance and construction of mosques (86 to 100 percent) and schools (41 to 66 percent). Participation in the settlement of land disputes, marketing of inputs and crop produce, and maintenance of watercourses and roads was comparatively lower, except in the Kot Raja area (Table 9).

Table 9. Organizational Behavior

Organizational behavior	Mirwal (N=59)	Shahpur (N=135)	Kot Raja (N=87)
Maintenance/ Construction of Mosque	86.4	100.00	97.7
Maintenance/ Construction of School	42.4	41.5	66.7
Settlement of Land Dispute	8.5	10.4	40.2
Purchase of Inputs	8.5	4.5	1.1
Marketing of Crop Produce	11.9	3.0	5.7
Maintenance of Watercourse	8.5	3.7	31.0
Maintenance/ Construction of Village Streets	10.2	2.2	57.5
Maintenance/ Construction of Village Well	-	3.7	24.1

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

These data indicate that religious activities are given the highest priority in organized behavior at the village level. Although about 75 percent of the respondents are irrigators, the participation level in the maintenance of irrigation infrastructure was only 8.5, 3.7 and 31 percent in Mirwal, Shahpur and Kot Raja Dams, respectively, at the time of the project inception. Local rural communities comprise relatively individualized social actors, who are most easily galvanized by religion and kinship identities. The overall level of experience in collective action for the management and development of common goods is low and a culture of organizational behavior is relatively undeveloped. The councils of elders are important traditional institutions, which may be incorporated into the institutional framework of irrigation reform. These, however, delegate decision-making power to a selected group within the community.

2.3. Agricultural Characteristics

This section indicates cropping patterns and yields/income from agricultural production in the pilot sites, and identifies deficits in cropping intensities, the actual area under irrigated cultivation and institutional linkages with government agencies.

2.3.1. Cropping Pattern

Cropping patterns are associated with factors such as climatic conditions, sources and reliability of irrigation water, soil quality, water demand of crops, size of landholdings, and farmers' decisions relating to the relative importance of subsistence and cash crops.

Wheat, maize and peanuts, as well as fodder for livestock, are considered traditional crops typical for subsistence-oriented farmers in rain-fed agriculture in the *barani* area. High value cash crops, such as chilies, sugarcane, vegetables, citrus, coriander and oilseed are considered modern and desirable by agricultural extension services and promoters of green revolution agriculture. Command area development in the small dams area, therefore, is not only associated with the expansion of the actual irrigated area to the projected command area, but also with a shift from traditional subsistence crops to modern cash crops.

At the time of the project inception, both cash crops and subsistence crops were grown in all seasons on irrigated and rain-fed lands. Overall, however, maize and fodder remained dominant during the *Kharif* (winter) season. Sixty-nine of the cultivators interviewed grew maize on irrigated fields and 85 on rain-fed fields, with an average per cultivator acreage ranging from 0.5 acres to 1.6 in the three project sites. Fodder was grown by 67 farmers on irrigated and by 29 on rain-fed land, on an average acreage ranging from 0.6 to 1 per farmer. Chilies were the only crop adopted by a majority of farmers (59) on irrigated lands in Mirwal and Shahpur, where the average acreage was 0.8 per farmer. In Shahpur three farmers grew vegetables on irrigated fields with an average acreage of 1 per farmer, and four farmers on *barani* lands with an average acreage of 2.2 per farmer. A few large farmers with an investment capacity and reliable access to irrigation canals grew lucrative cash crops during *Kharif*. Three of these farmers cultivated sugarcane and one grew citrus on relatively large lands (4.8 acres on average for sugarcane and 87 acres for citrus). During the *Rabi* season, wheat remained the most important crop grown by the majority of farmers on both, irrigated (171) and rain-fed fields (195). One farmer grew an onion cash crop and another coriander on irrigated land. For a detailed breakdown of cropping patterns, see Table 10.

IWMI's project staff attributed the predominance of traditional crops on irrigated land in both seasons, particularly among smaller farmers, to a traditional orientation, the lack of education and a lack of familiarity with irrigated agriculture. The adoption of cash crops among cultivators with large holdings was interpreted as 'progressive' and favorable. However, it must be noted that small farmers, in particular, value traditional crops as they afford food security and independence from markets, which are located at a distance and controlled by traders. In the case of chilies, which are grown with relative ease and little investment, small farmers are willing to combine subsistence and cash crops. Long-term investment in citrus orchards was made by the largest landowner at Mirwal Dam, who had almost complete control of one of the system's canals and privileged access to government subsidies. Nevertheless, if access to reliable irrigation water and markets is ensured, small farmers may profit from shifting some of their land to annual and perennial cash crops. Thus, the improved management of irrigation and participation in command area development activities is in their best interest.

Table 10. Cropping Pattern in Irrigated and Barani Areas of the Mirwal, Shahpur and Kot Raja Small Dams: Mean Acreage per Cultivator (Number of Cultivators)

Crops	Irrigated			Barani		
	Mirwal	Shahpur	Kot Raja	Mirwal	Shahpur	Kot Raja
Kharif						
Peanut	1.1 (2)	--	--	14.46 (29)	--	--
Oil Seed	.75 (1)	1.1 (2)	.87 (1)	7.97 (11)	1.63 (3)	1.0 (1)
Maize	1.32 (23)	1.69 (39)	.84 (7)	2131 (6)	2.89 (50)	2.04 (29)
Fodder	.70 (12)	1.08 (4)	.85 (51)	10.20 (12)	2.43 (17)	--
Orchard	87.0 (1)	2.41 (4)	.5 (1)	--	--	--
Vegetable	1.70 (8)	.87 (39)	1.0 (1)	1.25 (2)	2.63 (4)	--
Chili	1.0 (30)	.59 (29)	--	--	--	--
Sugarcane	1.69 (3)	--	--	--	--	--
Rabi						
Wheat	5.70 (33)	2.83 (64)	1.88 (74)	12.45 (45)	5.2 (113)	2.96 (37)
Gram	--	--	1.75 (2)	13.83 (6)	--	.63 (1)
Fodder	.52 (4)	1.75 (2)	.46 (14)	4.09 (7)	1.58 (3)	.88 (1)
Vegetable	.66 (4)	1.05 (12)	--	--	12.63 (2)	--
Onion	--	2.5 (1)	--	--	--	--
Oat	.125 (1)	--	--	--	--	--
Oil Seed	--	--	.69 (3)	--	--	2.02 (6)

Source: Cheema and Bandaragoda, 1997; Cheema et al, forthcoming.

2.3.2. Crop Yields

Data on crop yields collected in the baseline survey are somewhat inconclusive, as farmers do not measure the weight of most of the cash crops and of fodder. Data on income from cash crops were collected, but comparative figures for national averages are scant.

Yields for wheat in Mirwal and Shahpur were 700 kg per acre on irrigated and 566 kg per acre on rain-fed fields. In Kot Raja yields on irrigated fields were only 344 kg per acre. All are below the national average of 817 kg per acre. Sugarcane yields on irrigated fields in Mirwal were 13,400 kg per acre, while the national average is 19,000 kg per acre (Government of Pakistan, 1998, Cheema and Bandaragoda, 1997). Furthermore, the diagnostic survey of WRRI suggests that yields are constrained by the level of water use efficiency in irrigated fields, which at 6.7 – 10 kg/mm is below the potential (WRRI, 1997). The main causes identified are the use of poor seed material, low fertilizer use, heavy cut and fill due to land forming, and incomplete irrigation.

These data indicate that there is considerable room for improvement through better cultivation and irrigation practices.

2.3.3. Cropping Intensity

Under conditions of rain-fed cultivation, cropping intensities in the area of Shahpur Dam was 60 percent, while anticipated values for 1993 (six years after the dam's construction) was 140 percent (SDO, 1997a). At Mirwal Dam, the cropping intensity under *barani* agriculture was 70 percent, while 140 percent is expected by 2001 for irrigated fields (SDO, 1997b). At Kot Raja, these values are 70 and 120 percent, respectively (SDO, 1997c). The IWMI baseline survey reported cropping intensities of 118, 123 and 52 for irrigated land in Shahpur, Mirwal and Kot Raja, respectively (Cheema and Bandaragoda, 1997; Cheema et al, forthcoming). In *barani* land, the values for Shahpur and Mirwal were 47.7 and 51 percent, respectively. No data were available for Kot Raja.

Although the baseline survey's values indicate a considerable improvement through irrigation at Shahpur and Mirwal so far, there is still room for improvement if reliable and equitable irrigation supplies can be provided. However, the more pressing issue is the relatively small area, which is actually irrigated.

2.3.4. Irrigated Area vs. Culturable Command Area

Besides low yields, sub-optimal cropping intensities and a continued investment in subsistence crops in irrigated fields, the difference between actual irrigated area and culturable command area (CCA) was considered a central problem experienced in the pilot areas.

The CCA for the Shahpur dam is 1,231 acres, but the actual irrigated area was only 140 acres during the 1997 *Kharif* and the 1997/98 *Rabi* seasons. At Mirwal, the CCA is 1,050 acres, while the actual irrigated area was 184 acres during the 1997 *Kharif* and 180 acres during the 1997/98 *Rabi* seasons (see Table 12, below). This vast discrepancy is in part due to a lack of assistance to farmers, who are inexperienced in irrigated agriculture. Insufficient command area development, as well as insufficient maintenance and the disorganized operation of the irrigation system were significant obstacles for improved agricultural productivity. In addition, the concept of command area development, as consisting mainly of land leveling and the extension of the irrigation system, may be inadequate in the Pothwar Plateau. In undulating hills, contour terraces and a commensurate design of irrigation channels may be more conducive than land leveling. The latter is problematic because the acquisition of heavy machinery is difficult, the deposition of large quantities of removed soil material may cause environmental problems, and fertile topsoil would be lost. However, these considerations were not entertained in the planning and design of the small dams systems.

Data on the adequacy of water availability for the designed command areas are not available. However, the design was based on estimated source capacities of the reservoirs and anticipated cropping intensities (see Sections 2.3.3., 2.4.1-3, as well as Tables 13 - 15 in the annex and SDO 1997a, b and c). At Shahpur Dam, considerable seepage losses of approximately 16 l/s/km would have contributed to the limitation of its actual irrigated area (Bhatti, Cheema and Skogerboe, 1999).

2.3.5. Support Services

Farmers reported that support services by government organizations concerned with agriculture and irrigation were relatively weak. In most cases, only a minority of respondents to the baseline survey had contact with, or received services from OFWM, ABAD and SDO (Cheema and Bandaragoda, 1997). Some larger farmers reported that they were occasionally able to access support services and benefits. As a consequence, irrigation system maintenance was weak and a *warabandi* existed on paper only. Farmers with access to irrigation water failed to follow an organized irrigation schedule and tail-enders did not receive water. They consistently complained that subsidies and implements for the improvement of agricultural activities were utilized mainly by 'influentials'. Farmers harbored considerable suspicions and felt highly distrustful towards government agencies in general, which proved a major impediment in IWMI's mobilization activities. The weak linkages between farmers and the existing institutional framework in irrigation and agriculture in the small dams area, therefore, became a major target of social organization activities undertaken by IWMI.

2.4. Technical Characteristics

This section discusses the technical characteristics of the small dam irrigation systems in the pilot sites and points out the prevalent technical and related institutional problems adversely affecting irrigated agriculture.

2.4.1. Shahpur Dam

The Shahpur Small Dam was constructed on the Nadna Kas Stream, and was commissioned by the Small Dams Organization (SDO), Irrigation and Power Department of the Government of Punjab, during 1986 at a cost of Rs. 36.5 million. The reservoir of the Shahpur Dam has a gross storage capacity of 14,320 acre-feet, out of which 4,079 acre-feet is the dead storage capacity and the remainder is the live usable storage. The reservoir capacity has been fixed according to inflows generated by the catchment of the Shahpur Dam during standard dry years, from August 1948 to July 1979. It satisfies irrigation requirements for 1,231 acres of land and provides 2 mgd of drinking water supply to the town of Fateh Jang. The surface area submerged by water at the normal reservoir level amounts to 700 acres.

The irrigation system of the Shahpur Dam consists of an outlet structure from the dam and a main channel, which off-takes from the right side of the dam. This is a steel-lined concert conduit fixed at the dead storage level with arrangements to regulate the flow. The regulation is controlled by a sluice valve, which operates from a platform at the downstream end of the conduit.

The main channel is divided into two branch channels at RD 10+000. The length of the main channel is 10,000 feet. The left branch channel is 5,400 feet, while the length of the right branch channel is 24,000 feet. The discharge at the head of the main channel is 13 cusecs. There are 31 outlets in the irrigation system. The irrigation system network of the Shahpur Dam is represented in Figure 2 in the annex. Before the construction of the dam, the cropping intensity under *barani* agriculture was 60 percent, while the proposed cropping intensity of 140 percent was to be achieved within 6 years after its construction, by 1993. The salient features of the Shahpur Dam are given in Table 13 in the annex.

2.4.2. Mirwal Dam

The construction of the Mirwal Dam was completed at a cost of Rs. 422.29 million during 1990. The reservoir has a gross storage capacity of 3,765 acre-feet, out of which 2,726 acre-feet is the live storage capacity and the remainder is dead storage. The reservoir capacity has been defined according to inflows generated by the catchment of the Mirwal Dam during the standard dry years from August 1982 to July 1985, to satisfy irrigation requirements for 1,050 acres of cultivated land. The reservoir surface area at the Normal Pond Level (NPL) consists of 184 acres. The reservoir receives all of its inflow from rainfall runoff.

A sluice valve on the right flank provides an off-take from the reservoir. An additional sluice valve is also provided in the back, which could be used when sediment fills the reservoir to the level of the present working off-takes. The working off-takes are each controlled by 1-foot diameter sluice valves.

The irrigation system consists of one main channel and one minor (Sher Jang Minor), which off-takes from RD 9,600 of the main channel. The length of the main channel is 22,745 feet. The length of the minor is 5,500 feet. The discharge at the head of the main channel is 11 cusecs and the area under command is 1,050 acres. The irrigation system network of the Mirwal Dam is represented in Figure 3 in the annex. The main channel has two sections. The first is rectangular, made of brick masonry and 350 feet in length, while the second section is trapezoidal, with concrete lining having a 1:3:6 ratio. The command area has been developed by partial lining of the watercourses and land leveling. Before the construction of the dam, the cropping intensity, based on *barani* agriculture, was 70 percent, while with irrigation 140 percent are anticipated by 2001. The salient features of the Mirwal Dam are presented in Table 14 in the annex.

2.4.3. Kot Raja Dam

The Kot Raja Dam is located downstream of the Dhok Tahlian Dam, which supplies the Kot Raja reservoir with flood discharges. An ungated chute spillway has been provided on the left side of the dam for flood discharges. The discharge capacity of the spillway is 4,770 cusecs, which has been anticipated on the basis of 230 mm rainfall; the maximum probable 24-hour rainfall with a 1,000 years return period. The spillway structure is connected to the reservoir through a 1,130 feet approach channel.

The reservoir of the Kot Raja Dam has a gross storage capacity of 2,844 acre feet out of which 1,344 acre feet is the live storage capacity and the remainder is the dead storage. The reservoir capacity has been defined according to inflows generated by the catchment of the Kot Raja Dam during the standard dry year from August 1977 to July 1978, to satisfy irrigation requirements for 1,112 acres of land. The surface area of the reservoir at normal pond level is 169 acres. The expected life of the Kot Raja Dam is estimated to be 50 years and the defined dead storage capacity has been based on a sediment yield of 500 M3/Km2 per year.

One outlet structure has been provided in the main body of the dam. Pre-stressed R.C.C. pipes of 2-feet diameter have been used for this structure to discharge 14 cusecs of water. The outlet is controlled by means of a sluice valve on the U/S end. The sluice valve has been connected to the outlet machine fixed on the regulation platform.

The irrigation system of the Kot Raja Dam consists of a main channel, which off-takes at the right side of the main dam and two minors. The length of the main channel is 14,900 feet while Minor-1 is 5,000 feet long and Minor-2 is 5,500 feet long. There are three major siphons and 43 outlets in the irrigation system. For the irrigation channel, two types of sections have been adopted. Section No. 1 is rectangular and made of brick masonry on a 1:3:6 cement concrete bed. This design has been adopted in the head reaches along the slope of the hill. Section No. 2 is trapezoidal, with concrete lining having a 1:3:6 ratio. The designed discharge has been calculated according to a 10-day peak irrigation requirement for daytime irrigation. The construction of the Kot Raja Dam has raised the subsoil water level in the adjoining villages within a radius of about 5 miles. This has increased the yield of the existing wells and provides a potential source of additional groundwater, which can be tapped by tubewells. The command area of the Kot Raja Dam comprises 1,112 acres. The command area has been developed by partial lining of the watercourses and land leveling. Before the construction of the dam, the cropping intensity under *barani* agriculture was 70 percent and is expected to rise to 120 percent in irrigated land by 1998. The irrigation network is shown in Figure 4 in the annex, and the salient features of the dam are provided in Table 15 in the annex.

The fisheries potential of the area has been developed by providing facilities to satisfy the demand for fish fry and fingerlings. The Punjab Fisheries Department has auctioned the reservoir to the private sector for the development of fish culture for a period of three years.

2.4.4. Technical and Related Institutional Problems

The technical diagnostic survey carried out by WRRI (1997), as well as the field observations of IWMI's social organizing team and irrigation engineers (Bhatti, Cheema and Skogerboe, 1999), revealed serious problems in the small dams irrigation systems under study. The conveyance channels and, therefore, the distribution of water in the command areas are deficient. The level of the serving channels is frequently below the elevation of command area fields. The quality of the construction of the dams and channels is relatively poor, as indicated by pervasive leakage. Furthermore, farmers have operated the irrigation systems without an allocation and distribution schedule. Individual farmers have

been using water whenever they desire. As a consequence, substantial amounts of irrigation water were wasted and the distribution and application of water were inequitable and inefficient.

IWMI's field team concluded that this situation was due to a deficient institutional approach to the construction, operation and maintenance of the small dams systems. Beneficiaries were not actually involved in the planning, decision making and implementation of the construction project and its subsequent operation. Although water users associations had formally been established, farmers reported (in the baseline study) that their actual involvement was minimal. The approach had remained 'top-down' and local knowledge and concerns were largely excluded. There were no farmer contributions in cash or kind. In fact, suspicions towards the implementing agencies caused farmers to refuse payment of a 5 percent cost recovery share for the construction of watercourses. A court case regarding this matter is still pending.

Considering the inadequacy of financial resources available to the SDO and the lack of shared operation and maintenance, organized participation of farmers is assumed to be an indispensable component of irrigation management. The expectation is that maintenance costs can be reduced and the efficiency of resource use can be increased if water users are motivated, and their awareness and capacities are strengthened.

The following specific technical problems were identified at Shahpur and Mirwal Dams.

The irrigation system network at Shahpur was not properly maintained, as cleaning the silt deposit from surface run-off entering the channels was neglected. Manhole lids of the underground section of the canal were missing and debris collecting in the canal led to the recurrent blockage of the water flow. The layout of the watercourses is not conducive to maintaining the required levels and speed of the flow towards the tail end. Seepage losses in the canal are approximately 16 l/s/km. High losses are due to the low quality of the lining, cracks, deterioration and damage of the canal bed, sedimentation and weed growth. Conveyance losses have contributed significantly to waterlogged land adjoining the canals.

In most cases, bunds surrounding fields were not high enough to apply complete irrigation at critical growth stages and water losses are common because of spillage to adjoining fields. The low application efficiency leads to incomplete irrigation, over- and under-watering in different sections of the fields, and consequently the non-uniformity of crop stands. In some cases, excessive soil surface scraping for land forming has led to the exposure of sub-surface layers. This causes uneven percolation of water into the soil, which is confounded by the lack of organic matter in the soil. At the same time, farmers are facing difficulties in obtaining land leveling equipment and technical support from government services. Therefore, many fields in the command area are still undulating and make efficient irrigation difficult. Furthermore, the use of fertilizers and improved seed material is inadequate. All of these circumstances have adverse effects on crop yields.

The most critical issue, however, was the improper calibration of the division of the main channel at Shahpur Dam, which caused an insufficient water supply to the Right Bank Canal and, therefore, inequitable water distribution in its mid- and tail-reaches.

At Mirwal, the conveyance network and the dam were in a considerably better shape after seven years of operation. Farmers reported that this was mainly due to the better quality of construction. At the project inception, the system required minor repairs to cracks in the lining, and weeding. Furthermore, inadequate control structures for optimal flow, low canal and watercourse conveyance efficiency due to seepage, especially in unlined watercourses, and the lack of maintenance and low on-farm application efficiency prevailed.

Information on deficiencies of the Kot Raja irrigation system is not available, since, to date, neither IWMI nor WRRI were involved in assessment and improvement activities.

2.5. Summary of Problems in the Small Dams Systems

The description and analysis provided above indicates numerous and interlocked problems, constraints and challenges confronting collective action in the small dams area at the time of the project inception. These are summarized below for convenient reference.

- The geo-climatic conditions of the Pothwar Plateau limit opportunities for irrigated agriculture. Land leveling is a considerable cost factor, while the required equipment is not easily accessible to the majority of farmers. Alternative means of command area development have not been developed.
- Some services essential to organizational activity, such as communication, transport and banking, are restricted.
- Influential and powerful large landowners enjoy preferential access to resources and may dominate water users organizations.
- Predominance of small holders and the lack of experience with irrigated agriculture may limit motivation to use innovative agricultural practices. The majority of farmers favor 'traditional' crops, such as wheat, as a means towards basic food security.
- Caste boundaries may undermine farmers' willingness to engage in organized collective action.
- The relatively low level of education and high number of illiterate farmers may constrain their ability to manage a water users organization.
- Experience among farmers in collective action is low and a culture of organizational behavior for the management of resources is scarcely developed, except in the religious sphere.
- Yields are generally below national averages.
- While cropping intensities for irrigated agriculture are above values for *barani* cultivation, they fall short of design targets.
- The actual irrigated area is far below the anticipated culturable command area, due to insufficient command area development, as well as the lack of rational and equitable operation and maintenance of the irrigation systems.
- The inadequate support services by government agencies have caused the neglect of the majority of farmers and provided favorable access to resources to influential landowners. The relations between most farmers and government agency personnel are characterized by a lack of trust and cooperation.
- The design, construction, operation and maintenance of the small dam irrigation systems are deficient. The small dams systems are not managed as common goods through organized collective action, i.e. participatory irrigation management, or as public utilities through a rationalized professional service. Consequently, the systems are both, inefficient and inequitable.

3. METHODOLOGY AND PRACTICE OF SOCIAL ORGANIZATION

The action research program at the three pilot sites in the small dams area aimed at establishing a new institutional setup that could effectively address the problems and issues outlined in the previous chapter. The formation of water users organizations capable of participating actively in the tasks of operation and maintenance, as well as command area development, was considered a central institutional component for improved irrigation management. This chapter reports on the methodology developed and its implementation at the Shahpur, Mirwal and Kot Raja pilot sites. The experiences are reviewed and evaluated.

3.1. Methodology

Social organization is conceived as a slow step-wise transformation process of dispersed individuals affected by a particular environment and problem into a cohesive group prepared to engage in collective action for the management and development of a common good. The key element of participation is considered both, an end to the organizing process and a means of organization building. As an end, it is viewed as the capacity of farmers to participate in the management of irrigated agriculture in collaboration with local government agency personnel and NGOs on a sustainable basis. As a means, it is implied that the organization building process itself is primarily in the hands of the members of the organization to be built.

The role of social organizers is viewed as that of facilitators who initiate and support the process through their particular expertise and skills. They need to develop a detailed understanding of the social groups concerned and an increasing level of rapport with their members. They need to be able to assess the target groups' thinking about, and feelings towards, institutional change; identify the scope and content of possible change; and determine their style of interaction with the communities targeted.

The process of social organization proceeds in four phases and five dialogic steps. The four phases include support mobilization, diagnostic analysis, organizational development and organizational action (Skogerboe, et al, 1993; Bandaragoda and Memon, 1997). For a detailed overview of the social organization methodology, see also Figures 5 through 9 in the annex.

Support mobilization refers to the development of institutional arrangements and methods for the project activities in collaboration with partners. These include the establishment of a project implementation coordination committee; development of methods for training and pilot site selection; selection of pilot sites; selection, training and deployment of social organizing staff; and finally, entry into the field and initiation of the implementation process.

Diagnostic analysis involves both, initial rapport building with key informants and eventual social organization volunteers and field research to collect detailed socio-economic and technical information through the participation of key informants. Initial activities towards participatory water management are initiated, such as the assessment and calibration of irrigation structures. At the end of this phase, social organization volunteers are identified and selected by the targeted water users, and the first familiarization meetings are conducted.

The organizational development phase follows five dialogic steps, or types of meetings (familiarization, rapport building, consultation, selection and formation of the water users organization), which progressively intensify interactions with and among farmers, and involves increasingly larger numbers of participants. The goals of these meetings are the encouragement of behavior based on mutual trust, sharing information, consultation for consensus, developing

organizational options and strategies, and the implementation of an appropriate and mutually agreeable organization design. During this phase, training for office bearers of the WUOs is also initiated.

The organizational action phase involves further training, and the development of plans for operation and maintenance, as well as command area development based on a detailed assessment of the problems on the ground. Collaborative activities with partners in the irrigation and agriculture sectors are initiated and conducted. This open-ended phase is envisioned to lead towards sustainable and self-sufficient organizational activities of the WUOs and their partners from among government agencies and NGOs.

The organization process is to be documented on an ongoing basis by IWMI's field team to serve the iterative function of the action research program. That is, a persistent movement from diagnosis based on research to action based on community decisions, back to diagnosis, feedback and the reorientation of action.

3.2. Practice

3.2.1. Support Mobilization

During this phase, which lasted approximately until September 1996, IWMI and WRRI conducted a rapid appraisal exercise in the small dams area. Based on criteria such as the size of the reservoir and command area, level of command area development, number of water users, level of functioning of the irrigation system, and potential for increased irrigation supplies, three sites were chosen at Mirwal, Shahpur and Bhughtal Dams, the latter later being replaced by the Kot Raja Dam (see Section 1.2.).

After a difficult recruitment process, IWMI was able to select two social organizers and an assistant social organizer, to which a third social organizer was later added. Training was provided at IWMI's Lahore headquarters and Haroonabad Field Station, where social organization activities at the Hakra 4-R Distributory are carried out. The project team was led by a sociologist, who is a member of IWMI's national staff. Project leadership and support was provided by IWMI's Senior Management Specialist, of the international staff. The Director of IWMI Pakistan, who is an international staff Irrigation Engineer, as well as a national staff Irrigation Engineer, provided technical inputs to the project.

Initial meetings between IWMI staff and representatives from WRRI, SDO, ABAD and the Agricultural Extension Directorate took place during this phase to discuss project concepts, site selection and potential areas of collaboration.

IWMI opened its field station in Fateh Jang in August 1996 after an unsuccessful attempt to identify a suitable building in the Mirwal area.

The Project Implementation Coordination Committee (PICC) was only constituted in 1998 with the participation of WRRI, ABAD, OFWM, SDO, the Agricultural Extension Directorate, and water users organizations of Mirwal and Shahpur. The initial meeting deliberated issues such as the problematic legal status and registration of WUOs, necessary amendments to the WUO Ordinance of 1981, the potential for joint management agreements, the replicability of IWMI's organizing activities, maintenance problems at the dams, and water rights issues. The PICC did not meet on a continuous basis because of difficulties pertaining to the coordination of schedules and the need to

finance frequent meetings. However, throughout the duration of the project, IWMI's staff was in persistent contact with all of the parties involved.

Preliminary discussions with water users were held where farmers aired their grievances about the deficiencies in the operation and maintenance of the small dam irrigation systems.

3.2.2. Diagnostic Analysis

As discussed in Chapter 2, WRRI and IWMI staff conducted a detailed problem analysis using various research methods, such as walk-through, socio-economic and technical baseline surveys, informal meetings with informants, and the like. The key results were presented above. The collection and analysis of data overlapped with the identification of SOVs and initial familiarization meetings, which also have the function of information gathering. The main diagnostic analysis phase lasted from about the latter part of 1996 until the beginning of 1997. However, the need for ongoing diagnosis of problems and issues requires that this phase never be closed completely.

During this phase, community-based social organization volunteers (SOVs) were sought and trained. These members from among the communities were found to be valuable links with the farmers. The field staff was looking for non-controversial, motivated, trusted and well-informed members of the target communities. They helped in disseminating information about the project process and objectives to farmers, assisted in organizing farmers, arranged meetings, and participated in data collection. The farmers living in the project areas did the selection, in most cases. The SOVs were farmers with small to medium size landholdings, schoolteachers or unemployed educated youth willing to gain experience in social organization.

The mediation between the project and the farmers by SOVs proved indispensable because farmers were initially highly suspicious of yet another project focused on irrigated agriculture. After difficult experiences during the construction of small dams, the need for, and potential benefits of water users organizations were initially not perceived by many farmers. Overcoming the credibility gap, which adversely affected relations between beneficiaries and SDO personnel in particular, was perceived by IWMI staff as a crucial task. In this respect, the combination of a patient initial rapport building phase and the services of SOVs turned out to be useful strategies.

In addition, a training needs assessment was commissioned from ActionAid Pakistan, which identified needs in the areas of health, agriculture, livestock rearing, income generation, infrastructure development and education (ActionAid, 1998). Of these, only agricultural development needs were within the purview of the action research program, which are addressed below.

3.2.3. Organizational Development

The first phase of the dialogic approach to organization building was a series of informal familiarization meetings with small groups of farmers. These meetings revealed a fairly poor level of understanding among farmers about institutional development and the roles and functions associated with community organizations. Initially, people did not want to play an active role in the management of their irrigation systems. The following attitudes were found to be widely prevalent:

- Farmers were disillusioned about government agencies and dysfunctional community-based organizations;
- Farmers viewed themselves as passive recipients of services and material benefits;

- Some farmers feared exposure of their irregular irrigation practices;
- Farmers' fear of privatization of the irrigation schemes and of increases in water fees was widespread;
- Farmers feared conflicts among different sections within the community, particularly between castes and with 'influential' farmers; and
- Farmers had low expectations towards irrigated agriculture and sought improved income in off-farm employment.

During rapport building meetings, these issues were followed up by informing farmers about the intentions of the project and the potential to address these through social organization. The social organizers introduced farmers to the status and purpose of IWMI. These meetings continued to be informal, leaving ample time for participants to air their concerns about irrigation and agriculture. After these meetings, the SOVs were asked to conduct similar meetings with other small groups in the villages.

Eventually, a series of more formal consultation meetings in larger groups at the village level were conducted, involving farmers in discussions about possible solutions to their problems. Options for an acceptable and useful organizational design of water users organizations were explored. The main issues addressed were the eligibility for membership, organizational structures, mechanisms for the selection of office bearers, and the powers and tenure of the executive committee.

During these discussions, the field team staff focused its interventions to provide assistance in the process. They introduced some fundamental concepts and values considered crucial for the emerging organizational culture. Equal opportunities for participation in discussions and in the selection process for office bearers, as well as the need for freedom of expression, were stressed. The values of equity in the provision of resources and services and of consensus based decision-making were emphasized.

Farmers generally assimilated these values in their discourse on participation in irrigation management. They also came to accept the need for organized efforts to achieve equitable and efficient water management. An issue of continued concern was the legal basis of farmer-organized operation and maintenance, as the existing legal framework does not provide clear and sufficient powers to water users organizations at the small dams.

Among the key decisions reached during those meetings were the following:

- Although only a limited number of farmers were using water from the dam systems at this time, all farmers cultivating in the culturable command area should be able to become members of the WUOs.
- Initially, representatives to the executive committees should be selected at the village level in order to ensure representation from diverse social groups and alliances.
- Information about meetings should reach all farmers concerned, for which IWMI field staff and SOVs would be jointly responsible.
- At Mirwal Dam, three villages, namely Mithial, Kisran and Traggar, with a small number of cultivators in the CCA, should be treated as a single unit.
- At Mirwal Dam, each village unit can select three representatives to the executive committee of the WUO. At Shahpur Dam, the agreed number of representatives varied.

- The selection mechanism would be consensus-based upon mutual consultation among members in order to avoid conflicts between different social groups, such as castes, strata of property owners, political alliances, etc. These should be accommodated either by providing each section with representation or by finding mutually agreeable candidates. The need for commitment to a common concern beyond social divisions was continuously stressed.
- After the selection of village level representatives, a joint meeting of the selected persons and the general membership should be called to select office bearers, through negotiations aiming at consensus. Each village should be represented by at least one office bearer. The tenure of office bearers should be one year.

Significant was, that meetings were held in public places, such as schools in Shahpur and the SDO's rest-house at Mirwal Dam, in order to avoid caste taboos associated with private homes. The inclusion of uneducated farmers was ensured by the persistent efforts of the social organizers to reach and motivate all strata of the local society. The inclusion of some large landowners was eventually achieved with the same persistence. However, given their status and authority in the communities, this meant that they would eventually occupy key positions in the leadership of the water users organizations. Yet, persuasion by IWMI's social organizers and open debates among all farmer-members about the need for equitable resource use, motivated even the largest landowner in Mirwal, who had benefited from inequitable access to irrigation water supplies, to become one of the WUO's most active representatives and to embrace its newly emerging value system.

Despite these advances and agreements, negative attitudes and fears about privatization and fee increases continued, so that their discussion required considerable time and effort. IWMI staff and the supportive farmers stressed that community management, rather than privatization, was the aim of the project, and that fee increases would be impossible without the consultation and consent of the organized farmers.

However, the underlying causes of resistance were not sufficiently clarified, perhaps for fear of the divisive impact of delving into 'sensitive' issues. The field team continued to stress sabotage by 'mischievous elements', implying that some farmers and some government personnel, whose collusion might secure them unfair access to resources, may be behind 'negative propaganda'. Another matter of concern, which may underlie the worries of some farmers, is the fact that participatory irrigation management does require an increased effort from farmers. Some farmers communicated that they were now going to finance and undertake tasks which government personnel failed to deal with.

The selection criteria for the representatives and office bearers favored by many farmers were a sufficient level of education, thorough knowledge of the command area, capacity for interaction with government officials and other outsiders, and the ability to negotiate on behalf of the organization members.

Four selection meetings at the village level were organized during March 1997 in Mirwal and during August/September in Shahpur, where representatives for the positions of office bearers and advisory board members were selected.

In April 1997, the representatives designated by farmers from the villages located in the command area of Mirwal Dam met, together with their general membership, to select the office bearers. The attendance level was 66 percent. For each of the four villages, one office bearer was identified. Thereafter, the four designees allocated the positions of president, vice president, general secretary and treasurer among themselves. In addition, the farmer-members constituted a seven member advisory board. A few weeks later, a fifth office bearer was added to the executive committee as the

secretary of information. The general membership formally sanctioned all of these decisions. An oath-taking ceremony took place in May 1997.

In October 1997, the members of the WUO at Shahpur Dam met to designate office bearers and an advisory committee. The attendance level was over 70 percent. The procedure was similar to that of the Mirwal Dam WUO.

The selection meeting for office bearers of the Kot Raja Dam WUO took place in February 1999. The attendance level was 60 percent. Altogether, five representatives from the two villages in the command area were selected after deliberation. They then agreed on the distribution of positions among themselves, which was sanctioned by the membership present.

The office bearers selected include cultivators of smaller as well as of large landholdings. They range from 4.25 acres to 2,000 acres. Invariably, the presidents are among the largest landowners in their respective command areas, and, in two cases, the largest. Representation from all villages ensured the inclusion of diverse caste groups and locations. The consensus-based process was adopted to reach agreement on the distribution of offices among a wide range of interests. Competitive elections with alternative candidates may have encouraged friction, envy and the exclusion of minority groups, and caused conflict and lack of cohesion. However, dissent based on real conflicts of interest may also be avoided as parts of the membership may not openly voice their dissent due to the public nature of decision-making and fear of reprisals. The selection of large landowners for key positions in the end, reflects, in part, the effective status and power relations in the project sites and, in part, the higher capacities of these WUO members for leading their organizations.

In October 1997, the National Rural Support Program (NRSP), Islamabad, provided training in social organization methods to farmer representatives from Shahpur and Mirwal.

The final step of organization building was the official formation of water users organizations. In order to attain legal recognition and the capacity to act as a legitimate body of organized farmers, the three WUOs sought registration in 1998 and 1999 with the Directorate of OFWM, Rawalpindi, under the On-Farm Water Management and Water Users Association Ordinance of 1981. Thus, the farmers formed and registered Water Users Associations at the watercourse level. Thereafter, they registered their small dam level WUOs as Water Users Associations with OFWM under the ordinance.

This procedure was followed because the legal provisions currently in force do not provide for the formation and recognition of federated WUAs as Farmers Organizations. Therefore, it remains unclear how the rights and responsibilities of watercourse level WUAs and dam level WUAs are delineated and hierarchized. The enactment of rules and regulations, as well as bylaws for farmers organizations under the PIDA Act of 1997, a draft of which is currently under review, would, therefore, greatly facilitate legal entitlements and the stipulation of powers.

3.2.4. Organizational Action

In the course of organizational activities, the WUOs have established offices, opened bank accounts, raised funds from among their membership, held monthly meetings and kept minutes as well as other organizational records. IWMI staff assisted the leadership of the WUOs in all these activities. At this point, the WUOs have yet to draft their bylaws under the 1981 Ordinance.

Most importantly, the WUOs in Mirwal and Shahpur undertook a number of collaborative activities with government agencies to improve the operation and maintenance of their systems and to develop their command areas. The remainder of this chapter will discuss these activities, which are the central focus of the social organization program as stipulated under objective three in the introduction of this report.

3.2.4.1. Collaborative Activities in Operation and Maintenance

Collaborative activities were undertaken at Mirwal and Shahpur Dams. To date, the WUO at Kot Raja Dam has evolved to the point of formal organization establishment.

Organizational Links: The establishment of a close working relationship between the WUOs and the field staff of the various government departments operating in the area was a significant achievement of collaborative activities. Particularly in the case of the SDO, a relationship characterized by suspicion and disregard changed to one of increasing mutual consultation, responsiveness and cooperation. The Project Director (equivalent of Superintending Engineer), along with his Executive Engineer, Sub-divisional Officer and Sub-engineers, participated in and made substantial contributions to all of the important events. The sub-engineers in particular maintained a continuous presence and became accessible communication partners for the farmers and IWMI staff.

WRRI also was a partner in operation- and maintenance-related activities. Their staff contributed to the training of WUO members and prepared a survey report entitled "Initial Technical Diagnostic Surveys for Mirwal and Shahpur Dams in the Pothwar Plateau" during April 1997.

Two farmer – agency coordination meetings were held at Shahpur and Mirwal Dams. The government actors involved were SDO, ABAD, ADBP, as well as the Agricultural Extension Directorate and the Soil Conservation Department. At Mirwal, the Project Director of SDO expressed the department's willingness to hand over O&M responsibilities to the WUO, if farmers obtained quality training and demonstrated capacity. The need for the preparation of a new *warabandi*, assessment and collection of abiana fees, the appointment of a valve man, and the support services from OFWM and Agricultural Extension was mutually recognized. At Shahpur, farmers and agency personnel discussed the system's state of disrepair, the need to implement the existing *warabandi*, the involvement of farmers in repair works, the potential for lift irrigation, and agricultural improvements.

Needs Assessment: The assessment of needs for operation and management work identified two general aspects: human resource development needs for capacity building through training; and physical-technical needs for the improvement of the physical irrigation infrastructure.

During the social mobilization process, IWMI irrigation experts realized that the water users were not fully prepared to play an active role in maintaining and operating their systems. After conducting an awareness campaign on the issues involved, farmers requested training in key O&M practices.

In a joint walk-through along the irrigation systems, all of the deferred maintenance needs along the main and secondary channels, as well tertiary channels, were identified, and water users were encouraged to suggest possible solutions.

The most important physical need identified at Shahpur was of a socio-technical nature. The distribution of water between the two branch canals was not equitable because of a faulty

bifurcation structure at RD 10+000. Thus, an agreement about equitable discharge levels and the design of an improved bifurcation structure based on this agreement was needed. Furthermore, it was recognized that the main channel between the dam and the bifurcation point had innumerable leaks in the exterior wall and the bed of the lined channel, causing losses of at least 45 percent. The left branch canal was also in a very poor condition.

At Mirwal Dam, a survey conducted in collaboration with WRRI revealed losses of irrigation water in the conveyance system of 30 to 40 percent, despite the apparent good condition of the relatively new system. SDO and the WUO decided during a walk-through to repair the construction joints of the main channel, which were leaking due to vegetative growth. In addition, the need for land leveling was identified, since the elevation of many fields in the command area prevented access to gravity flow. The provision of earth removal equipment for leveling and the installation of lift pumps are two costly solutions, which require the cooperation and financial support of OFWM and the Soil Conservation Department.

Planning: Joint planning meetings involving concerned government agencies, farmer representatives and IWMI staff were held. They discussed and decided on the following strategy. SDO headquarters in Islamabad would be persuaded to undertake as many of the repairs as possible within its financial and human resource capacities. Water users needed to be involved in the repair works to ensure quality standards. IWMI would be requested to provide seed money for additional repairs and water users would contribute the labor power required to clean and repair channels.

Training: Capacity building for O&M required training, persistent interaction with IWMI and SDO staff and reliable follow up. Two-day formal training sessions on O&M, including demonstration sessions, were held at both dam sites in February 1998. Besides WUO members and IWMI staff, SDO and WRRI personnel also participated. In addition to lectures, considerable time was spent on a walk-through and discussions. Problems were analyzed in the field and scenarios for solutions were developed. Besides problem identification and solving, the concept and practice of participatory irrigation management was discussed. Finally, detailed maintenance plans were jointly developed.

Implementation: The bifurcation structure at Shahpur was originally designed for each branch canal to draw full discharges on alternate days. However, this operational arrangement was modified later to supply simultaneous discharges based on their respective command area sizes of 685 acres (RBC) and 375 acres (LBC), both branches. Accordingly, design discharge proportions were 60 percent for RBC and 40 percent for LBC. Unfortunately, flow conditions due to the physical state of the branch canals reversed this proportion at 40:60. Past the bifurcation point, RBC consists of an underground pipe with an irregular slope, while LBC has an open flume. These hydraulic conditions increased the flow to LBC. As a consequence, farmers in the two sub-command areas were in persistent conflict and RBC farmers sought to obstruct the LBC flow at night. The contentious issue proved a major obstacle for social organization. Therefore, IWMI's team made the resolution of this conflict and alterations at the bifurcation structure a priority issue. The resolution of this problem eventually functioned as an excellent exercise to galvanize the divided community and strengthen its convictions about, and capacity for collective action. Successful problem solving is the best way to build strong organizations.

The principle of sanctioned command areas was introduced to the farmers and discussed during formal training sessions. This implies that both sub-systems agreed on discharges proportional to the size of their respective command areas. A consensus on the implementation of this principle was eventually attained and a written agreement among all parties formalized the resolution of the conflict. The water share was fixed at 60:40 for RBC and LBC, respectively. Accordingly, current

meters were installed and simultaneous readings of discharges to the branch canals were used to calibrate a temporary weir to adjust the flow according to the new design. Once the agreed flow levels were secured, the new arrangement was tested for 5 days. After farmers from both command areas were satisfied with the sufficiency of the new distribution regime, a permanent weir was installed. IWMI provided the equipment, expertise and financial resources (Rs. 1,700), while SDO sanctioned the process and provided a mason to construct the permanent weir. Measured channel flows have been changed from 2.67 cusecs for RBC and 4.01 cusecs for LBC before March 1998, to 4.08 cusecs for RBC and 2.60 cusecs for LBC from April 1998 (Table 11).

Table 11. Water Distribution (cfs) between RBC and LBC at Shahpur Dam

Channel	Before (March 30, 1998)	After (April 1, 1998)
RBC	2.67	4.08
LBC	4.01	2.60

Source: Bhatti, Cheema and Skogerboe, 1999.

The SDO was requested by the Shahpur WUO and persuaded by IWMI staff to finance and carry out repairs of the main channel connecting the dam and the bifurcation weir. The works involved repairing damage caused by floods, relining, raising the wall of the main sump, depositing G.I. wire crates before the spillway bucket, and repairing aqueducts, at a total cost of Rs. 1,220,000.

IWMI agreed to finance essential outstanding repairs of the LBC and some watercourses with the labor power contributed by WUO members. Although IWMI generally avoids the provision of material incentives for organizing farmers, this exception was considered vital for the success of the project. The alterations of the flow regime accepted by LBC cultivators reduced their apportionment, and therefore, required that their sub-system be well maintained to ensure reliable water delivery throughout the branch canal. The works involved patching, relining and repairing the canal walls, rebuilding the canal bed, and removing vegetation and silt. The cost for materials was Rs. 57,814, and the cost of labor contributed was estimated at Rs. 52,650. The transparent handling of funds among the collaborators and the farmers' contribution of labor power kept costs at a realistic minimum.

All of these activities were carried out during the spring and summer of 1998.

Agreement was also reached among farmers and SDO that the irrigators would follow a modified version of their *warabandi.*

At Mirwal Dam, the WUO and SDO jointly implemented maintenance plans to remove silt and vegetative growth in the channels, and to repair their construction joints during the spring of 1998. The problem of elevating land levels above those of channels was addressed by initiating lift pump irrigation. Through the intervention of IWMI, six farmers obtained permission from SDO to start lift pump operations. Some received technical advice and financial support in the form of subsidies from OFWM. Only one farmer obtained subsidies and machinery from the Soil Conservation Department under ABAD to level his land. Although several farmers had applied for land leveling equipment and made financial deposits they were not provided with services, as machinery was committed to other beneficiaries.

A systematic procedure for water distribution was non-existant at both pilot-sites, and farmers irrigated whenever they saw fit, with the result that tail end irrigators were disadvantaged. The WUOs, SDO and IWMI jointly produced inventories of the cultivators, their land in the culturable command areas, and each outlet (*mogha*) that served their land. The removal of illegal outlets was

agreed upon and new distribution schedules (*warabandi*) were designed on the basis of the inventory data. Farmers received training in the design of *warabandi*. The principle of equity was discussed and eventually accepted by all WUO members. Large landowners accepted that they had to relinquish preferential access and irrigate according to the size of their holdings. The new schedule is based on a 24-hour operation for seven days, with consideration only for legal outlets. One farmer was permitted to establish a new outlet.

Although the need for a revised *warabandi* was generally accepted and new distribution schedules were designed, many farmers continue to practice ad-hoc irrigation. This indicates that an appropriate 'irrigation culture' has yet to be established.

3.2.4.1. Collaborative Activities in Command Area Development

As mentioned in the previous section, to date, collaborative activities for command area development were undertaken mainly in Shahpur and Mirwal, while activities in Kot Raja have only just begun. Training in improved agricultural techniques is the focus of this section. However, it must be recognized that command area development is a function of both enhanced water availability and agricultural practices. Thus, the O&M improvements discussed in the previous section are closely linked with the support services on the agricultural side.

Organizational Links: The main partners approached for the provision of training and extension services were the Wheat Program of the National Agricultural Research Center (NARC), WRRI, ABAD, the Soil Testing Laboratory at Attock, the Department of Fisheries, the Agricultural Extension Directorate and the Agricultural Development Bank of Pakistan.

Needs Assessment: During the diagnostic analysis phase, farmers' problems in agricultural production were assessed in detail. The main areas of potential improvement are in the management of crops, soils, diseases and pests, land and livestock. Of particular concern was the introduction of cash crops suitable to irrigated agriculture.

Planning: Farmers and IWMI staff planned to invite various speakers for lectures and demonstrations, to arrange soil testing, to buy plant materials from nurseries, and to visit research stations with demonstration plots.

Training: In October 1997, a Scientific Officer from NARC conducted a training on wheat production covering the topics of land preparation, sowing methods, the selection of high-yielding varieties, seed rates, laboratory soil testing and the use of fertilizers.

In January 1998, WRRI conducted a training workshop on citrus cultivation in orchards. The high suitability of the geo-climatic conditions in the Pothwar Plateau for citrus, the use of chemical and biological pest controls, irrigation methods and the selection of varieties were discussed.

In December 1997 and October 1998, training on soil management and testing was provided. Sampling techniques and the fertilizer requirements of different soils were discussed. Farmers from Kot Raja Dam visited ABAD demonstration plots and received information about new cash crop varieties suitable for irrigated agriculture.

The Assistant Director, Department of Fisheries, visited the Mirwal Dam site and informed farmers about opportunities in fisheries development. Farmers were asked to seek the department's assistance. No follow-up took place.

The Manager of the Agricultural Development Bank of Pakistan discussed the possibility of providing agricultural credit to farmers. Interested farmers were able to receive credit for inputs up to Rs. 50,000 on a 6-month basis.

Although increased agricultural extension services were promised, this was not followed up by the relevant agencies.

Implementation: The implementation of the new agricultural technologies is a function of individual farmer decisions and the availability of resources. The largest farmer in the pilot sites had already invested in advanced methods of citrus and livestock production. The IWMI field team reported an increased interest and enthusiasm among farmers after the training sessions and information visits. Their readiness to adapt the information may be indicated by the cooperative effort among farmers to purchase citrus and almond seedlings, as well as seed and fertilizer inputs, and the yield increase of wheat crops in the 1997-98 cropping season.

The combined effects of the collaborative activities for improved O&M and command area development are indicated by two observable short-term trends, the increase in the actual irrigated area, and the increased yields of the 1997/98 wheat crop. The expectation may be that increased and more reliable water supply and the provision of information and material inputs for better agricultural practice lead to higher agricultural productivity.

In fact, by the 1998/99 *Rabi* season, the cropped area under irrigated cultivation had increased by 57 percent in Shahpur and by 84 percent in Mirwal when compared to the previous year. A comparison of the 1997 and 1998 *Kharif* seasons shows a slight decline of 5 and 6.5 percent, respectively (Table 12). As a result, the actual irrigated area, when compared to the CCA, has overall increased from 11 to 18 percent in Shahpur and from 17 to 26 percent in Mirwal. Although this still falls far short of the assumed irrigation potential, gains are considerable. Further increases in irrigated area are mainly dependent on land leveling and the extension of the existing irrigation networks, both of which are costly and dependent on sufficient support services from government agencies.

Table 12. Comparison of Pre- and Post-Improvement Cropped Areas (acre)

	Kharif			*Rabi*		
	1997	1998	Trend	1997-98	1998-99	Trend
Shahpur (CCA = 1231)	140	133	- 5%	140	220	+ 57%
Mirwal (CCA = 1050)	184	172	- 6.52%	180	331	+ 84%

Source: SDO, 1997a and b.

The increase in the yields of the 1997/98 wheat crop over 1996/97 was 34 percent, as recorded by Akram and Cheema (forthcoming). The authors report a record yield of 1,040 kg per acre, which exceeds the national average by about 220 kg per acre. They also report that the use of fertilizer per acre increased by 14 percent from 4.3 kg to 4.9 kg. Improved water supply, better seed material, improved fertilizer application and land preparation, as well as favorable weather conditions may have contributed to this increase. Unfortunately, no data for the 1998/99 season are available.

In both cases, expanded irrigated area and increased wheat yields, the assumed impacts are extremely short-term and can be interpreted as no more than indicative trends. Further research on long-term impacts, as well as full irrigation management transfer will be necessary to reliably ascertain whether the social mobilization of farmers for participation in O&M can produce sustainable trends.

4. ASSESSMENT OF THE SOCIAL ORGANIZATION STRATEGIES

In this chapter, the effectiveness of project interventions will be discussed, specifically in relation to expected impacts as formulated in the Inception Report. The viability of the strategies developed and tested by IWMI to organize water users will be assessed, and short-term impacts on O&M and command area development will be analyzed.

4.1. Project Interventions and Expected Impacts

The Project Inception Report (IIMI 1996, p. 22) provides a framework for the analysis of key project interventions and expected impacts. The following discussion follows the logic of this framework to review the key impacts of the project.

4.1.1. Conflict Resolution

Intervention: Establish agreed farmer-run mechanisms for discussion of land and water related issues and conflicts.

Purpose: Provide open mechanisms for conflict resolution.

Impact: Reduced number of water/land disputes.

Measurement: a) Total number of disputes: 39. b) Proportion of disputes resolved through agreed mechanisms: 26, i.e. 66 percent. (No data on the level of conflict prior to the social organization process are available, as farmers do not register or count their disputes.)

4.1.2. Land Use Pattern

Intervention: WUO attends to land preparation in the command area.

Purpose: Improve land use pattern.

Impact: Increased area under irrigation.

Measurement: Area under irrigation during the *Rabi* seasons of 1997/98 and 1998/99 increased from 140 to 220 acres in the Shahpur Dam command area, i.e. by 57 percent. For the Mirwal Dam command area the increase was from 180 to 331 acres, i.e. 84 percent. A comparison of the 1997 and 1998 *Kharif* seasons show a slight decline of 5 and 6.5 percent, respectively.

4.1.3. Farmer's Training in Irrigated Agriculture

Intervention: Train farmers in irrigated agriculture.

Purpose: Shift their practices from *barani* land cultivation to irrigated agriculture.

Impact: Improved practices: HYV use, fertilizer use.

Measurement: No data for area under HYV are available. Their relevance would be limited without irrigation management transfer. Yields per acre of wheat have increased by 34 percent between 1996/97 and 1997/98. During the same period, the fertilizer use per acre increased by 14 percent.

Farmers received training in wheat production practices, citrus cultivation, soil management and testing, and undertook exposure trips.

4.1.4. Equity in Water Distribution

Intervention: Assist WUO to develop water rights and related allocation rules.

Purpose: Shift from ad-hoc water distribution to area-proportional allocation.

Impact: Improved equity in water distribution.

Measurement: No data are available on inter-quartile ratios along main channels. Their relevance would be limited without irrigation management transfer. In the Shahpur Dam command area, inequitable distribution between the two branch canals, i.e. 2.67 cusecs for 60 percent of the irrigated area of RBC and 4.01 cusecs for 40 percent of the irrigated area at LBC, was reversed to 4.08 cusecs for RBC and 2.60 cusecs for LBC. Furthermore, revised *warabandi* were accepted and partially implemented at the Mirwal and Shahpur pilot sites.

4.1.5. Operation and Maintenance

Intervention: WUO attends to maintenance of small dam and canal system.

Purpose: Effective maintenance.

Impact: More reliable irrigation.

Measurement: Data on the number of irrigation applications missed per season and on annual government expenditures on maintenance are not available. Their relevance would be limited without irrigation management transfer. The rehabilitation of the irrigation systems at Shahpur Dam during 1998 cost the government Rs. 1,220,000, IWMI contributed Rs. 57, 814, and farmers contributed Rs. 52,650 in labor costs. Farmers received training in O&M.

4.1.6. Farmer's Training in Agricultural Practices

Intervention: Train farmers in agricultural practices.

Purpose: Create interest among farmers regarding improved methods.

Impact: Better yields.

Measurement: Yields per acre of wheat have increased by 34 percent between 1996/97 and 1997/98. Farmers received training in wheat production practices, citrus cultivation, soil management and testing, and undertook exposure trips.

Data collection for measurable impacts was not possible in many instances and would not have been meaningful, because the water users organizations were unable to fully assume the rights and responsibilities associated with an actual irrigation management transfer or joint management agreement. Given the institutional, socio-economic and cultural constraints outlined in this report, the expected impacts listed in the Inception Report were far too ambitious. Within a period of less than three years, it was possible to establish water users organizations and to initiate collaborative activities on improved O&M and command area development. Many of these activities were

remedial and sought to compensate for deficiencies during the period after the construction of the dams.

These accomplishments indicate a growing capacity among WUOs and their partners for participatory irrigation management. However, the process is quite slow and difficult and the project enabled only the ground preparation for successful participatory irrigation management. The enactment of an appropriate legal framework sanctioning the transfer of management activities to WUOs and an intensified dedicated effort by facilitators and support service agencies for an indefinite period will be needed to ensure the consolidation and sustainability of the achievements made.

4.2. Viability of Social Organization Strategies

The salient features of the social organization strategy applied by IWMI for its action research program at the small dams pilot sites involved a step-wise process consisting of support mobilization, diagnostic analysis, organizational development and organizational action. The organization development phase proceeded through 5 dialogic steps or types of meetings: familiarization, rapport building, consultation, selection and formation of the water users organization. While the organization building process aimed at capacity for participatory collective action in irrigation management and command area development, the strategy itself was also participatory, involving farmers in the deliberation of action plans, in decisions and in their implementation. Forging strong links with partners in both, project implementation and collaborative activities between farmers and government agencies, were significant strategic elements.

Support mobilization proved an essential ingredient for the viability of the social organization strategy, and consequently, the water users organizations. Strong links were forged with the Small Dams Organization both at the field level and with the Project Office in Islamabad. These were effective in the planning and implementation of O&M related collaborative activities, which led to improvements in the irrigation systems. Deferred maintenance was undertaken jointly and the implementation of revised *warabandi* schedules was partially accomplished. Both of these interventions promoted the more efficient and equitable delivery of irrigation water. Links with WRRI led to the collection and analysis of important data and to training activities. Collaboration with ABAD, NRSP, ADBP, the Agricultural Extension Directorate, Soil Conservation Department, the Department of Fisheries, NARC, the Agricultural Development Bank, and OFWM mobilized valuable support services. Problems were experienced with the Project Implementation Coordination Committee (PICC) due to constraints related to scheduling and finance. Nevertheless, at its inception meeting, the PICC provided direction to the project, and subsequent consultation between IWMI and individual members of the PICC took place on an ongoing basis. Support mobilization relied predominantly on persistent informal contacts and personal rapport between IWMI staff, farmer leaders and agency personnel. In the local cultural environment, these types of contacts are paramount in order to accomplish work. Therefore, the suggestion is to accord this level of interaction a central place in social mobilization strategies. Nevertheless, the support mobilization arrangements were unable to transcend current social and legal constraints sufficiently to achieve officially sanctioned sustained participatory irrigation management.

The diagnostic analysis of socio-economic and technical data is an indispensable element of the mobilization strategy. This involves both, conventional data collection tools (baseline survey, technical survey, field measurements) and participatory methods (walk-through, semi-structured interviews with individuals and groups, participatory mapping). The diagnostic analysis fulfilled two important purposes. First, a sound knowledge base of the project setting and its socio-technical problems was generated. Second, the participatory methods involved the target groups in data

collection, and thereby, linked rapport building with the development of farmers' capacity for self-analysis. In participatory research, the target groups learn to take an analytic perspective of their own social, geo-physical and technical environment, which strengthens their ability to manage their resource systems. The farmers involved during diagnostic analysis exercises at the pilot project sites clearly gained an increased understanding of their irrigation and social systems. This served as a valuable foundation for organization building and collaborative activities. This strategy component, therefore, can be judged as crucial and viable.

The organization development process resulted in the successful establishment of three water users organizations at three pilot project sites. The patient approach of involving increasingly larger groups of farmers in the process of organization building proved as prudent and as viable as in the other IWMI-facilitated social organization projects in the Punjab and Sindh Provinces. Moving from familiarization, rapport building and consultation to the selection of office bearers and the formalization of WUOs, based each step of the mobilization process on solid results during the previous one. Thereby, trust and confidence, motivation and capacity among farmers were built as their pressing concerns and problems were identified, discussed and tackled. This procedure was particularly useful in a situation where farmers had experienced difficulties with the previous irrigation development project (small dams construction), and the subsequent absence of O&M and support services. The action research program, therefore, had to overcome deep-seated mistrust. Not only did it manage to establish rapport between farmers and social organizing staff, but also to forge cooperative relations between farmers and personnel of the SDO and other government agencies.

Relationships among different social groups of cultivators, namely, different strata of landowners and different castes, posed further significant constraints for social mobilization. The project strategy led to alliances between these potentially antagonistic actors. Several indicators demonstrate their recognition of common goods and concerns and the building of their willingness to cooperate.

The careful procedure of the village-based selection of representatives ensured participation of most caste and kinship groups in the WUOs' executive committees. The stress on open debate and consultation and the mutually recognized value of consensus helped to avoid adversarial relations in decision-making, and instead, institutionalized broad representation. Great care was also taken to ensure the representation of small, midsize and large landowners. As discussed above, the invariable selection of the largest landowners for the posts of president reflects local authority relations, as well as a considerable degree of confidence among the membership in the ability of these WUO officers to manage the organization and to represent farmer interests in the institutional environment. The fact that the president of the Mirwal WUO and other larger landowners gave up privileged access to irrigation water in the interest of equity demonstrates the effectiveness of the mobilization strategy in popularizing democratic and equity-oriented values. Especially in Mirwal, a high level of commitment of the executive body to the common welfare of the communities in the command area was demonstrated during recent field interviews. Farmers recognized that individual gain was interdependent with the welfare of the community, as all irrigators in the command area depend on the effective and prudent management of a common resource.

The equitable distribution of water and the resolution of conflicts may be considered the ultimate test of the viability of water users organizations. These were addressed to a considerable degree by the organizational structures and cultures developed. As was shown in Chapter 3, farmers were able to agree on revised *warabandi* and the closure of illegal outlets in Shahpur and Mirwal. However, the implementation of revised *warabandi* remained partial and their long-term sustainability cannot be ascertained as yet.

The most virulent conflict over inequity in water distribution between the Right and Left Bank Channels at Shahpur was amicably resolved after detailed technical and social problem diagnosis and the design of a mutually satisfactory technical solution. The conflicting parties agreed on a principle of water allocation and were able to realize this principle in practice.

The process documentation of IWMI's social organizers recorded a total of 39 water-related conflicts among water users at Mirwal and Shahpur. The WUOs' efforts to resolve these conflicts were successful in two-thirds of all cases. Although a significant minority of cases remained unresolved, the WUOs became a valuable mechanism, which is recognized by their members, for hearing and addressing conflicts. Depending on the level of conflict, whether between individuals or groups of irrigators, different actors were invited to attend meetings where cases were heard and solutions were sought. Representatives from the WUOs, IWMI, SDO and OFWM attended these meetings. However, it remains to be seen whether joint conflict resolution among farmers can be sustained without the persistent presence of outside support by IWMI, SDO or OFWM staff.

During the organizational action phase of the project, the strategy of collaborative activities proved viable in the majority of cases. Given that farmers and government agencies will have to work as partners and deal with the system O&M and command area development jointly, the facilitation of collaboration from the outset is a paramount necessity in the social mobilization process. Since farmers and government agency personnel were often on extremely uneasy terms, IWMI's facilitation of trust building and common experiences helped them to overcome deep-seated suspicion. Farmers have clear limitations in terms of time, material resources and education, and they will continue to require effective support services from government agencies or other service providers (NGOs, consultants). The function of joint management of the irrigation systems is not necessarily a complete 'take-over' by farmers. Farmer involvement has the potential of reducing O&M costs as they can make contributions in the form of labor power and irrigation fees, particularly if the latter are assessed and collected with the involvement of the WUOs. Furthermore, organized farmers who maintain well-functioning relations with government actors will be able to hold these accountable and insist on receiving professional services, if farmer participation in irrigation management becomes a legal entitlement and precondition for funding of government activities in the water sector.

However, the lack of a legal framework with clearly defined rights and responsibilities for both, WUOs and irrigation personnel, at this point in time, is the most significant constraint of joint irrigation management. The provisions of the WUO Ordinance of 1981 are insufficient for joint management above the watercourse level. Therefore, while SDO professed its sincere willingness to hand over components of system management to WUOs, they are reluctant to enter into joint management agreements until this is legally sanctioned.

Farmers and SDO staff have clearly demonstrated their capacity for cooperation at the Mirwal and Shahpur Dams. It may be expected that with the enactment of bylaws for water users organizations and the implementation of PIDA and Area Water Boards in the current process of institutional reform in the Punjab Province, these relationships and activities can be regularized, routinized and expanded. Therefore, at this moment, it will be important that facilitators of reform, such as IWMI, take influence and provide advice at the higher policy level in order to consolidate and formalize the gains made at the grassroots level.

Despite these constraints, the WUOs were able to make a good start in planning and implementing measures for improved O&M and command area development. The foundation for equitable water distribution is in place. The technical infrastructure of the systems was repaired and is maintained. The actual irrigated area has been increased. Farmers have demonstrated a willingness to adopt cash

crops on their farms, and the yield of the 1997/98 wheat crop showed an increase of 34 percent. As mentioned above, these impacts are very short-term and may be tenuous. Only the continuation of farmer mobilization on a wider scale and future research on long-term developments can show whether these trends can be consolidated and will be sustainable.

5. CONCLUSION

The impact of the closure of the project will be analyzed and recommendations for potential future interventions in the small dams area will be made.

5.1. Project Closure

With the closure of the project, IWMI field staff had to withdraw its support to the water users organizations it had facilitated. Given the stage of development the WUOs were able to attain and the impact the social organization process was able to make so far, the sustainability of organized collective action among farmers at the pilot sites is questionable. Farmers have become highly dependent on IWMI staff and demand the continuation of dedicated, reliable and supportive services. They also stated that their capacity for organized conduct, collective decision-making and interaction with agency personnel continued to depend on the presence of IWMI staff. This self-assessment is supported by the fact that WUO members ceased to meet regularly after the project closure, despite the experience of an equity-related conflict in at least one instance.

During field visits to the pilot sites in the final months of the project, WUO members at the Shahpur and Mirwal Dams adamantly requested IWMI to extend its project for another two to three years. They argued that the process of organization building was only halfway accomplished and that the expansion and improvement of the command area was not yet sufficiently achieved. Without IWMI's presence, they saw little chance for a successful continuation of the activities initiated so far.

Thus, the WUO members themselves do not judge their WUOs to be sustainable as yet. The causes for this lack of sustainability were ascertained by probing into the expectations of WUO members towards IWMI. While there appears to be a clear and lasting need for technical and organizational support in the form of logistical, material and training inputs, farmers indicated that they had no confidence in government actors' willingness to provide such support in a timely and dedicated manner.

It is evident that perhaps the most important function of IWMI, besides the facilitation of organization building, was advocacy in the interest of the water users organizations. IWMI staff was able to influence government officials at various organizational levels, and thereby, mobilize resources and responsiveness to the farmers' needs. IWMI has access to information about resources that is not available to farmers, who, therefore, can only attract such resources with great difficulty. IWMI's expertise and reputation, together with the social status of its professional staff, compensate for the gap in influence and status between farmers and government actors. Farmers bitterly complained about the lack of response from government agency personnel before IWMI's intervention. Since IWMI's presence and the establishment of WUOs, training has been provided and maintenance activities were carried out promptly. Advocacy is not a manifest function reflected in the objectives and outputs of the project, but rather a persistent latent function in need of greater systematic attention in research and project design. At this point in time, farmers have no confidence in their own ability to mobilize internal and external resources for development activities without support through advocacy.

5.2. Recommendations

In order to overcome their significant lack of influence and status within the social context of irrigated agriculture, farmers need and seek to form a federation of dam level WUOs at the district or division level. The small dams do not form a contiguous system, but are scattered throughout several districts. Therefore, federations could be organized in such a way for farmers to find a logical level of partners among SDO staff. The federation could be the counterpart of an executive engineer, who heads one to three divisions, at times within two districts, with a number of sub-divisional officers under him. The WUOs are already interacting regularly with sub-engineers and field level irrigation staff. Interaction at the federation / executive engineer level is needed in order to gain access to information and decision-making processes at the higher levels. Furthermore, the federations would be able to send representatives to an Area Water Board at the level of all, or of a significant number of dams, where they can act as counterparts to the SDO Project Director.

Obviously, this scenario would require the expansion of the social mobilization program to all small dam systems. The members of the current pilot WUOs are prepared to play a central role in farmer-to-farmer mobilization, if supported by IWMI field staff. NGO support to take on IWMI's current facilitation and advocacy role would need to be explored and designed into future projects. IWMI's ability to act as a facilitator and support to WUOs is limited. Projects are confined in space and time and ongoing support services are not within its purview. Therefore, NGOs already active in the project areas, such as NRSP/PRSP, could render open-ended support services. These would act as social mobilizers and mediators with government agencies. IWMI would provide training and support throughout the process, and monitor its progress. Eventually, support services functions could be provided by government agencies themselves, if they are able to internalize the values and tasks of joint irrigation management. Future projects should take care to involve government agencies at the local level from the outset.

The structural re-organization of roles and tasks alone is insufficient, as the significance of cultural constraints in the relations between organized water users and agency staff demonstrates. Capacity building among farmers, besides training in organizational and technical skills, needs to build the confidence of farmers so that they become capable of gathering information, negotiating and making decisions on their own. One of the significant lessons learned in this action research project is that a social organization program needs to design the gradual 'weaning' of WUOs by increasingly turning over initiatives for collective action from facilitators to farmers. This may be among the most difficult aspects of the process, as the target group and the facilitators easily become habituated to a relationship of mutual dependence. However, successful organization development plans from the outset to gradually withdraw organizers as clients' capacities strengthen. It is crucial that facilitation is recognized as a support activity. Facilitators should not act on behalf of their clients.

Concepts for command area development among farmers, government personnel and facilitators still appear to be fairly weak. They are focused on agricultural extension, land leveling and the expansion of water channels. The opportunities for an alternative design of field and watercourse structures need to be researched. Moreover, farmers not only require training on financial management, leadership, operations, maintenance, irrigation and agricultural infrastructure development, conflict resolution and legal issues. They also need an integrated command area business and development plan for irrigated agriculture as a whole, in order to evolve a system that is capable of enhancing and financing irrigation, economic production, and thus, their standard of living.

The concept of the modern farmer as a businessman was found to be appealing to mid-size and larger farmers who would like to enhance both their material and symbolic capital. Farmers need a vision and motivating future perspective to galvanize their energies and efforts. So far, they appear to be easily frustrated and impeded by their many negative experiences with institutional support services. Command area development opportunities would be in improved cash crop agriculture and livestock rearing, processing agricultural and livestock products for local and export markets as well as fisheries, and perhaps small scale tourism. These and other areas for development need to be researched.

If WUOs are to manage and operate their small dams and become self-sufficient sustainable entities, irrigation needs to be viewed and developed in the context of the total farming and production systems of these areas. At current levels of production, most farmers appear to be incapable of paying irrigation fees at cost recovery levels and of financing the development of their command area. Improved irrigation, as well as improved production outputs and incomes, are interdependent goals and conditions. They are interdependent factors in the development of agri-production systems. Only if production leads to higher incomes would sufficient funds for the operation, maintenance and development of the small dams irrigation systems be available. These relationships may be depicted as follows:

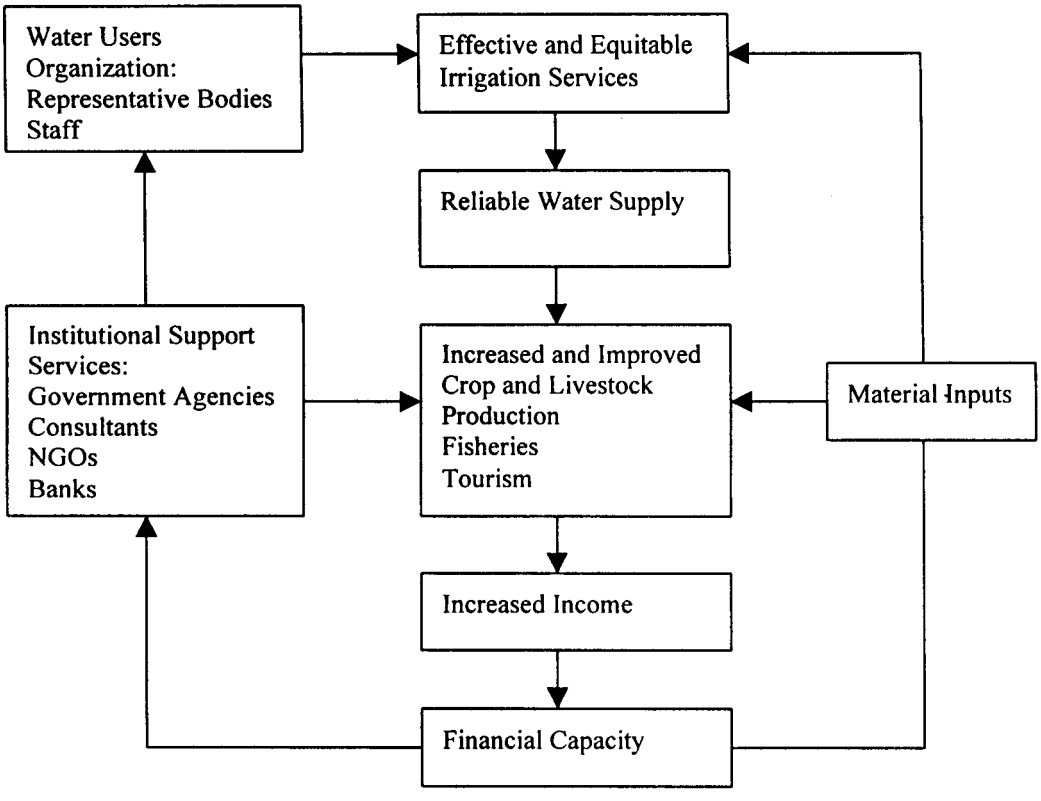

Figure 1. Interdependent Factors in the Development of Agri-Production Systems

Future social organization projects would need to do research on the social and economic opportunities and constraints of total agri-production systems development.

A crucial component of future project work would also be capacity building and reorientation among SDO personnel. They need to explore and eventually define their new roles and functions as providers of support services. Partnerships between SDO and WUOs would require agreements on mechanisms, structures and conventions of co-operation. As pointed out above, informal mechanisms based on personal relationships and rapport are as important as reliable formal mechanisms. An important recommendation for future projects is that the participants should not be shy about informative and open debates on new roles and institutional arrangements, which clarify the concerns and worries of all actors involved.

The small dams systems offer a precious opportunity for the sincere promotion of reform in the irrigation sector. They are independent of the large-scale Indus Basin Irrigation System and, therefore, more easily managed by smaller units of water users organizations and support service personnel. The pilot projects have demonstrated the willingness and ability of farmers and SDO staff to become 'irrigation partners' capable of leaving behind old antagonisms. They have also demonstrated that the process of getting to this point is long and difficult, and far from complete. Therefore, it is hoped that the accomplishments of the pilot projects are not abandoned, but can be consolidated by the continuation and expansion to the Federation and Area Water Board levels of the reform process initiated at the small dams.

Small Dams Organization (SDO). 1997a. Operational Manual of Shahpur Dam. Small Dams Organization, Islamabad.

Small Dams Organization (SDO). 1997b. Operational Manual of Mirwal Dam. Small Dams Organization, Islamabad.

Small Dams Organization (SDO). 1997c. Operational Manual of Kot Raja Dam. Small Dams Organization, Islamabad.

Shahid, A. S. and M. Ashraf. 1989. Benchmark Survey of Mirwal Dam. Punjab Economic Research Institute, Lahore. Publication No. 262.

Skogerboe, G.V., L. P. Poudal and K. B. Shrestha. 1993. M & O Guidelines for Turnover of Irrigation Systems to Farmers. Water Resource Development vol. 9. no. 4.

Water Resources Research Institute (WRRI). 1997. Initial Technical Diagnostic Surveys for Mirwal and Shahpur Dams in the Pothwar Plateau. WRRI, Islamabad.

World Bank. 1994. Pakistan Irrigation and Drainage: Issues and Options. World Bank, Washington D.C.

ANNEXURES

REFERENCES

ActionAid. 1998. Participatory Rural Appraisal for Training Needs Assessment in Small Dam Command Area Villages (Fateh Jang). ActionAid, Islamabad.

Agency for Barani Areas Development (ABAD). 1986. Punjab Barani Tract in Figures. ABAD, Rawalpindi.

Agency for Barani Areas Development (ABAD). 1988. Masterplan for Barani Area Development. ABAD, Rawalpindi.

Akram, M and M.A. Cheema. Forthcoming. Short-term Effects of Farmer Training on Increases in Wheat Productivity in the Mirwal Command Area.

Awan, N.M. 1979. A Review of the Punjab Barani Commission Report. Paper presented at a CEWRE Seminar, Lahore.

Bandaragoda, D. J. and Y. Memon. 1997. Moving towards participatory irrigation management. IIMI, Lahore. Report No. R-26.

Bhatti, M.A., M.A. Cheema and G.V. Skogerboe. 1999. Maintenance and Operational Activities in Shahpur and Mirwal Small Dams. IIMI, Lahore.

Cheema, M. A. and D. J. Banadaragoda. 1997. Baseline Survey for Farmers Organizations of Mirwal and Shahpur Small Dams, Punjab, Pakistan. IIMI, Lahore. Report No. R-38.

Cheema, M. A. and D. J. Bandaragoda. 1998. Social Organization for Improved System Management and Sustainable Irrigated Agriculture in Small Dams. Yearly Progress Report April 1997-March 1998. IIMI, Lahore.

Cheema, M.A., M. Sharif, J. Longmire, and U. Farooq. 1992. Initial Sources of Information and the Pioneers in the Adoption of Recent Technologies for Rice B-385. PARC Unit, Ayub Agriculture Research Institute and University of Agriculture, Faisalabad.

Cheema, M. A., S. Ahmad, W. Ahmad and Z.U. Haq. Forthcoming. Benchmark Survey of Kot Raja Small Dam. IIMI, Lahore.

Government of Pakistan. 1998. Economic Survey 1997-98. Government of Pakistan, Islamabad.

Government of Punjab. 1986. Umbrella PC1 for Small Dams Project. Irrigation and Power Department, Lahore.

IIMI. 1996. Social Organization for Improved System Management and Sustainable Irrigated Agriculture in Small Dams – Inception Report. IIMI, Lahore. Report No. P-5.

Iqbal, S.M. and S.A. Khan. 1991. Benchmark Survey of Jabbi and Nikka Small Dams. Punjab Economic Research Institute, Lahore. Publication No. 275.

Lionberger, H.F. 1961. Adoption of New Ideas and Practices. Iowa State University Press, Ames.

Table 13. Salient Features of Shahpur Dam and Command Area

A. Hydrology	
Area of Catchment up to Dam Site	202 sq km
Rainfall in Mean Year	737 mm
Average Annual Sedimentation	5,88,000 cubic meters (cum)
Design Flood before Routing	1,390 cum/s
Design Flood after Routing	1,008 cum/s
Average Annual Inflow	2,060,100 cum
B. Reservoir	
Gross Storage Capacity	17,665,000 cum
Dead Storage Capacity	12,573,000 cum
Live Storage Capacity	5,092,000 cum
Normal Reservoir Level	444.58 m
Dead Storage Level	442.73 m
Annual Withdrawal for Irrigation	1,041,000 cum
Pond Area at N.P.L.	283.40ha
C. Dam	
Type	Concrete Gravity
Maximum Height	24.39 m (80 feet)
Length at Top	93.29 m (306 feet)
Top Width	3.04 m (10 feet)
Upstream Slope	
Vertical Down Stream Slope	0.8 : 1
Top Level of Dam Embankment	448.78 m (1472 feet)
D. Spillway	
Type	Ogee Spillway
Spill Level	444.58 m (1458 feet)
Width	85.36 m (280 feet)
Capacity	1008 cum/s (35,600 cfs)
E. Irrigation System	
Type	**Gravity Flow**
GCA	644.13 ha (1591 acres)
CCA	506.00 ha (1250 acres)
Proposed Cropping Intensity	140 percent
Kharif	55 percent
Rabi	85 percent
Capacity of the System	15 cusecs
Slope of Main Channel	1 : 5000
Length of Main Channel	3048.78 m (10,000 feet)
Length of Branches	9083.16 m (29,800 feet)
Left Channel	1645.94 m (5400 feet)
Right Channel	7315.28 m (24,000 feet)

Source: SDO, 1997a, Operational Manual.

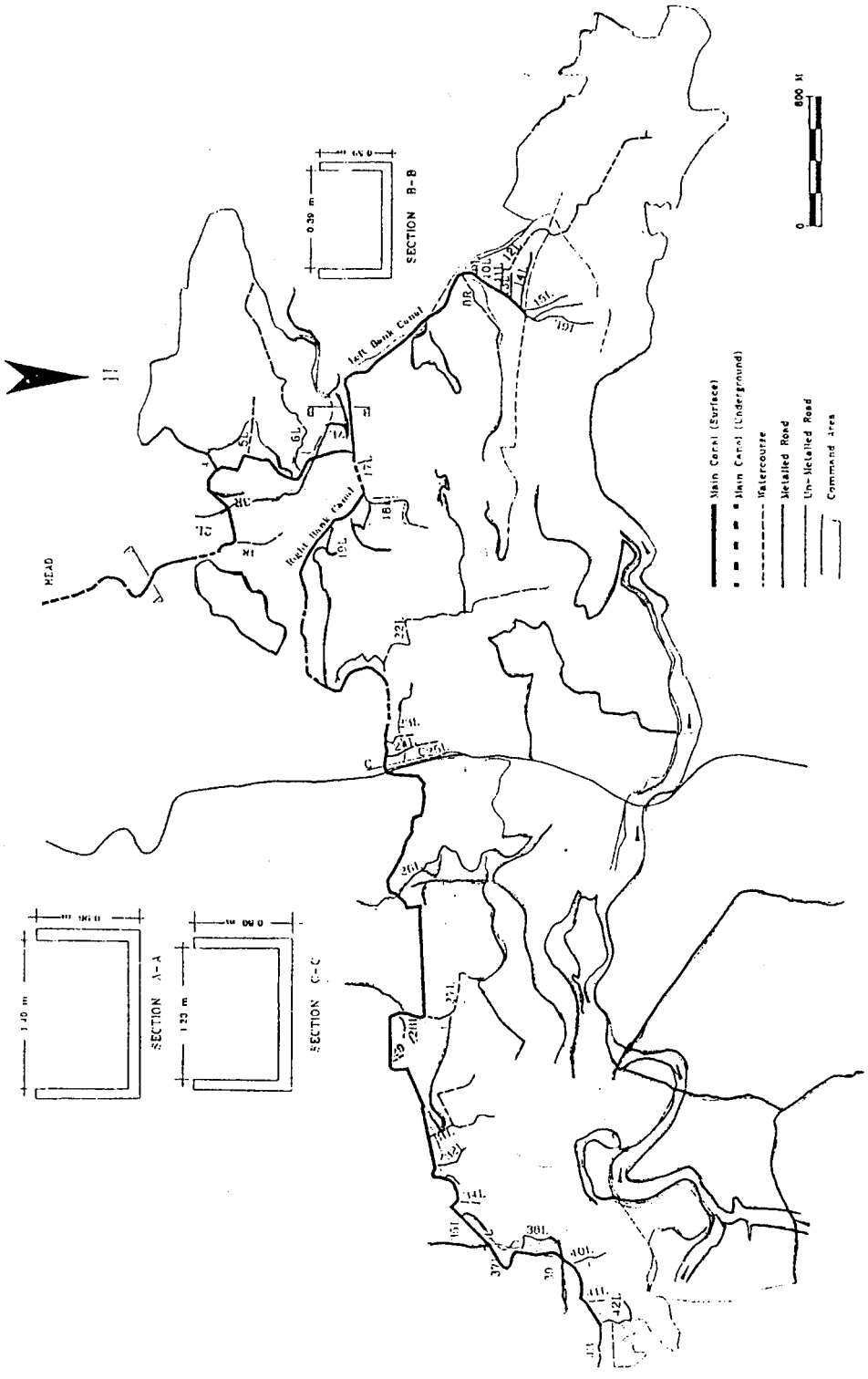

Figure 2. Map of Shahpur Small Dam
Source: WRRI, 1997

Table 14. Salient Features of Mirwal Dam and Command Area

A. Hydrology	
Area of Catchment up to Dam Site	38 sq km
Rainfall in Standard Dry Year	611 mm
Rainfall in Mean Year	740 mm
Design Flood before Routing	300 cum/s
Design Flood after Routing	203 cum/s
Average Annual Inflow	48,52,000 cum
B. Reservoir	
Gross Storage Capacity	46,47,000 cum
Dead Storage Capacity	12,81,000 cum
Live Storage Capacity	33,67,000 cum
Normal Reservoir Level	400 m
Dead Storage Level	394.82 m
Annual Withdrawal for Irrigation	23,58,000 cum
Estimated Evaporation Losses	14,16,000 cum
Pond Area at N.P.L	74 ha
C. Dam	
Type	Concrete gravity dam
Maximum Height	24 m
Length at Top	370.42 m
Top Width	1.79 m
Upstream Slope	Vertical
Downstream Slope	0.8 : 1
Top Elevation of Dam Embankment	403 m
D. Spillway	
Type	Ogee Spillway
Spill Level	400.3 m
Spillway Width	30 m
Capacity	252.69 cum/s
E. Irrigation system	
Type	Gravity Flow
Gross Command Area (GCA)	465.21 ha
Culturable Command Area (CCA)	424.14 ha
Proposed Cropping Intensity	140 percent
Kharif	55 percent
Rabi	85 percent
Capacity of the System	11 cusecs
Slope of Main Channels	1 : 2000
Length of Main Channels	6934.45 m
Length of Minor Channels	1679.92 m

Source: SDO, 1997b, Operational Manual.

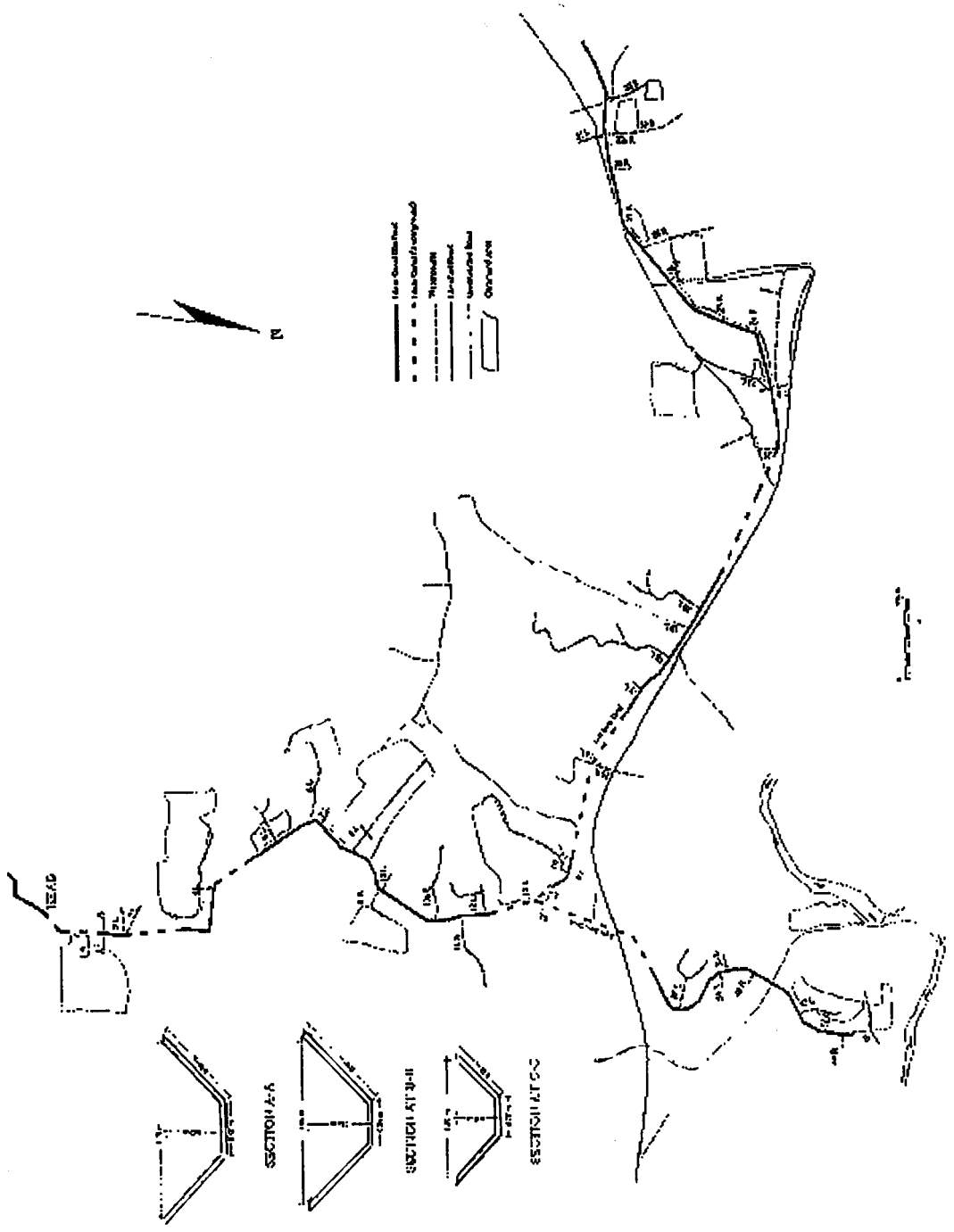

Figure 3. Mirwal Small Dam
Source: WRRI, 1997

Table 15. Salient Features of Kot Raja Dam

A. Hydrology	
Area of Catchment up to Dam Site	24 sq km
Rainfall in Standard Dry Year	564 mm
Rainfall in Mean Year	700 mm
Average Annual Sedimentation	39396 cubic meter
Design Flood before Routing	395 cum/s
Design Flood after Routing	135 cum/s
Average Annual Inflow	38,73,000 cum
B. Reservoir	
Gross Storage Capacity	35,10,000 cum
Dead Storage Capacity	18,50,000 cum
Live Storage Capacity	16,60,000 cum
Normal Reservoir Level	521.16 m
	521.80 m
Dead Storage Levels	517 m
Annual Withdrawal for Irrigation	23,21,000 cum
Estimated Evaporation Losses	5,83,000 cum
Pond Area at N.P.L.	68 ha
C. Dam	
Type	Homogeneous Earth Fill Dam
Maximum Height	24.12 m (79.14 feet)
Length at Top	197.93 m (650 feet)
Top Width	6.1 m (20 feet)
Up Stream Slope	1 : 3
Down Stream Slope	1 : 2.5
Top Level of Dam Embankment	525.60 m (1724.42 feet)
D. Spillway	
Type	Chute Spillway
Length of Approach Channel	344.42 m (1130 feet)
Spill Level	521.16 m (1709.62 feet)
Clear Water Way	25 m (82 feet)
Capacity	135.1 cum/s (4770 cusecs)
E. Irrigation System	
Type	Gravity Flow
G.C.A.	500 ha (1236 acres)
C.C.A. in Existing Chakbandi	347 ha (857 acres)
Potential Command Area	450 ha (1112 acres)
Proposed Cropping Intensity	120%
Kharif	50%
Rabi	70%
Capacity of the System	14 Cusecs
Slope of Main Channel	1 : 2000
Length of Main Channel	4537 m (14900 feet)
Length of Minors	3200.2 m (10500 feet)
Minor No. 1	1524.4 m (5000 feet)
Minor No. I2	1676.8 m (5500 feet)

Source: SDO, 1997c, Operational Manual.

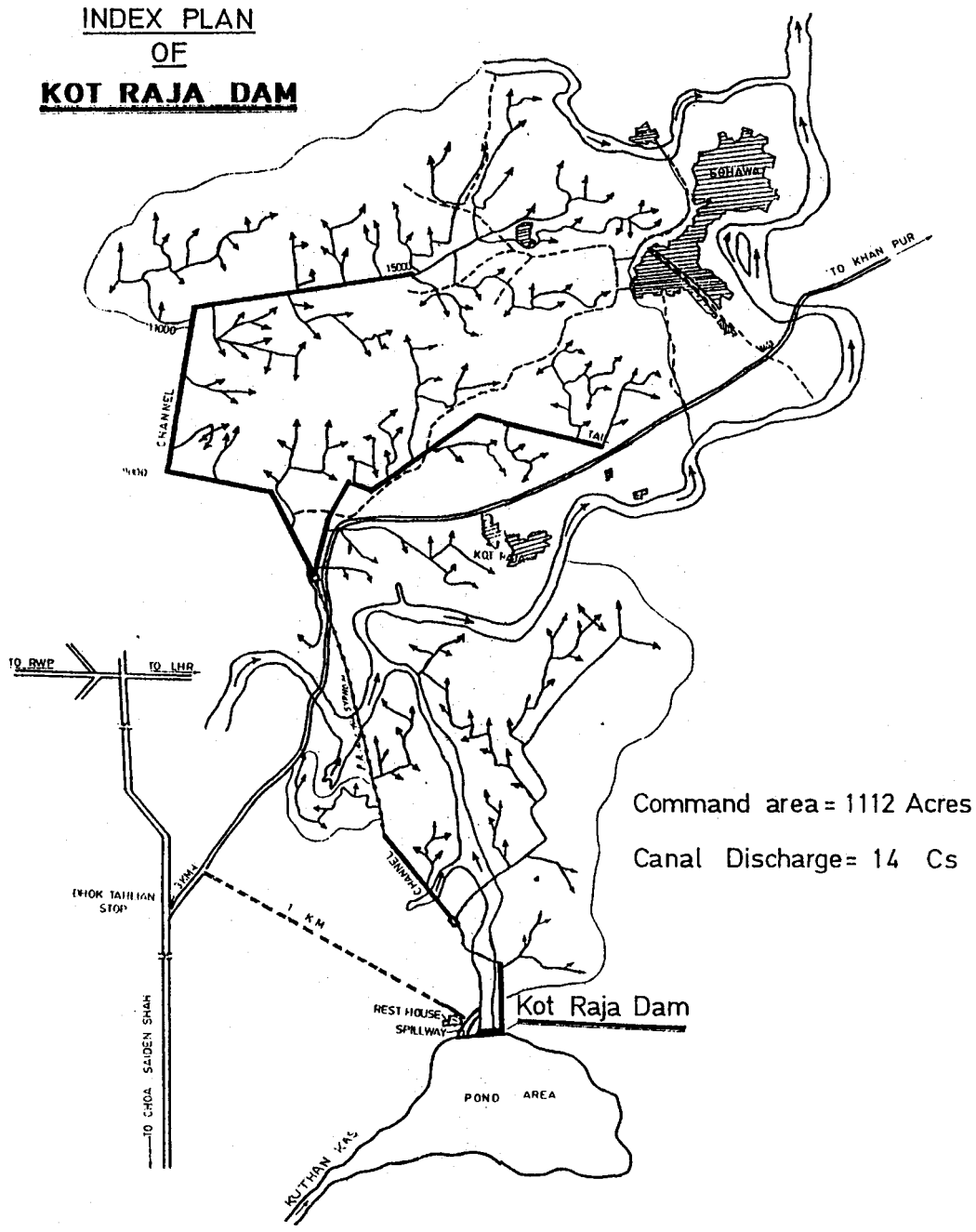

Figure 4. Kot Raja Small Dam
Source: SDO, 1997

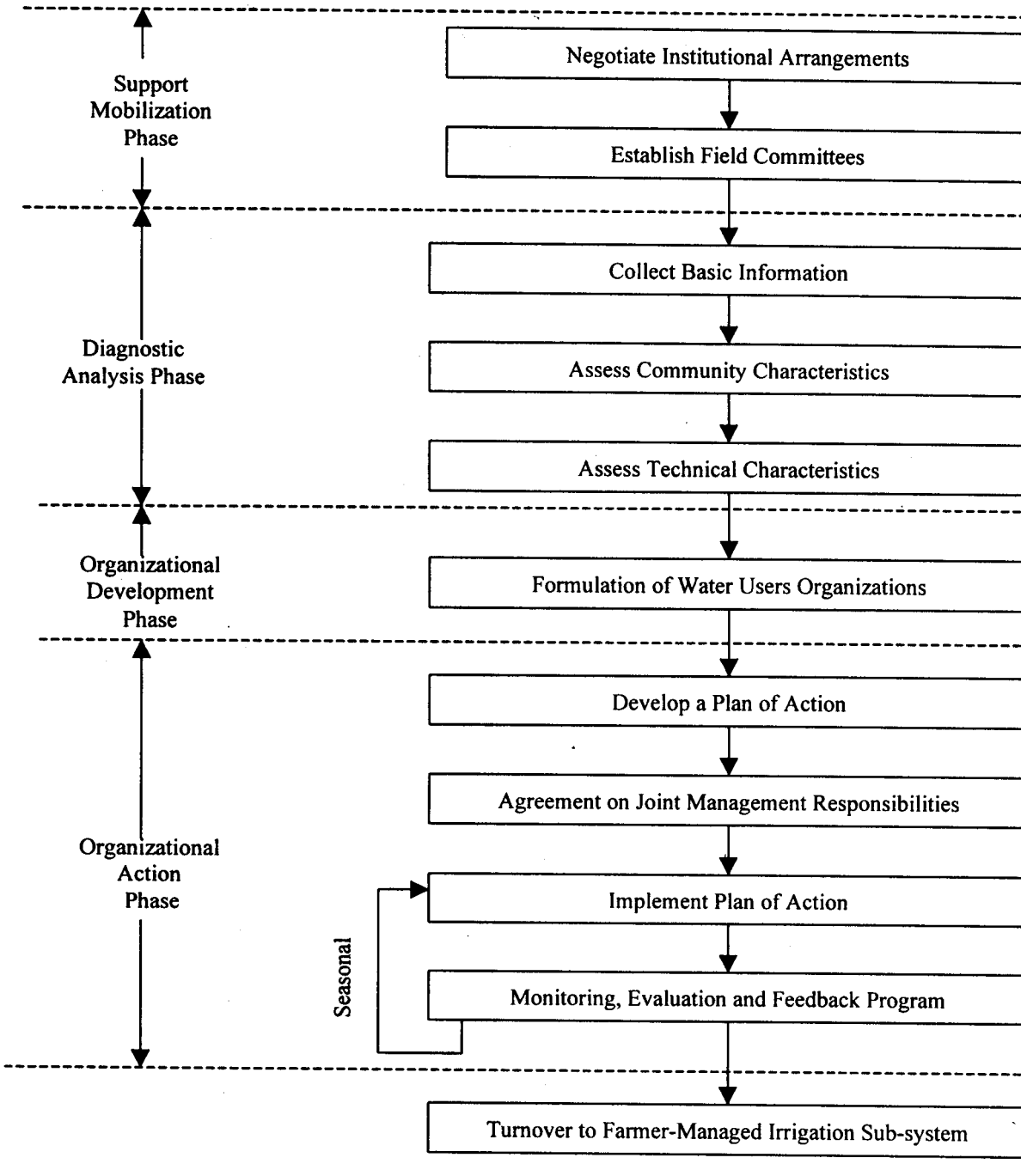

Figure 5. Process for Creating Sustainable Water Users Organizations
Source: Skogerboe et al. 1993.

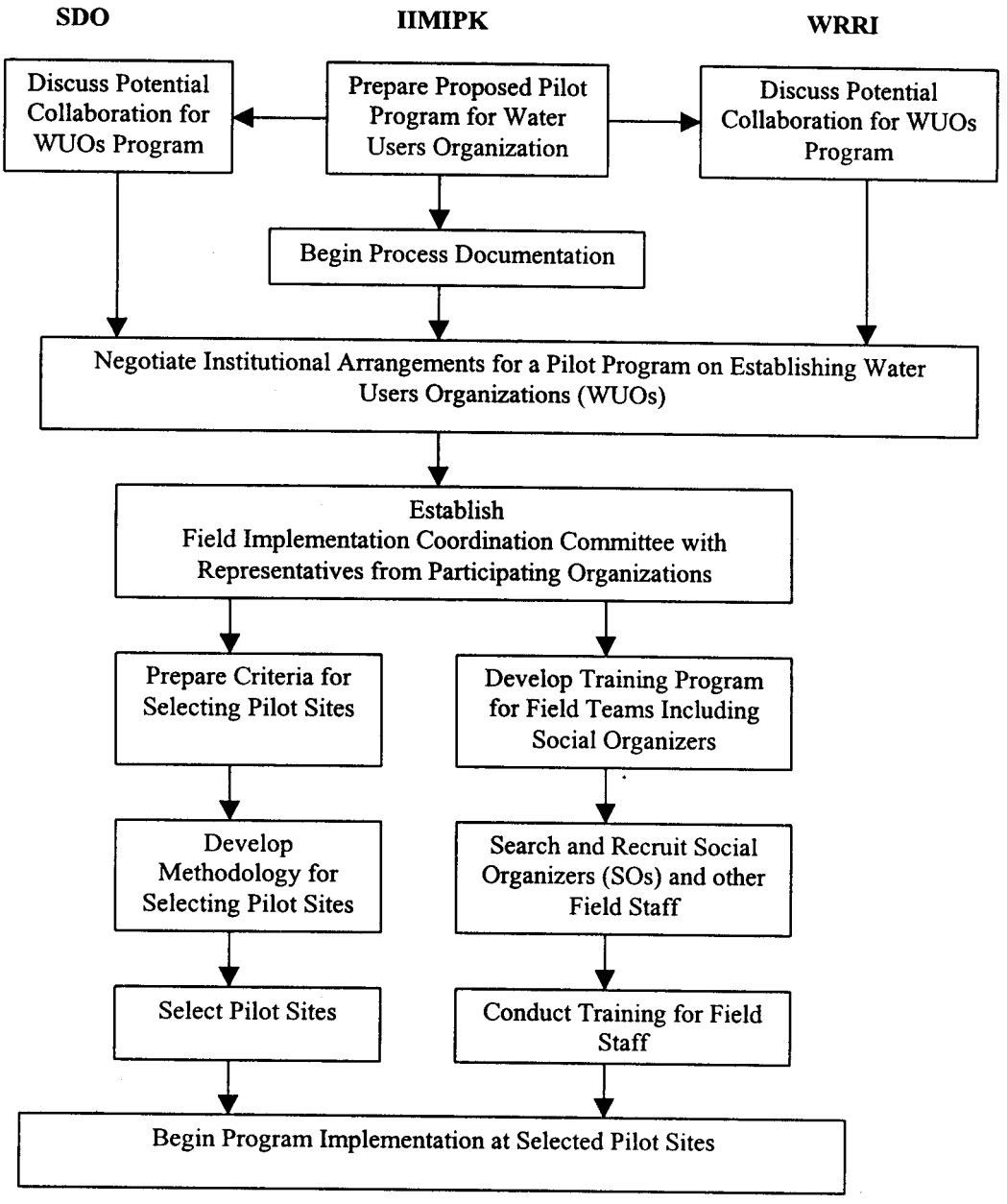

Figure 6. Phase 1: Support Mobilization
Source: Skogerboe et al. 1993.

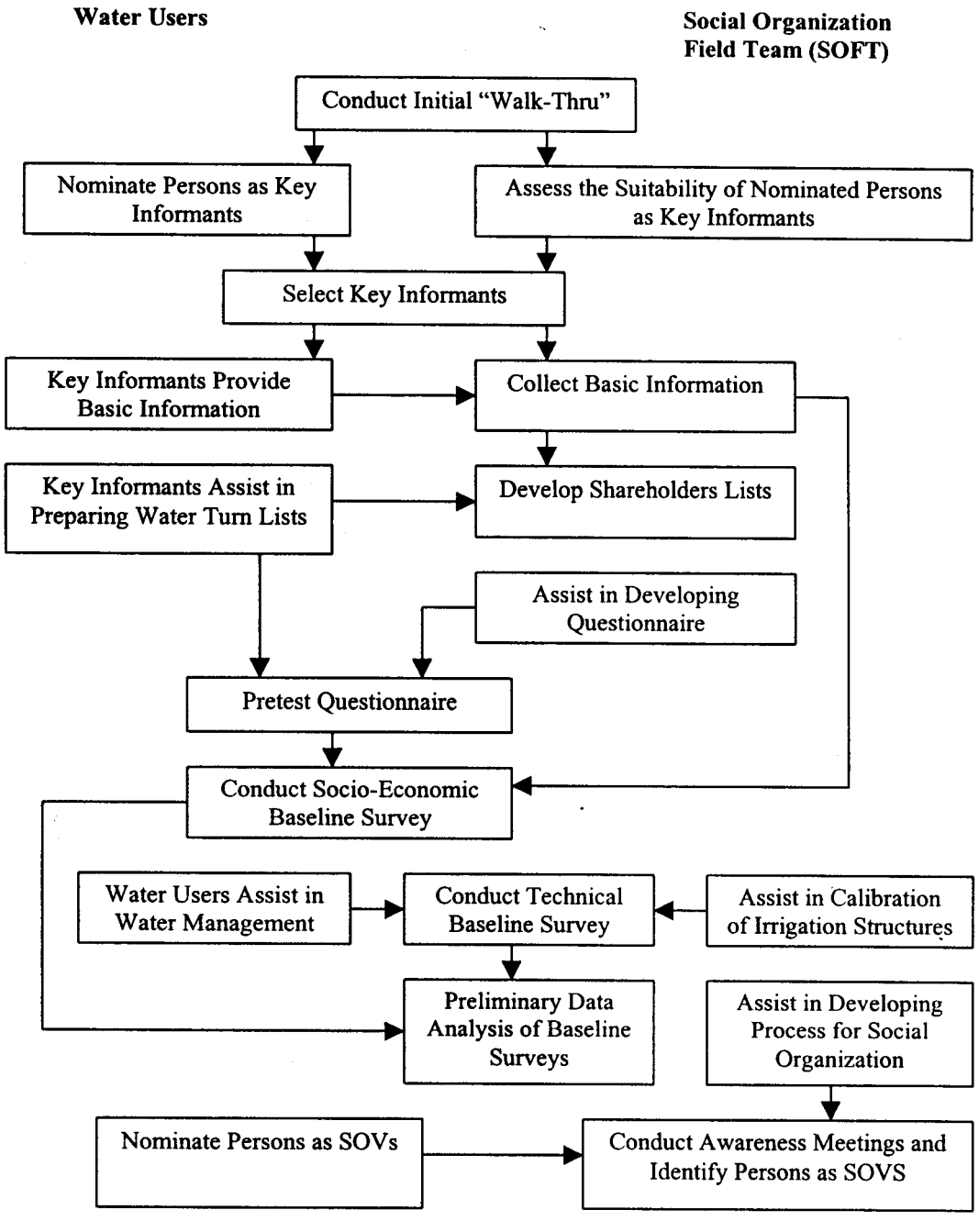

Figure 7. Phase 2: Diagnostic Analysis
Source: Skogerboe et al. 1993.

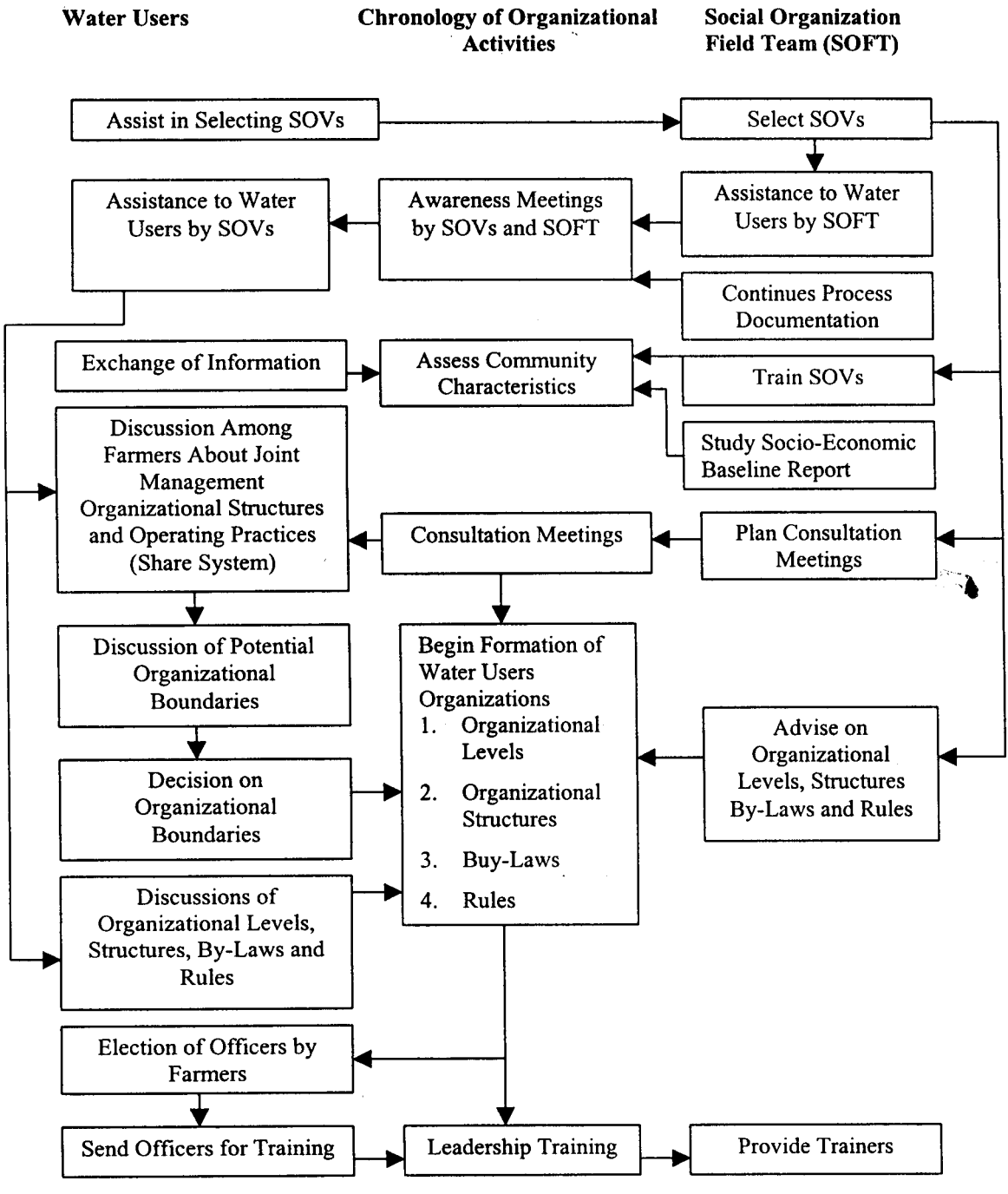

Figure 8. Phase 3: Organizational Development
Source: Skogerboe et al. 1993

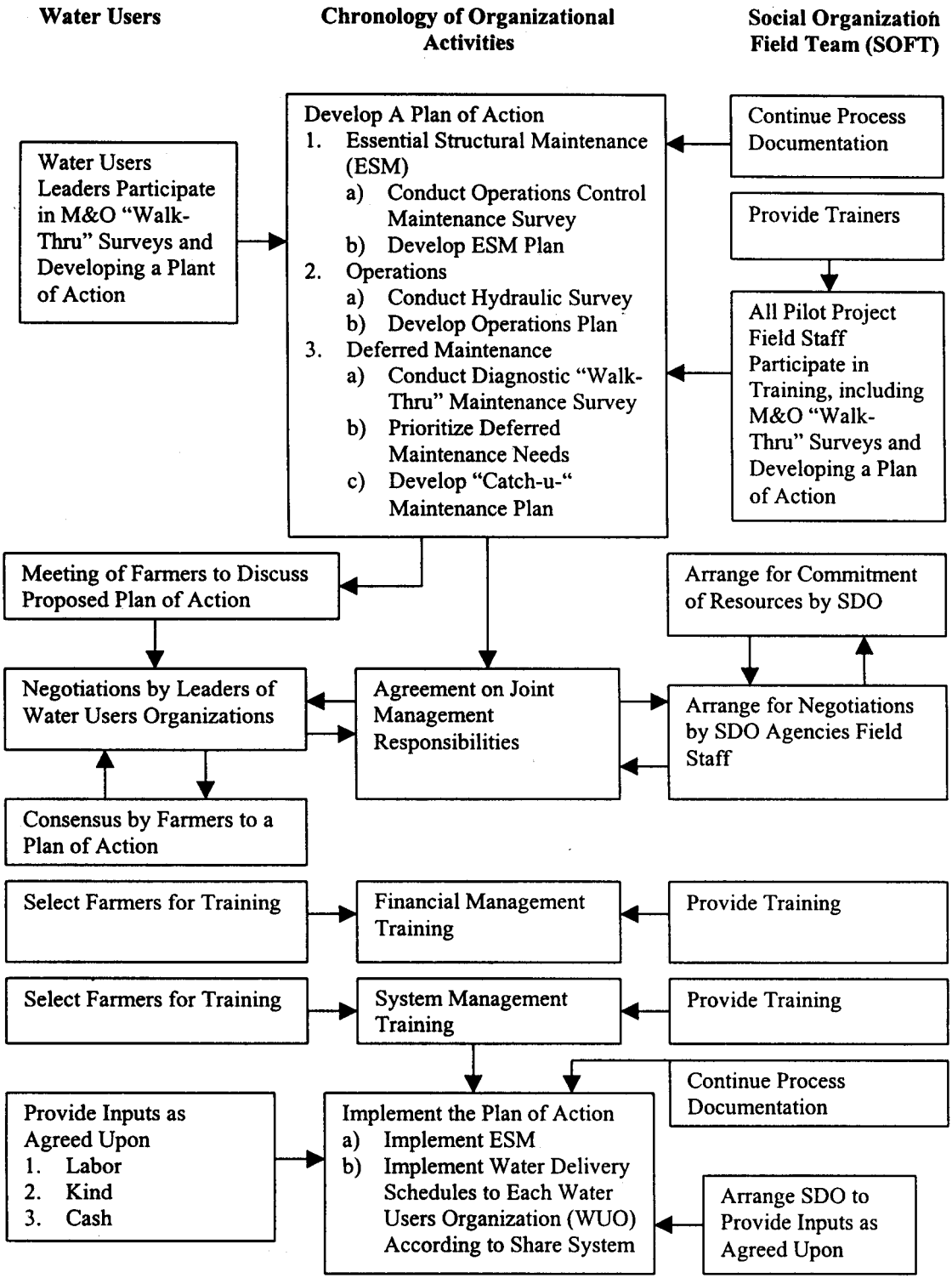

Figure 9. Phase 4: Organizational Action
Source: Skogerboe et al. 1993

IIMI-PAKISTAN PUBLICATIONS
RESEARCH REPORTS

Report No.	Title	Author	Year
R-1	**Crop-Based Irrigation Operations Study in the North West Frontier Province of Pakistan** Volume I: Synthesis of Findings and Recommendations	Carlos Garces-R D.J. Bandaragoda Pierre Strosser	June 1994
	Volume II: Research Approach and Interpretation	Carlos Garces-R Ms. Zaigham Habib Pierre Strosser Tissa Bandaragoda Rana M. Afaq Saeed ur Rehman Abdul Hakim Khan	June 1994
	Volume III: Data Collection Procedures and Data Sets	Rana M. Afaq Pierre Strosser Saeed ur Rehman Abdul Hakim Khan Carlos Garces-R	June 1994
R-2	Salinity and Sodicity Research in Pakistan - Proceedings of a one-day Workshop	J.W. Kijne Marcel Kuper Muhammad Aslam	Mar 1995
R-3	Farmers' Perceptions on Salinity and Sodicity: A case study into farmers' knowledge of salinity and sodicity, and their strategies and practices to deal with salinity and sodicity in their farming systems	Neeltje Kielen	May 1996
R-4	Modelling the Effects of Irrigation Management on Soil Salinity and Crop Transpiration at the Field Level (M.Sc Thesis - published as Research Report)	S.M.P. Smets	June 1996
R-5	Water Distribution at the Secondary Level in the Chishtian Sub-division	M. Amin K. Tareen Khalid Mahmood Anwar Iqbal Mushtaq Khan Marcel Kuper	July 1996
R-6	Farmers Ability to Cope with Salinity and Sodicity: Farmers' perceptions, strategies and practices for dealing with salinity and sodicity in their farming systems	Neeltje Kielen	Aug 1996
R-7	Salinity and Sodicity Effects on Soils and Crops in the Chishtian Sub-Division: Documentation of a Restitution Process	Neeltje Kielen Muhammad Aslam Rafique Khan Marcel Kuper	Sept 1996
R-8	Tertiary Sub-System Management: (Workshop proceedings)	Khalid Riaz Robina Wahaj	Sept 1996
R-9	Mobilizing Social Organization Volunteers: An Initial Methodological Step Towards Establishing Effective Water Users Organization	Mehmoodul Hassan Zafar Iqbal Mirza D.J. Bandaragoda	Oct 1996
R-10	Canal Water Distribution at the Secondary Level in the Punjab, Pakistan (M.Sc Thesis published as Research Report)	Steven Visser	Oct 1996
R-11	Development of Sediment Transport Technology in Pakistan: An Annotated Bibliography	M. Hasnain Khan	Oct 1996
R-12	Modeling of Sediment Transport in Irrigation Canals of Pakistan: Examples of Application (M.Sc Thesis published as Research Report)	Gilles Belaud	Oct 1996
R-13	Methodologies for Design, Operation and Maintenance of Irrigation Canals subject to Sediment Problems: Application to Pakistan (M.Sc Thesis published as Research Report)	Alexandre Vabre	Oct 1996

Report No.	Title	Author	Year
R-14	Government Interventions in Social Organization for Water Resource Management: Experience of a Command Water Management Project in the Punjab, Pakistan	Waheed uz Zaman D.J.Bandaragoda	Oct 1996
R-15	Applying Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) for Building Inter-Agency Collaboration	Derk Kuiper Mushtaq A. Khan Jos van Oostrum M. Rafique Khan Nathalie Roovers Mehmood ul Hassan	Nov 1996
R-16	Hydraulic Characteristics of Chishtian Sub-division, Fordwah Canal Division	Anwar Iqbal	Nov 1996
R-17	Hydraulic Characteristics of Irrigation Channels in the Malik Sub-Division, Sadiqia Division, Fordwah Eastern Sadiqia Irrigation and Drainage Project	Khalid Mahmood	Nov 1996
R-18	**Proceedings of National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan**	M. Badruddin Gaylord V. Skogerboe M.S. Shafique (Editors for all volumes)	Nov 1996
R-18.1	Volume-I: Inauguration and Deliberations		
R-18.2	Volume-II: Papers on the Theme: Managing Canal Operations		
R-18.3	Volume-III: Papers on the Theme: Water Management Below the Mogha		
R-18.4	Volume-IV: Papers on the Theme: Environmental Management of Irrigated Lands		
R-18.5	Volume-V: Papers on the Theme: Institutional Development		
R-19	Detailed Soil Survey of Eight Sample Watercourse Command Areas in Chishtian and Hasilpur Tehsils	Soil Survey of Pakistan IIMI-Pakistan	Nov 1996
R-20	Unsteady Flow Simulation of the Designed Pehur High-Level Canal and Proposed Remodeling of Machai and Miara Branch Canals, North West Frontier Province, Pakistan	Zaigham Habib Kobkiat Pongput Gaylord V. Skogerboe	Dec 1996
R-21	**Salinity Management Alternatives for the Rechna Doab, Punjab, Pakistan**	Gauhar Rehman Waqar A. Jehangir Abdul Rehman Muhammad Aslam Gaylord V. Skogerboe	May 1997
R-21.1	Volume One: Principal Findings and Implications for Sustainable Irrigated Agriculture		
R-21.2	Volume Two: History of Irrigated Agriculture: A Select Appraisal	Gauhar Rehman Hassan Zia Munawwar Asghar Hussain	Jan 1997
R-21.3	Volume Three: Development of Procedural and Analytical Liniks	Gauhar Rehman Muhammad Aslam Waqar A. Jehangir Abdul Rehman Asghar Hussain Nazim Ali Hassan Zia Munawwar	Jan 1997
R-21.4	Volume Four: Field Data Collection and Processing	Gauhar Rehman Muhammad Aslam Waqar A. Jehangir Mobin Ud Din Ahmed Hassan Zia Munawwar Asghar Hussain Nazim Ali Faizan Ali Samia Ali	Jan 1997
R-21.5	Volume Five: Predicting Future Tubewell Salinity Discharges	Muhammad Aslam	Jan 1997

Report No.	Title	Author	Year
R-21.6	Volume Six: Resource Use and Productivity Potential in the Irrigated Agriculture	Waqar A. Jehangir Nazim Ali	Feb 1997
R-21.7	Volume Seven: Initiative for Upscaling: Irrigation Subdivision as the Building Block	Gauhar Rehman Asghar Hussain Hassan Zia Munawwar	Apr 1997
R-21.8	Volume Eight: Options for Sustainability: Sector-Level Allocations and Investments	Abdul Rehman Gauhar Rehman Hassan Zia Munawar	Apr 1997
R-22	Salinisation, Alkalinisation and Sodification on Irrigated Areas in Pakistan: Characterisation of the geochemical and physical processes and the impact of irrigation water on these processes by the use of a hydro-geochemical model (M.Sc Thesis published as Research Report)	Nicolas Condom	Mar 1997
R-23	Alternative Scenarios for Improved Operations at the Main Canal Level: A Study of Fordwah Branch, Chishtian Sub-Division Using A Mathematical Flow simulation Model(M.Sc Thesis published as Research Report)	Xavier Litrico	Mar 1997
R-24	Surface Irrigation Methods and Practices: Field Evaluation of the Irrigation Processes for Selected Basin Irrigation Systems during Rabi 1995-96 Season	Ineke Margot Kalwij	Mar 1997
R-25	Organizing Water Users for Distributary Management: Preliminary Results from a Pilot Study in the Hakra 4-R Distributary of the Eastern Sadiqia Canal System of Pakistan's Punjab Province	D.J. Bandaragoda Mehmood Ul Hassan Zafar Iqbal Mirza M. Asghar Cheema Waheed uz Zaman	Apr 1997
R-26	Moving Towards Participatory Irrigation Management	D.J. Bandaragoda Yameen Memon	May 1997
R-27	Fluctuations in Canal Water Supplies: A Case Study	Shahid Sarwar H.M. Nafees M.S. Shafique	June 1997
R-28	Hydraulic Characteristics of Pilot Distributaries in the Mirpurkhas, Sanghar and Nawabshah Districts, Sindh, Pakistan	Bakhshal Lashari Gaylord V. Skogerboe Rubina Siddiqui	June 1997
R-29	Integration of Agricultural Commodity Markets in the South Punjab, Pakistan	Zubair Tahir	July 1997
R-30	Impact of Irrigation, Salinity and Cultural Practices on Wheat Yields in Southeastern Punjab, Pakistan	Florence Pintus	Aug 1997
R-31	Relating Farmers' Practices to Cotton Yields in Southeastern Punjab, Pakistan	P.D.B.J. Meerbach	Aug 1997
R-32	An Evaluation of Outlet Calibration Methods: A contribution to the study on Collective Action for Water Management below the Outlet, Hakra 6-R Distributary	Arjen During	Aug 1997
R-33	Farmers' use of Basin, Furrow and Bed-and-Furrow Irrigation Systems and the possibilities for traditional farmers to adopt the Bed-and-Furrow Irrigation Method.	Nanda M. Berkhout Farhat Yasmeen Rakhshanda Maqsood Ineke M. Kalwij	Sep 1997
R-34	Financial Feasibility Analysis of Operation and Maintenance Costs for Water Users Federations on three distributaries in Province of Sindh, Pakistan.	Amin Sohani	Sep 1997
R-35	Assessing the Field Irrigation Performance and Alternative Management Options for Basin Surface Irrigation Systems through Hydrodynamic Modelling.	Ineke Margot Kalwij	Oct 1997
R-36	Socio-Economic Baseline Survey for Three Pilot Distributaries in Sindh Province, Pakistan.	Yameen Memon Mehmood Ul Hassan Don Jayatissa Bandaragoda	Nov 1997

Report No.	Title	Author	Year
R-37	Socio-Economic Basline Survey for a Pilot Project on Water Users Organizations in the Hakra 4-R Distributary Command Area, Punjab.	Muhammad Asghar Cheema Zafar Iqbal Mirza Mehmood Ul Hassan Don Jayatissa Bandaragoda	Dec 1997
R-38	Baseline Survey for Farmers Organizations of Shahpur and Mirwal Small Dams, Punjab, Pakistan.	Muhammad Asghar Cheema Don Jayatissa Bandaragoda	Dec 1997
R-39	**Monitoring and Evaluation of Irrigation and Drainage Facilities for Pilot Distributaries in Sindh Province, Pakistan**		
R-39.1	Volume One: Objectives, Stakeholders, Approaches and Methodology	M.S. Shafique B.K. Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-39.2	Volume Two: Bareji Distributary, Mirpurkhas District	B.K. Lashari Waryam Balouch Ghulam Mustafa Talpur Muhammad Nadeem Asghar Ali Memon Badrul Hassan Memon M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997
R-39.3	Volume Three: Dhoro Naro Minor, Nawabshah District	B.K. Lashari Abdul Rehman Soomro Nizamuddin Bharchoond Muneer Ahmed Mangrio Parvez Ahmed Pirzado Fateh Mohammad Mari M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997
R-39.4	Volume Four: Heran Distributary, Sanghar District	B.K. Lashari M. Naveed Khayal Niaz Hussain Sial Abdul Majeed Ansari Abdul Jalil Ursani Ghulam Shabir Soomoro M. Ghous Laghari M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997
R-40	**Maintenane Plans for Irrigation Facilities of Pilot Distributaties in Sindh Province, Pakistan.**		
R-40.1	Volume One: Dhoro Naro Minor, Nawabshah District	Abdul Rehman Soomro Munir Ahmed Mangrio Nizamuddin Bharchoond Fateh Muhammad Mari Parvez Ahmed Pirzado Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-40.2	Volume Two: Heran Distributary, Sanghar District	Abdul Majeed Ansari Niaz Hussain Sial Abdul Jalil Ursani Ghulam Shabir M. Ghous Laghari M. Naveed Khayal Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997

Report No.	Title	Author	Year
R-40.3	Volume Three: Bareji Distributary, Mirpurkhas District	Asghar Ali Memon Waryam Balouch Ghulam Mustafa Talpur Muhammad Nadeem Badrul Hassan Memon Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-41	**Preliminary Business Plans**	Pervaiz Ahmad Pirzada Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-41.1	Volume One: Dhoro Naro Minor, Nawabshah District		
R-41.2	Volume Two: Bareji Distributary, Mirpurkhas District	Muhammad Nadeem Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-41.3	Volume Three: Heran Distributary, Sanghar District	Niaz Hussain Sial Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-42 Final Report	Prospects for Farmer-Managed Irrigated Agriculture in the Sindh Province of Pakistan. Final Report.	D.J. Bandaragoda Gaylord V. Skogerboe Yameen Memon	Dec 1997
R-43	Study Tour of Pakistani Pilot Project Farmer-Leaders to Nepal	Mehmood Ul Hassan Yameen Memon	Jan 1998
R-44	Self-Help Maintenance Activities by the Water Users Federation of Hakra 4-R Distributary	Waheed uz Zaman	Feb 1998
R-45	Semi-Detailed Soil Survey of Chishtian Irrigation Sub-Division	Soil Survey of Pakistan IIMI-Pakistan	Mar 1998
R-46	Tenancy and Water Management in South-Eastern Punjab, Pakistan	Annemiek Terpstra	Mar 1998
R-47	The Collaboration between the International Irrigation Management Institute and Cemagref in Pakistan: Proceeding of a one-day workshop	IIMI Cemagref	Apr 1998
R-48	Methodologies for Developing Downstream Gauge Ratings for Operating Canal Discharge Regulating Structures	Paul Willem Vehmeyer Raza ur Rehman Abbasi Mushtaq A. Khan Abdul Hakeem Khan Gaylord V. Skogerboe	Apr 1998
R-49	Community Irrigation Systems in the Province of Balochistan	Olaf Verheijen	Apr 1998
R-50	Modelling Soil Salinity and Sodicity Processes in an Unsaturated Zone using LEACHM: A Case Study from the Chishtian Irrigation Sub-Division	M. Aslam J.C. van Dam	Apr 1998
R-51	Water Measurement Training for Subsystem Management of Hakra 4-R Distributary by the Water Users Federation	Waheed-uz-Zaman Anwar Iqbal Abdul Hamid Gaylord V. Skogerboe	May 1998
R-52	Comparison of Different Tools to Assess the Water Distribution in Secondary Canals with Ungated Outlets	Mobin ud Din Ahmad E.G. van Waijjen Marcel Kuper Steven Visser	May 1998
R-53	Sediment Behavior of Sangro Distributary, Mirpurkhas Sub-division, Sindh	Gilles Belaud Abdul Hakeem Khan Ghulam Nabi	May 1998
R-54	Evaluation of the Integrated Approach Developed in the Context of the IIMI-CEMAGREF Collaboration in Pakistan	Patrice Garin Marcel Kuper Frederic Labbe Pierre Strosser	May 1998

Report No.	Title	Author	Year
R-55	Development of a Modified Low-Cost Pitot Tube for Measuring Pump Discharges	M.S. Shafique Nisar Hussain Bukhari M. Mohsin Hafeez	June 1998
R-56	Institutional and Physical Determinants of Water Management Performance at the Tertiary Level: The Dynamics of Watercourse Maintenance in the Pakistan Punjab.	Cris H. de Klein Robina Wahaj	June 1998
R-57	Formalization of Water Users Associations by Farmer Leaders of Hakra 4-R Distributary.	Waheed uz Zaman Nasir Sultan Bilal Asghar Muhammad Amjad Kamran	July 1998
R-58	Water Balance in Dhoro Naro Minor Command Area Sindh, Pakistan	Bea Keller Gabor Jaimes	July 1998
R-59	Performance Assessment of the Water Distribution System in the Chishtian Sub-division at the Main and Secondary Canal Level	Zaigham Habib Marcel Kuper	July 1998
R-60	Transition from local level Management to State Regulation: Formalization of Water Allocation Rules in Pakistan	Mehmood ul Hassan Abdul Hamid D.J. Bandaragoda	Aug 1998
R-61	Multiple Uses of Irrigtion Water in the Hakra 6-R Distributary Command Area, Punjab, Pakistan	Waqar A. Jehangir Muhammad Mudasser Mahmood ul Hassan Zulfiqar Ali	Aug 1998
R-62	Field Discharge Calibration of Head Regulators, Mirpurkhas Sub-Division, Jamrao Canal, Nara Circle, Sindh Province, Pakistan	Abdul Hakeem Khan Gaylord V. Skogerboe Rubina Siddiqi Bakhshal Lashari Zahid Hussain Jalbani Muhammad Ali Khuwaja Muhammad Hashim Memon Waqar Hussain Khokhar	Aug 1998
R-63	Training Farmers to Organize Farmers: Lessons Learned in Social Organization for Irrigated Agriculture at the Hakra 4-R Distributary	Mehmood ul Hassan Zafar Iqbal Mirza D.J. Bandaragoda	Sep 1998
R-64	Physical Characteristics and Operational Performance of Mirpur Khas Sub-Division, Jamrao Canal Division, Nara Circle, Sindh Province, Pakistan	Abdul Hakeem Khan Rubina Siddiqui Zahid Hussain Jalbani Muhammad Ali Khowaja Waqar Hussain Khokhar Muhammad Hashim Memon Bakhshal Lashari Gaylord V. Skogerboe	Sep 1998
R-65 R-65.1	**GIS Metadata for an Irrigation System** Volume I: Chishtian Sub-Division	Mobin-ud-Din Ahmad Yann Chemin Salman Asif Samia Ali	Oct 1998
R-65.2	Volume II: Selected Watercourses within Chishtian Sub-Division	Samia Ali Yann Chemin Salman Asif Mobin-ud-Din Ahmad	Oct 1998
R-66	Application of Crop-Based Irrigation Operations to Chashma Right Bank Canal	Juan Carlos Alurralde Carlos A. Gandarillas Gaylord V. Skogerboe	Oct 1998
R-67	A Gender Analysis of Casual Hired Labor in Irrigated Agriculture in the Pakistan Punjab	Cris H. De Klein	Nov 1998
R-68	Pre-Takeover Comparative Performance of Water Users Organizations of Hakra 4-R Distributary, Punjab, Pakistan	Wahee-uz-Zaman Abdul Hamid	Nov 1998
R-69	Preliminary Business Plan for the Water Users Federation of the Hakra 4-R Distributary	Mehmood Ul Hassan Mohsin Khatri	Nov 1998