Working Paper No. 39

FARMERS' ORGANIZED BEHAVIOR IN IRRIGATED AGRICULTURE IN PAKISTAN'S PUNJAB

A Case Study of Six Watercourse Command Areas in Junejwala Minor, Lower Chenab Canal System

Saleem M. Malik
Waheed-uz-Zaman
Marcel Kuper

IIMI
INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

Malik, S., Waheed-uz-Zaman, and M. Kuper. 1996. *Farmers' organized behavior in irrigated agriculture in Pakistan's Punjab: A case study of six watercourse command areas in Junejwala Minor, Lower Chenab Canal System.* Colombo, Sri Lanka: International Irrigation Management Institute (IIMI). ix + 47p. (IIMI Working Paper No.39).

/ irrigated farming / irrigation systems / farmer participation / farmers' associations / water users' associations / farmer-agency interactions / watercourses / canals / case studies / social aspects / land tenure / leadership / conflict / irrigation effects / Pakistan / Punjab /

DC 631.7
ISBN 92-9090-328-7

IIMI's Working Paper series is intended to stimulate discussion among people interested in aspects of irrigation management. These papers make available the results of recent or ongoing research, and the informed opinions of IIMI staff members and collaborators, as early as possible. The views expressed are, therefore, those of the authors and do not (at this stage) necessarily represent the consensus of IIMI or its partners. IIMI will welcome comments on this paper, which should be sent either to IIMI or to the authors at the following address:

Information and Communications Division
International Irrigation Management Institute
P.O. Box 2075
Colombo, Sri Lanka

Contents

Figures

Tables

Abstract

Increased participation of farmers in the management of Pakistan's canal irrigation system is advocated by the federal government and donors to help address the low levels of performance of irrigated agriculture in Pakistan. However, past efforts in establishing Water Users Associations have shown that establishing sustainable, robust farmers' water management organizations is not an easy task. The aim of this paper is to assess the existing organization of irrigation activities in six tertiary units in Pakistan's Punjab and to evaluate the effect of the social setup of the villages to which these units belong on the present organization of the irrigation activities. In doing so, a number of hypotheses that have been advanced in the literature on favorable conditions for successful farmer organizations are tested. This case study can also contribute to the ongoing discussion of increased responsibilities for stakeholders, by exposing existing strengths and constraints in the present irrigation setup.

The irrigation system in Pakistan has been laid out to minimize farmers' involvement at main and secondary levels to ensure a fair and equitable distribution of water without being affected by traditional structures in the society. Hydrological boundaries do not coincide with social or administrative boundaries. However, the study shows that the social characteristics or social capital of a village impact on how effectively irrigation activities are organized by farmers. The study also exposes the fact that existing irrigation institutions (e.g., warabandi) have clear rules and boundaries that limit interactions and possible conflicts between farmers. Moreover, the number of institutions that are functional is kept very small, as organizations are dissolved when targets have been achieved.

1. INTRODUCTION

1.1 Context

Irrigation has been practiced in the Indus Basin for more than 4,000 years. The present, contiguous irrigation system, which dates back to the period from the late nineteenth to the early twentieth centuries, annually irrigates an area of about 16 million hectares (ha). Surface water delivered through this canal system is still the most important source for irrigation, despite the increasing contribution of groundwater through public and private tube wells. It is estimated that groundwater presently provides about 30 percent of the irrigation water supplied to the root zone.

The system is, to a large extent, managed by the government with farmers' involvement officially confined to the tertiary (watercourse) level,[1] where they have to clean the watercourse and field channels and share the water among themselves following a predetermined irrigation roster, referred to as *warabandi* (*wahr* = turn, *band* = fixed).

Formal farmers' organizations (apart from the officially registered warabandi) have only been introduced to the system in the late 1970s. The On-Farm Water Management (OFWM) Program worked through Water Users Associations (WUAs), embedded in a legal framework, to mobilize labor and funds for improvement of watercourses[2] (Meinzen-Dick et al. 1994). While WUAs have been successful in lining watercourses,[3] most have ceased to exist once the short-term (construction) objective had been achieved.

Of course, farmers play an important role in irrigation activities, which are not necessarily confined to watercourse activities, as was demonstrated by farmers' involvement in the cleaning of distributaries (secondary canals) in the 1992 "self-help" annual desiltation campaign (van Waijjen and Bandaragoda 1992). Also, farmers frequently intervene in the water distribution at higher levels of the irrigation system (Hafiz Ullah 1994).

With the rapid development of private tube wells, which has effectively turned the Indus Basin into a conjunctive use irrigation system, farmers have further extended the scope of their activities. Water acquisition through their own or shared tube wells has become part of a larger set of water markets, where tube-well and canal water is traded, often on a monetary basis. In line with other irrigation activities, the mechanisms for selling and buying water are still informal, although recent discussions in the irrigation sector have advocated the provision of a legal framework for water transactions.

A recent review of the irrigation sector has highlighted increasing problems of the Irrigation Departments to manage canal irrigation systems and the government is now discussing options of transferring responsibility for managing the canal system at the distributary level to farmers (Meinzen-Dick et al. 1994). The concept of proportional water distribution is infringed upon when

---

1 Gilmartin (1994) argues that one of the achievements of British-Indian engineers had been to design irrigation channels in which silting and scouring were balanced over time ("regime channels"), thereby effectively excluding local communities from their traditional maintenance role at the main-system level.

2 Originally, the concept of watercourse improvement included earthen improvement (compaction) as well as lining of watercourses. However, in later programs, lining was more and more emphasized.

3 From 1976 to 1992, there have been 13 OFWM projects in which 14,700 WUAs were established (OFWM 1991).

the Irrigation Departments are facing an increased water demand by farmers and are responding on a case-by-case basis to these demands without checking on the consequences for other parts of the system (Kuper et al. 1994). The inability of Irrigation Departments to deal with demands from farmers and other pressure groups, is an issue that may be related to the fact that responsibility for managing the irrigation system is not shared between government and the end-users.

Recently, the World Bank (1994) has advocated the introduction of market incentives in the existing irrigation setup of Pakistan, by creating so-called Public Utilities (PUs) at the canal-command level. The creation of PUs is seen as an interim step towards the establishment of user groups that are able to take over responsibility for operations and maintenance of the irrigation system. It is clear that the degree of success of farmer participation in operations and maintenance at higher levels of the system will depend largely on the ability of farmers to cooperate within a new framework.

Several case studies have been undertaken, relating the experiences of farmer organizations in a number of countries around the world. A number of more theoretical studies have used these experiences to formulate major determinants for success of farmer organizations in irrigation management (Meinzen-Dick et al. 1994, Ostrom 1992, and Uphoff 1986). It is argued here that the hypotheses formulated in these studies will need to be tested for the local conditions, particularly if these hypotheses are (perhaps implicitly) going to be applied in Pakistan in the drive for changing the irrigation setup. The present study aims to test some of these hypotheses by evaluating the social characteristics or social capital[4] of a number of sample villages and correlating that with the way irrigation activities are organized in the hydraulic units associated with these villages.

The objective of this paper is to document the informal organized behavior of farmers in six watercourses and associated villages in the Junejwala minor command area in the Punjab and to assess the social capital of these villages/watercourses. The effect of the social capital on irrigation activities of farmers is then analyzed.

1.2 Past Research in Pakistan's Punjab

Freeman and Lowdermilk (1976) found that among a list of farm problems (lack of water, fertilizers, credit, labor), water posed by far the most important constraint to increased agricultural production on the farms. This had particular reference to insufficient canal supplies, in some cases augmented by groundwater from public tube wells that were installed under the Salinity Control And Reclamation Projects (SCARP). Over the past 20 years, problems in the canal water delivery have aggravated to the extent that the issue was discussed in the Punjab Provincial Assembly in 1992, where members of parliament expressed concern over "alleged tail shortages in the distributaries and depressed feelings of farmers" over the poor performance of the irrigation

[4] Social capital is here defined as the aggregate of social characteristics (shared norms, patterns of behavior, overlapping social networks) of a group (of farmers) that determine the potential of that group to organize themselves for collective activities.

system (Punjab Provincial Parliament 1992). ***Canal water is a scarce resource that needs to be better managed for increased agricultural production.***

Freeman and Lowdermilk (1976) stated that an increased control over the source of irrigation supply would ensure a better agricultural output. They suggested four options through which farmers could attempt to expand their control over water, the constraint that is so important to them. These options are (1) water markets, (2) groundwater use through tube wells, (3) water theft, and (4) securing concessions from irrigation officials. At the time of publication, all of these options were observed to happen on a substantial scale. Recent research results (Strosser and Kuper 1994; Johnson 1989, and Murray-Rust and Vander Velde 1992) indicate that the same holds true today on an even larger scale. Cropping intensities have gone up dramatically, made possible by large-scale development of private tube wells in irrigated Punjab (Johnson 1989). Water trading plays an important role, securing a more dependable source of irrigation water for small farmers who do not have the means to invest in tube wells themselves, while water theft and obtaining concessions from irrigation officials are reportedly increasingly occurring. ***Farmers play an important (informal) role in operations and maintenance at higher levels of the irrigation system. Their present role needs to be studied in order to assess their potential for a more formal role, as envisaged in recent proposals (World Bank 1994).***

Water use efficiency was evaluated for a number of watercourses by Freeman and Lowdermilk (1976). The delivery efficiency is affected substantially through farmers' collective and individual actions in watercourse maintenance and repair. The authors advocated the establishment of so-called Water Users Associations (WUAs), a platform of farmers that would interact first with government agencies on watercourse lining and maintenance, and later possibly on other issues of water management at tertiary level. The concept of WUAs was also supported by Mirza and Merrey (1979), although they listed a number of prerequisites for WUAs to be successful.

Dissatisfaction with physical conditions of watercourses, the assumed importance of conveyance losses, and the degree of organization of farmers, led to the implementation of On-Farm Water Management (OWFM) programs in Pakistan (Byrnes 1992). Under these programs, watercourse improvement was sponsored by the government, provided farmers would establish a so-called Water Users Association (WUA) to mobilize labor and funds to contribute to the lining of the *sarkari khal*[5] and the provision of *pukka nakkas*.[6] An ordinance was promulgated in 1981 in the Punjab by which WUAs are registered and a board is established. These WUAs are established for sharing the cost of watercourse improvement and have several other responsibilities, such as the mobilization of farmers, distribution of work and financial contributions, settlement of disputes and arrangement of diversions during construction. From 1976-77 to 1991-92 there have been 13 OFWM projects for the improvement of watercourses, in which 14,700 WUAs were established (OFWM 1991). Once a watercourse is improved, a WUA

---

5 *Sarkari* = government, *Khal* = channel; the term sarkari khal generally refers to the "main" watercourse or tertiary canal that has been constructed by the government. Field channels/ditches leading to individual farms are not included in the sarkari khal.

6 A *pucca* (or fixed) *nakka* is a farm outlet on a watercourse, shared by several farmers. It is a concrete structure, in which round lids can be fitted to open and close field channels.

supposedly looks after the maintenance, repair, and periodic cleaning of the watercourse. Several authors (e.g., Byrnes 1992) have shown that WUAs generally stop functioning once the physical works have been completed.

Eight years after the initiation of these WUAs, Mirza (1989) found that informal farmer organizations, which were prevalent modes for managing water at watercourse level before implementation of WUAs, were still dominating the operation and maintenance of the irrigation system at tertiary level. WUAs have failed to perform any better than the informal organizations, because of constraints posed by the sociocultural milieu.[7] Merrey (1979) argues that the Punjab rural society is characterized by a set of values and mechanisms that encourage conflict and tend to discourage cooperation on a long- term basis. ***Concerns have been expressed about the ability of farmers to form long-term organizations.***

In his analysis of the warabandi system, Merrey (1990) suggests that the low performance of the irrigation system in the Punjab in terms of adequacy, reliability, and equity of water deliveries and in terms of agricultural production, is as much related to the local farmer organizational ineffectiveness (at watercourse level) as to the weak interface between the farmer-managed subsystem at watercourse level and the main system. An effective local farmer organization could, therefore, be part of a solution to present problems in irrigated agriculture. However, Ireson (1988) clearly indicates that emphasis on farmer cooperation is not adequate, without similar attention being paid to the development of government agency (e.g., the Punjab Irrigation and Power Department) policies and attitudes regarding the incorporation of farmer participation in overall system operations. Not involving the Punjab Irrigation and Power Department (PID) in the process of OFWM could, therefore, be a reason for the failure of the enactment of WUAs.

Experiences with the OFWM projects will need to be evaluated to understand the causes for failure of long-term organization of farmers.

Merrey (1986) found a number of common denominators that characterize watercourses, which are successfully maintained and where farmers are able to effectively organize themselves to line their field channels. Equitable landholding distribution (a majority of farmers has holdings of 2.5 to 10 acres[8]), a relative equal distribution of power and influence among farmers, the progressiveness of the community, the previous history of cooperation on community projects and the existence of one single biradari in a village or watercourse, were all factors seen as contributing towards effective water management at watercourse level. Meinzen-Dick et al. (1994) distinguish between internal and external conditions for sustainable farmer organizations. Among internal determinants for successful organizations, they mention the importance of leadership and education, the advantage of having collective memory of successful examples of cooperation in the past, a relatively small group size, the positive influence of high relative benefits, credibility of punishment, the sense of ownership of group members, whether or not the organization was built

---

7 Several other authors have pointed out the unfavorable environment for WUAs with the Ordinance providing very little empowerment to WUAs (Uphoff 1986, Byrnes 1992, and Meinzen-Dick et al. 1994).

8 1 acre = 0.40469 ha.

on existing organizations, a homogeneity of background of members, and accountability of the organization. Interestingly, among the host of external conditions mentioned by Meinzen-Dick et al. (1994), water scarcity is prominent, building on Uphoff's inverted U relationship between water supply and farmers' perceived need for organization.

A number of social characteristics that are likely to impact on the way irrigation activities are organized by farmers have been identified by various authors, as discussed in this section. These hypotheses were tested in this case study and are reviewed in this report (section 5.2).

2. RESEARCH LOCALE AND METHODOLOGY

2.1 Research Locale

The Lower Chenab Canal (LCC) irrigation system, located in the Rechna Doab, the interfluvial region between Chenab and Ravi Rivers, covers a gross area of about 1.5 million hectares, of which 1.24 million hectares make up the culturable command area (CCA [see map 1]). It constitutes the single largest irrigation system in Pakistan's Punjab and is administered by the Punjab Irrigation and Power Department (PID) through the office of the Chief Engineer. Faisalabad Zone.

The climate is semiarid with an annual average rainfall of around 500 mm. The LCC system is located in the transition zone of the agro-ecological rice-wheat and cotton-wheat belts of the Punjab. Other main crops grown in the area are maize, sugarcane, oil seeds, vegetables and forage crops. Fruit orchards, citrus in particular, are common and are observed to increase in area. Annual cropping intensities, originally designed at a level of 50 or 75 percent have gone up dramatically. PID presently estimates intensities to be at a level of 133 percent for the LCC (Faisalabad Zone, 1991) and IIMI research findings indicate that actual intensities may be even higher than that (150-160 %).

This increase was made possible by greater and more reliable canal supplies after construction of Tarbela and Mangla dams and associated works and by the installation of public tube wells in the late 1960s under the Salinity Control and Reclamation Project in the LCC system (SCARP 1). Subsequent large-scale installations of private tube wells by farmers have significantly contributed to this trend. In IIMI-Pakistan research sites, (private) tube-well densities in the range of 5 to 15 tube wells per 100 ha were found to exist, constituting on average 50 percent of the total irrigation water application (Murray-Rust and Vander Velde 1992). Tube-well development is encouraged by perceived deficiencies in surface supplies and is limited by groundwater quality.

Lower Gugera, one of the branch canals of the LCC system, offtakes at Buchiana Head where Upper Gugera Branch ends and splits up into two branch canals, Burala and Lower Gugera Branch (see map 1). Lower Gugera has its tail at Bhagat Head, where the water is divided into four distributary canals of different sizes. Pir Mahal Distributary is the second largest of these distributaries and has a design discharge of 4.68 cumecs (165 cusecs). It has three minors, of which Junejwala minor is the biggest, with a design discharge of 1.08 cumecs (38 cusecs). This minor falls under the jurisdiction of Bhagat subdivision, Lower Gugera canal division (see map 2).

Junejwala minor, which offtakes from Pir Mahal 27 km downstream of Bhagat Head is 16 km long, and serves approximately 5,200 ha (12,880 acres) of CCA through 19 outlets. Six outlets were selected in 1989 by IIMI to carry out detailed monitoring of irrigation activities.[9] These sample watercourses are located in each of the three reaches, head, middle, and tail, of the minor. The physical characteristics of the six outlets are given in table 1.

Table 1. Characteristics of sample watercourses (1989).

Water-course	Distance from head (km)	Design "Q" (l/s)	CCA (ha)	Number of tube wells		Unlined (U)/ Lined (L)
				Private[a]	Public	
6R	2.0	31.2	118	9 (7.6)	0	U
8L	2.5	53.4	268	26 (9.7)	0	U
27R	8.3	29.2	130	13 (10.0)	0	L
29R	9.0	25.5	98	5 (5.1)	1	U
41L	12.6	31.7	160	23 (14.4)	1	L
46L	14.3	45.6	224	25 (11.2)	2	U

[a] The tube-well density (number of tube wells per 100 ha) is given within parentheses.

Surface-water allocations were originally fixed at a rate of 0.25 l/s/ha (2.64 cusecs/1,000 acres CCA). The actuality that water duties (discharge over area) are slightly different for the sample watercourses may be due to the fact that area has been included under CCA in later years or that extra water has been allocated for "garden" crops.

Three of the six sample watercourses do not have access to public tube-well water, whereas 46L has two such tube wells. It is apparent from table 1 that there is quite a number of private tube wells with tube-well density ranging between 5 and 15 tube wells per 100 ha.

9 The objectives of the project under which these watercourses were selected were focused on interrelated issues of irrigation and salinity. Socioeconomic factors were much less taken into account for the site selection.

In two tertiary units, watercourses were lined under the On-Farm Water Management (OFWM) program (27R and 41L) and in 29R, lining is under discussion by farmers and OFWM department.

To help the reader better understand the report, in which the six villages/watercourses are frequently mentioned, and to present a mental picture of the sample villages, brief outlines of them are given here.

Chak 6R

This village has no access to a metaled road and is located 8 km to the east of Pir Mahal (see map). The village is dominated by the Arain caste.

Chak 8L

This village has access to a metaled road. However, the streets of the village are not properly maintained and there are heaps of filth in them. The village has 5 mosques, each representing a caste.

Chak 27R

This village is located on the main road. The village is relatively clean and it is often called a "single-man dominated village." A retired army man owns 200 acres of land in the command area of this village.

Chak 29R

A few years ago, the residents of this village migrated to an area near Pir Mahal Town and established a new colony called Harsabad. The water users mostly live in the respective watercourse command areas in scattered houses.

Chak 41L

This village is located on a metaled road. It has 4 mosques for 4 castes. Arain and Rajputs are the main castes of this village.

Chak 46L

This village is located near the main road that leads to Sadnai Head. Pir Altaf is a very famous religious personality of this village.

2.2 Research Methodology

The study correlates the social characteristics of a number of sample villages with the way irrigation activities are organized in the hydraulic units associated with these villages. A synthesis of both elements is carried out, by analyzing and interpreting all social characteristics and irrigation activities, followed by an exercise to allot scores. Thus, a correlation between the social capital of a village and the irrigation activities of the associated hydraulic units can be carried out.

The data on which the present study is based were collected primarily through unstructured interviews of farmers (and their groups) of the six villages relating to the six sample watercourses. The study was executed at the watercourse as well as village level in the belief that social relations at the village level are intricately linked with irrigation-related activities at the watercourse level. Some characteristics of the sample villages are presented in table 2.

Table 2. Characteristics of sample villages.

Sample village	Chak 6R	Chak 8L	Chak 27R	Chak 29R	Chak 41L	Chak 46L
Area of village (ha)	490	700	420	400	560	820
Number of watercourses	3	3	4	4	3	4
Population	3,500	4,500	2,500	1,500	5,000	2,500

The interview process was completed in two phases. In the first phase, group interviews were held with 20 "knowledgeable" farmers, three or four farmers from each sample command, to gain a basic understanding of the issues related to (in)formal organizations and associations of farmers. These farmers formed part of a larger sample of farmers for which other data, such as tube-well operations, were collected.

In the second phase, 72 farmers, 12 from each watercourse command, located evenly in the head, middle, and tail of the watercourses, were interviewed. These farmers also formed part of the sample of farmers, for which primary data were collected. As all of the farmers interviewed are tube-well owners, a bias is introduced in the sample. During the interviews, questions on water-related activities that are jointly carried out, such as watercourse cleaning, warabandi, and watercourse lining were posed and information on social setup and organization (castes, panchayat, etc.) was collected.

A comprehensive primary data collection on irrigation-related variables was initiated in May 1989. Surface-water flows at the heads of six sample outlets and at secondary level were monitored through stage readings and converted into discharges through stage-discharge relationships.

A census of private and public tube wells for the whole command area of the minor was undertaken in 1989, revealing the existence of 13 public tube wells and over 350 private wells.

Information regarding the basic characteristics of the tube wells including location, type (power source), bore depth, and date of installation were collected during the census. More detailed information, i.e., daily operational hours, discharge, and water quality, was collected from August 1989 onwards for three sample watercourse commands, namely, 6R, 27R and 41L.

In April 1991, the sample size for tube-well data collection was increased and three other watercourse command areas were incorporated, for which the surface supplies were already monitored (8L, 29R and 46L). The data collection continued till the end of November 1992.

3. IRRIGATION: SURFACE WATER AND GROUNDWATER SUPPLIES

The Junejwala minor command represents a conjunctive use irrigation environment. Canal supplies, deemed insufficient in volume and unreliable in timing are augmented by a range of public and private tube wells. In this section, irrigation supplies from both surface water and groundwater sources will be analyzed and presented for the six sample watercourses. This information will be used in a later stage of the paper when irrigation activities are analyzed for the extent and scope of farmer participation.

3.1 Canal Supplies

Problems of inequity in canal water distribution at main-system and distributary level in the Punjab have been reported on frequently (Bhutta and Vander Velde 1992, Kuper and Kijne 1992, and Ahmed et al. 1993). Relative quantities of water delivered through head outlets in distributaries are up to seven times more than those through tail outlets.

Junejwala minor is no exception to this, when analyzing available data for the period 1989-1992. Discharges to the sample watercourses have been transformed into ***Delivery Performance Ratios***, which give the ratio of actual supplies over intended supplies (design). This is presented in figure 1 for kharif 1991.

A clear head-to-tail trend can be seen when tail watercourses such as 41L and 46L are receiving on average 25 percent of their design supply against a supply to head watercourses of 60 to 70 percent.

In addition to the volume, the reliability of supplies is another factor considered unfavorably by farmers (Strosser and Kuper 1994). Flows in main and secondary system are highly variable, caused by unscheduled operations upstream in the system, breaches, illegal irrigation especially in kharif, etc. In table 3, the percentage of dry days for the sample outlets is presented for six consecutive seasons.[10]

[10] This percentage gives the number of dry days divided by the number of irrigation days. The dry days during the annual closure are not counted here. The annual closure, scheduled for a period of three weeks, is generally prolonged. In 1992, for instance, the closure lasted for almost 7 weeks. If this would be accounted for, the values for rabi would be even higher than those of table 3.

Figure 1. Canal supplies to sample watercourses in kharif 1991.

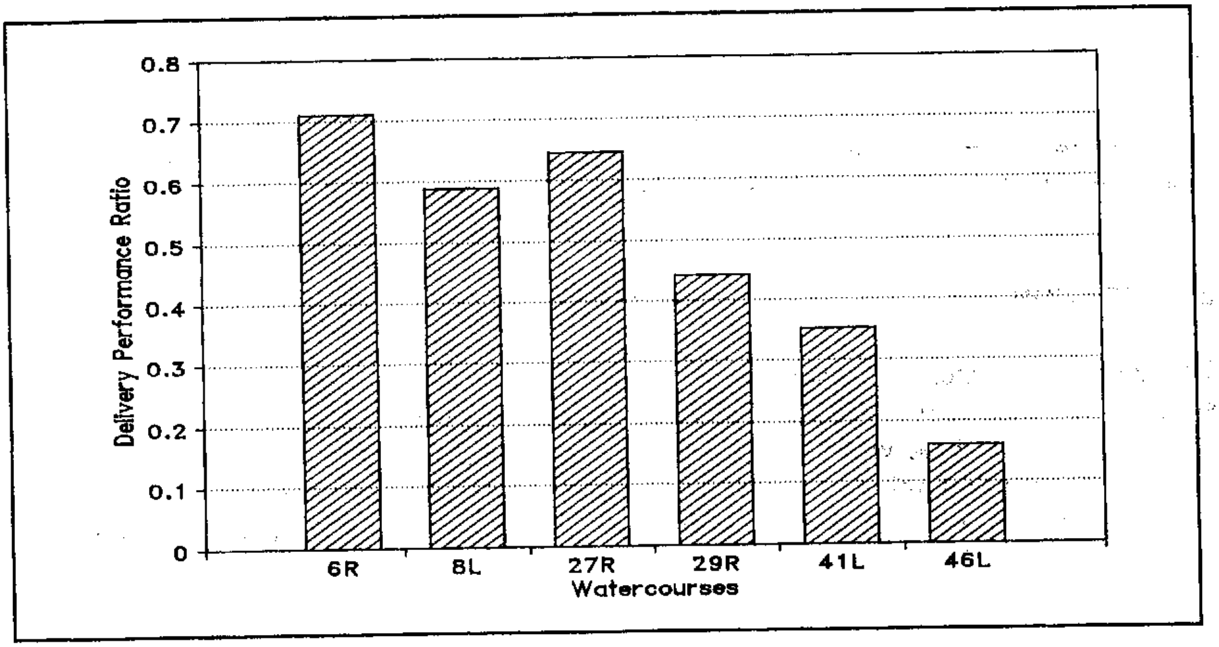


Table 3. Percentage of dry days for sample watercourses.

Watercourse	Kharif 89	Rabi 89/90	Kharif 90	Rabi 90/91	Kharif 91	Rabi 91/92
6R	23	11	30	16	31	10
8L	23	12	34	20	37	10
27R	33	26	53	39	53	12
29R	38	30	56	45	58	15
41L	67	53	70	59	59	20
46L	81	57	75	58	70	28

The substantial improvement in water supply in rabi 1991/1992, specially true for middle and tail watercourses, reflects an unusual heavy desiltation carried out in the annual closure of 1992, both in the parent channel, Pir Mahal, as well as in Junejwala minor. This was executed both by PID and by farmers and is indicative of the attention the maintenance of irrigation canals received from the civil administration in this annual closure. It is also a good example of the benefits that can be obtained through collective action.

Inside the watercourse command area, water is distributed following a fixed roster of turns (warabandi). Every farmer is entitled to a certain time period of water. Warabandis in watercourses in the Punjab are traditionally not rigidly enforced by the Irrigation Department (ID).

It was estimated that by 1939 more than 50 percent of the watercourses had informal water distribution systems, referred to as *katcha* warabandi[11] (Gilmartin 1994). Farmers need to appeal to PID themselves, for the Department to step in and register an official (*pukka* or fixed) warabandi. This happened on a larger scale only from the 1960s onwards.

In the sample watercourses, a conversion from katcha to pukka warabandi has occurred over the past 25 years (see table 4). Most farmers, particularly those with small landholdings, that were interviewed expressed a distinct preference for pukka warabandi, as a fixed distribution of water discourages influential farmers from taking more water than others. Farmers claim that pukka warabandi has reduced the number of disputes over water.[12] Pukka warabandi has apparently also reduced the incidence of inclusion of land, hithertofore not entitled to water, in the warabandi of a watercourse.[13] In all five watercourses, pukka warabandi was established by PID on the instigation of farmers (often at tail ends of watercourses), who felt that their access to canal water was constrained by other (influential) farmers.

It seems likely that increased pressure on water resources (higher cropping intensities) during the last decades has led farmers to opt for pukka warabandi. The importance of water supply on warabandi is confirmed by the history of water distribution in chak 29R, where farmers opted for pukka warabandi early on but reverted back to katcha warabandi when a public tube well was installed, increasing the available supplies.[14] The warabandi in this watercourse is not officially registered, but is in practice not much different from the pukka warabandis in the other watercourses.

Table 4. Warabandi status in sample watercourses.

Watercourse	Warabandi status	Year of conversion
6R	pukka	1982
8L	pukka	1967
27R	pukka	1991
29R	katcha	1982
41L	pukka	1977
46L	pukka	1975

11 Katcha, which literally means unrefined, probably is best translated as informal, or local, or unofficial.

12 Ostrom (1992) emphasizes the need for clear rules/boundaries to avoid conflicts in an institution.

13 As the discharge to a watercourse is, generally, not changed, inclusion of land in a warabandi means a reduction in supplies to other farmers. This process has reportedly been another major source of conflict among farmers.

14 Uphoff (1992), as quoted in Meinzen-Dick et al. 1994, refers to an inverted U shape relationship between water supply and (returns to) farmer organization.

3.2 Public Tube Wells

Public tube wells have been installed in the Punjab through SCARPs (Salinity Control And Reclamation Projects) from the 1960s onwards, in response to perceived problems of high water tables in relation to salinity. These tube wells, installed also in the Junejwala minor command, are usually 100 m deep, large, electric wells, driven by turbine pumps. The design discharge is generally in the range of 70 to 100 l/s (2.5 to 3.5 cusecs). Studies of the public tube wells installed under the SCARPs indicate that the volume pumped by public tube wells has significantly decreased during the last 20 years.[15]

Four such tube wells were installed in the sample watercourses, one each in 29R and 41L and 2 in 46L (probably because of its large CCA). For unknown reasons, no public wells were installed in the other three watercourses.

For operation and maintenance, an operator from PID is assigned to each tube well, supported by a workshop at (sub)divisional level. These operators are, however, frequently absent from their tube wells and farmers have become de facto operators, even taking responsibility for (minor) repairs.

Most tube wells are not in good working condition due to deferred maintenance and wear and tear of the equipment, facing frequent breakdowns of machinery and power. Contributing to this problem is the fact that farmers do not generally make allowance for the four-hour rest, originally fixed for these tube wells.

Public tube wells are performing better in kharif than in rabi. The understandable reason for this difference is that farmers make extra efforts to get public tube wells in working order during the high water requirement season. This effort of the farmers involves a good deal of organization. It involves the persuasion of ID officials/officers as well as monetary contributions.

The extent of the poor performance of public tube wells is reflected in the day-to-day operation in the sample watercourses, with three out of four public tube wells working less than 50 percent of their total expected time with rest hours excluded from the expected time (see figure 2). The tube well with the best performance has worked 60 percent of the expected time while another has worked just about 30 percent of the time.

The situation is compounded by the fact that the discharge of public tube wells has gone down substantially over the past 20 years. In many cases, actual discharges are now 50 percent of the original pumping capacity.

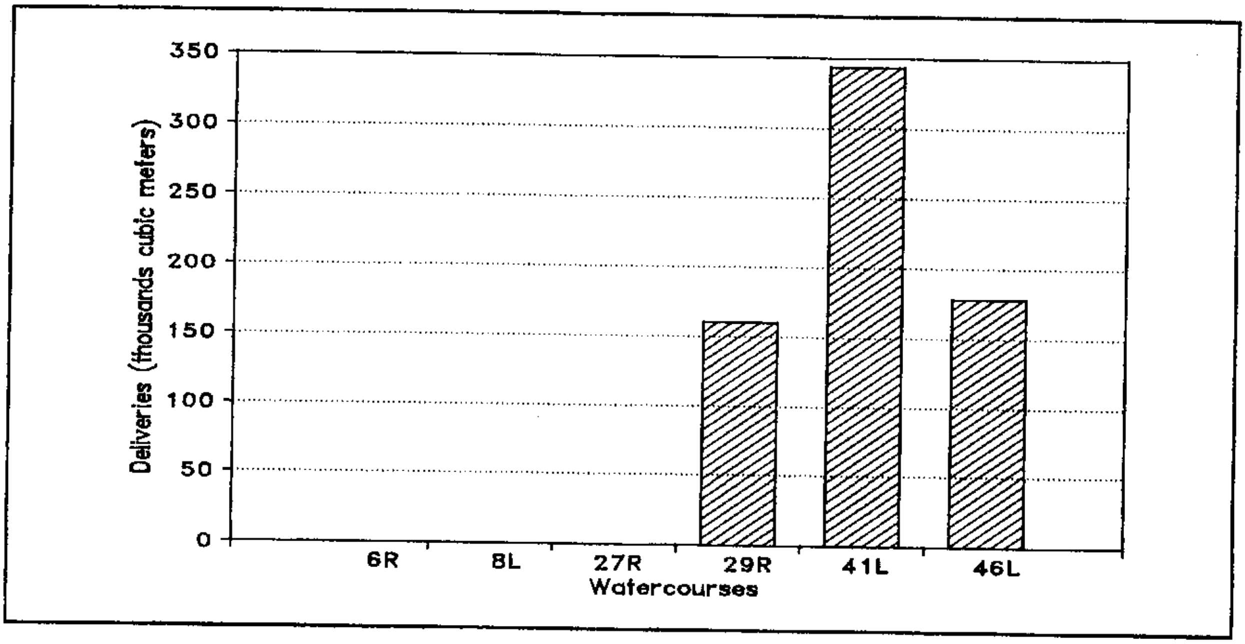
3.3 Private Tube Wells

Even before the inception of the SCARPs, privately owned tube wells existed. Stimulated by the opportunities that were offered by tapping the groundwater aquifer, apparent to large groups of farmers through the large volumes of water provided by public tube wells, and encouraged by subsidies from the government, the development of private tube wells got real pace only after

15 According to data collected by the Tube Well Wing of the Irrigation and Power Department, the utilization rate of public tube wells in SCARP 1 has gone down from 70 percent in 1960 to less than 45 percent in 1985 (Malik and Strosser 1993).

1980. In the Junejwala minor command, the density increased from an average of 3 tube wells per 100 ha in 1980 to about 9 in 1990.

Figure 2. Operation of public tube wells in Junejwala minor command.



Presently, the tube-well density in the sample watercourses varies, ranging from 5.1 to 14.4 tube wells per 100 ha. The density is higher in the tail watercourses (12.5 tube wells per 100 hectares) than in the head reach (9.1 tube wells per 100 hectares) and the middle reach (7.9 tube wells per 100 hectares). The higher density at tail command areas is partly explained by the small quantity of canal water available to tail-end farmers.

The density is also found to be affected by groundwater quality (Johnson 1989). 41L, the watercourse command with the largest population of private tube wells, has on average the best quality groundwater[16] with an average EC of 0.88 dS/m, whereas 27R, the watercourse command with the smallest population of tube wells has the highest average EC value (1.40 dS/m). Farmers usually realize that an unrestricted use of low quality tube-well water may influence their agricultural production.

Utilization rates of private tube wells were found to be influenced by the source of power (Malik and Strosser 1993) and this holds true also for the Junejwala minor command. Out of 90 tube wells, operated in the sample watercourses in 1990, 15 were electric, contributing 68 percent to the total operation hours, whereas the 50 diesel and 25 PTO (power take-off) tube wells contributed 23 and 9 percent, respectively. This is explained by the fact that operation and

[16] EC (in dS/m) is used here as a proxy for the groundwater quality. The higher the EC value of the water, the lower the quality is considered to be.

maintenance costs of electric tube wells are less than half that of that of other types (Malik and Strosser 1993).

The tail watercourse command areas use the largest quantities (measured in mm) of private tube-well water, followed by head and middle watercourses (see figure 3). This may be partly due to the fact that out of a total of 15 electric tube wells, with a higher utilization rate than nonelectric wells, 6 are in the head watercourse commands, 8 are in the tail commands and just one electric tube well is located in the middle command areas.

For all command areas, the utilization rate of private tube wells during kharif (summer season) is much higher than that of rabi (winter season). This difference is mainly explained by the higher crop water requirements during the hot kharif season.

4. SOCIAL CAPITAL

First, a description of the sociological setup of the sample villages[17] is given in order to understand how these sociological characteristics influence farmers' water management behavior. Then the irrigation activities of the sample watercourses are examined, after which the discussion will focus on the effect of social organizations on water management activities of farmers.

4.1 Castes and Biradaris

Three basic categories of social characteristics are often thought essential to understanding the social organization of villages in the Punjab, i.e., *biradari* or kinship ties, the caste system, and the land distribution/tenancy status (Mirza et al. 1975 and Freeman and Lowdermilk 1976). The setup is rather complicated and often diverse patterns emerge, giving the same term different connotations.

Biradaris (brotherhood) are generally defined as kinship groups. In some instances they are taken to be the smallest groups of farmers, organized based on blood relations, headed by the eldest competent male. Decisions on irrigation practices by individual farmers are strongly influenced by other members of the biradari, while cooperation between farmers is often limited to farmers from within the same biradari (Freeman and Lowdermilk 1976).

Castes are basically a set of horizontal hereditary social strata, traditionally based on occupational specialization. Biradaris are generally linked into these (sub)castes. In table 5, the main castes of the sample villages are given, in which the subcastes have been lumped together.

17 To facilitate an easy cross-reference, the villages will be referred to by the name of the sample watercourse that belongs to these particular villages. Thus, the village comprising watercourse 6R will be alluded to as chak 6R.

Figure 3. Irrigation supply for sample watercourses from canal and groundwater resources for 1991/1992.

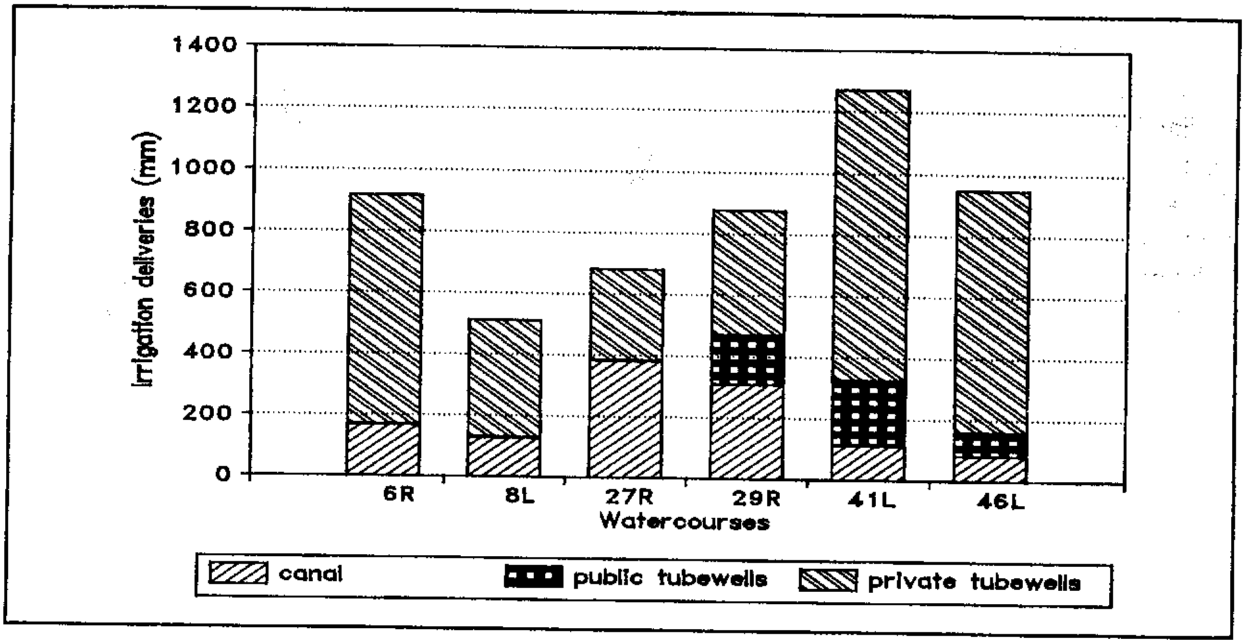


Table 5. Castes in sample villages as a percentage of the total population.

Caste	Village					
	6R	8L	27R	29R	41L	46L
Main caste (%)	Arain 50	Arain 40	Arain 61	Jat 36	Arain 50	Rajput 52
2nd caste (%)	Rajput 20	Gujjar 30	Faqir 15	Sial 33	Rajput 20	Kammis 17
3rd caste (%)	Kammis 12	Jat 16	Kammis 15	Arain 29	Kammis 8	Sial 5
Population	3,500	4,500	2,500	1,500	5,000	2,500
Settlers (%)	90	95	90	25	95	52

Most villagers belong to agricultural castes (Arain, Rajput, Gujjar, Jat, Sial) with sizeable artisan communities (Kammis) only in chaks 27R and 46L. These artisan castes (e.g., shoemakers, blacksmiths, etc.) provide services to the agricultural castes, in return for which they receive agricultural products. The study area is generally dominated by the Arain caste, a traditional farming caste. They migrated from India at the time of partition. Chak 46L stands out for its large population of Mayo (Rajput), who also settled in the area after partition. The remainder of the population in this chak is made up of a myriad of local (sub)castes.

A further study of the castes in the study area revealed an intricate and often complex pattern of subcastes or biradaris. For the villagers, who originally belong to this area (e.g., Jats, Gujjar ["locals"]), these biradaris are usually well defined. Groups of 3 to 20 families indicate kinship. This applies also, although to a lesser extent, to the Rajput settlers, who have migrated to this area after partition. The origin of these settlers often demarcates the different biradaris. The Arain settlers claim that their caste is more important than the biradari. Where older villagers, belonging to the Arain caste, still have a notion of the different biradaris that exist, it appears that this concept is slowly disappearing. This is particularly true for chaks 6R, 8L, 29R and 46L. This is not the case, however, in chaks 27R and 41L, where clear-cut biradaris can be identified and villagers are very much aware of them. There are eight and five biradaris in 27R and 41L, respectively, within the Arain caste. The different concepts of caste and biradari for Rajputs and Arain are often claimed to stem from the fact that the Rajput caste is no longer "pure." Many subcastes have made the transition to the socially attractive Rajput caste, particularly during the turbulent period of partition, when a large population flux occurred. Arains claim to have kept the inflow and outflow for their caste limited, which lessens the need for distinguishing further between subgroups.

Differences between castes or biradaris appear to be particularly important during the time of elections. In table 6, the number of biradaris and their size (as percentage of the total population) is presented.

Table 6. Biradaris in sample villages.

	Village					
	6R	8L	27R	29R	41L	46L
Biradari						
Largest	42	38	25	36	23	20
2nd largest	16	20	12	33	10	13
3rd largest	10	10	9	10	8	8
Number of biradaris	23	20	18	6	25	27
No. of numberdars[a]	2	2	2	2	2	3

[a] A *numberdar* is responsible for the agricultural tax collection in his area, in return for which he is allowed to keep a certain percentage of the revenues. It is a hereditary position.

The number of biradaris in the sample villages varies from 6 in chak 29R, to 27 in chak 46L. The largest biradaris are usually made up of the larger agricultural castes such as Arain and Rajput. Artisan biradaris are generally small and fragmented, thus explaining the large number of biradaris in, for instance, chaks 6R and 46L. Chak 29R is a relatively small village with only a limited number of biradaris. The Rajputs in chak 46L are subdivided into ten different biradaris.

4.2 Land Distribution and Tenancy

The distribution of power and influence in a village/watercourse are related to the land distribution and tenancy status and are thus of importance in this study. The land tenure status, for instance, impacts on farmer organization and on decisions taken by farmers regarding agricultural practices, especially when taking decisions on long-term investments.

Land ownership and cultivation in the study area constitute an intricate pattern, as evidenced by table 7. Three common types of farmers can be distinguished; owner-cultivators, tenants, and lessees. Tenants are farmers who cultivate the land of others and give a specified share of the crop to the land owner. Thus, the owner has to share all the risks. Lessees or contractors cultivate agricultural land of others and pay a fixed amount of rent per season or per year. The pattern becomes even more complicated, as many farmers have land under multiple holding types.

The status of a contractor is considered by farmers to be better than that of a tenant. Farmers consider a typical contractor to be a farmer, who is financially in a position to pay for the contract, irrespective of the actual benefits he is going to get, and who is confident of his agricultural skills and resources (e.g., personnel) to make the contract worthwhile.

The cost of contracting land varies in the study area from Rs 7,900 (per ha per year) in 6R to Rs 4,200-4,900 in the other five watercourses. Competition for land appears to be more important in 6R, where the average holding size is only 1.5 ha. Even within watercourses, rates tend to range widely. These rates depend on a host of factors, such as the type of relation between owner and contractor, the availability of canal water, the presence of a tube well, the fertility of the soil, access to pukka roads, proximity to urban centers, groundwater quality, soil salinity, etc.

Detailed information on landownership and cultivation patterns in the sample watercourses is presented in table 7. The average holding size is almost double in 27R, 29R, and 46L, as compared to the other watercourses. In 29R and 46L, this is mainly due to the fact that the land is less fragmented than in the other watercourses, with only 27 (2%) of the farmers owning less than 2 ha (see figure 4). In the other watercourses, this percentage ranges from 59 to 78 percent. In 27R, the large average holding size is due to the relative unequal distribution of land (standard deviation = 3.9).

The actual farm size (area cultivated by farmers) is generally similar to the holding size, even when land is contracted out or handed over to tenants on quite a large scale. An exception is 29R, where the farm size is much bigger due to the fact that four farmers have leased large areas of land, cultivating farms larger than 10 ha.

The amount of land contracted out or cultivated by tenants is substantial, on average about 30 percent of the cultivated area. 29R is clearly an exception as the majority of the land is cultivated by lessees/tenants.[18]

---

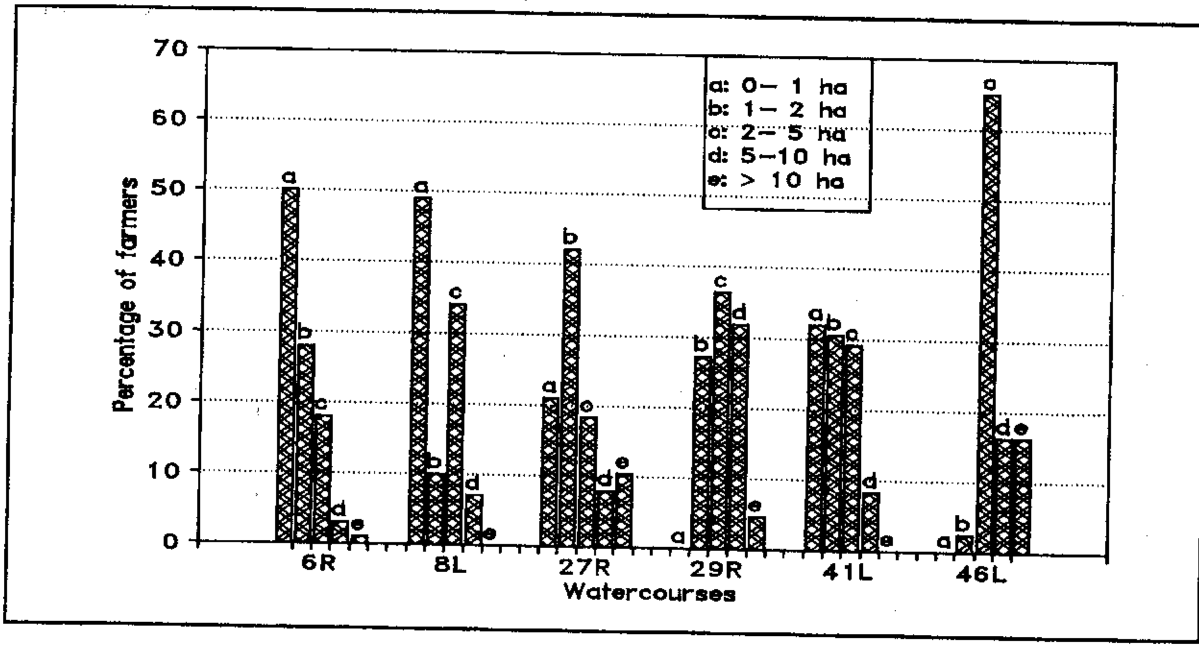
18 Farmers indicated that the main reason that their efforts to line the watercourse ultimately failed was the presence of such a large group of lessees/tenants, who were not ready to invest in this project.

Table 7. Land distribution (ha) and tenancy in the sample watercourses.

Social Characteristic	Watercourse					
	6R	8L	27R	29R	41L	46L
Number of land owners	100	89	38	22	70	43
Number of cultivators	91	90	41	14	64	44
Cultivated area[a]	146	169	116	82	143	201
Holding size						
Average	1.5	1.9	3.0	3.7	2.0	4.7
Standard deviation	1.8	1.9	3.9	2.3	1.7	2.5
Farm size						
Average	1.6	1.9	2.8	5.8	2.2	4.6
Standard deviation	1.9	1.7	3.6	4.7	2.1	2.2
Owner/cultivators						
Total number	73	72	18	2	40	29
Cultivated area	120.5	126.1	79.6	32.7	94.0	125.7
% of cultivators	80	80	44	14	63	66
% of cultivated area	83	75	69	40	66	63
Tenants						
Number of tenants	7	7	13	4	9	7
Cultivated area	16.6	15.8	24.3	10.9	15.8	25.5
% of cultivators	8	8	32	29	14	16
% of cultivated area	11	9	21	13	11	13
Lessees						
Number of lessees	11	11	10	8	15	8
Cultivated area	8.9	27.1	12.1	38.4	33.2	49.8
% of cultivators	12	12	24	57	23	18
% of cultivated area	6	16	10	47	23	25

[a] This is the actual cultivated area in hectares.

Figure 4. Land distribution patterns in sample watercourses.



In most of the watercourses, the area on contract exceeds the area cultivated by tenants. Farmers confirmed that there is a trend to convert tenancy agreements into (cash) contracts.

4.3 Leadership and Power/Influence Distribution

There are a number of common denominators that respondents attribute to "leaders" or influential persons in their villages. These influentials generally have one or more of the following characteristics: a large landholding, wealth, leadership of the respective caste or biradari, social attributes ("wisdom," judgment, education, relations with government officials or politicians), political or official position (councillor[19] or *numberdar*[20]) and religious leadership.

Influentials usually play an important role in village matters such as conflict resolution and the organization of activities of common interest, including those pertaining to irrigation. However, the sphere of interest and the area of influence of particular individuals are difficult to assess. Landlords who have lands in one or more of the watercourses that serve the village area do not always provide leadership in command areas where they have limited or no lands. The village level remains, however, an important level of analysis (along with the watercourse) for leadership patterns, as decisions on irrigation activities were quite often found to be taken at

19 A councillor is an elected member of a local Union Council, which is entrusted by the Provincial Government with the responsibility of development works, such as roads, clinics, etc.

20 A numberdar is responsible for the agricultural tax collection in his area, in return for which he is allowed to keep a certain percentage of the revenues. It is a hereditary position.

a village level.[21] The total number of influentials in the sample villages, along with their attributes are presented in table 8. The values mentioned in the table reflect the main attributes of leadership that were identified by the respondents.

Table 8. Leadership in the sample villages.

	6R	8L	27R	29R	41L	46L
Number of influentials (i)	8	6	4	3	7	11
Population/i	440	750	625	500	715	230
Attributes:						
Political position	3	3	3	1	4	3
Numberdar	1	1	-	1	-	1
Landownership	-	1	3	2	-	3
Social attributes	6	5	4	3	6	9
Religion	-	-	-	-	-	2
Caste	3	6	-	-	-	2

Chaks 6R, 8L and 46L appear to be more caste conscious, as respondents consider the caste base an important attribute for an influential. Caste may play a role in the other villages, but it was not explicitly mentioned by respondents. A position as numberdar in a village does not automatically make a person influential. From a total of 13 numberdars in the sample villages (2 to 3 for each chak), only 4 were reported to be influential. Political position yields, relatively, the most influence, when almost 50 percent of the influentials have been elected to representative bodies.[22] The smallest number of influentials is found in 8L and 41L, while the highest number of influentials is found in 46L.

The leaders in chaks 27R and 29R can be qualified as big landlords employing tenants to cultivate their lands. They are often inter-competing for influence in the villages, which is most evident during the time of (local) elections. The three influential landlords in 27R are not residing in the village, but wield influence when major decisions are taken. Part of their influence is transferred to their tenants or servants, who have been found to transgress rules or agreements under the protection of their masters.

In chaks 6R and 41L, landholding size is generally small (see tables 7 and 9) and landownership does not play a major role in village affairs. In chak 8L, leadership is reportedly

---

21 In chak 46L, for instance, farmers of all four watercourse commands in the village applied jointly to the Irrigation Department to change their warabandi from katcha (=loose) to pucca (=fixed).

22 This argument can also be turned the other way round, in a sense that influentials seek to obtain political positions.

fragmented, caste being the main basis for labeling individuals as "influential." There is no individual capable of inducing the different castes to work on projects of common interest.

In chak 46L, the situation is more complex with a large number of influentials identified by the respondents. A religious leader along with the leader of the main caste plays a positive role in uniting the villagers. Often, decisions pertaining to village affairs (e.g., during elections) are taken by a group of 11 village representatives and accepted unanimously by the villagers.

Table 9. Largest landholding sizes in sample villages (ha).

Landholding	Sample village					
	6R	8L	27R	29R	41L	46L
Biggest	12	101[a]	81	61	7	41
2nd biggest	10	9	20	10	6	26
3rd biggest	10		11	10	5	20
		10				
Average	11	0.04	38	27	6	29
Coefficient of Variation	0.1		0.8	0.9	0.2	0.3

[a] However, this farmer owns about 80 hectares in other village areas.

4.4 Conflicts and Conflict Resolution

Small conflicts and quarrels between villagers occur frequently in the sample villages. Land and water, scarce resources in rural Punjab, are major causes of these conflicts and many examples of such disputes were given by respondents, regarding, for instance water theft or the alignment of field ridges. These disputes are ranked here according to their frequency of occurrence:

1. water theft (within the watercourse)
2. disputes on the alignment of ridges of fields
3. theft of agricultural commodities
4. quarreling among women and children
5. divorce
6. murder cases
7. litigation of Haq Shufa[23]

These conflicts are usually kept to the village and are dealt with by a village *panchayat*.[24] The panchayat can be official and registered with the government, but in most

[23] This relates to the (Islamic) tradition of giving preference to neighbors when selling land. When villagers feel they have not been given the opportunity to buy land, because an outsider has offered more money, disputes arise.

cases it is informal. The composition and size of a panchayat are not fixed and often only part of the panchayat convenes to take a quick decision regarding minor conflicts. A permanent panchayat is only present in chak 46L, where it is sustained mainly through the influence of the religious leader in this village. A panchayat (or part of it) generally convenes at the request of one of the parties to hear both sides and to take a decision. The panchayat can fine villagers or impose other sanctions on people found at fault.

Conflicts because of water are common in the sample watercourses. However, the frequency of theft cases varies from once a month to once in several months for the different watercourses. These disputes were generally referred to the panchayat for settlement. In some other cases, they were resolved between the accused and the aggrieved. In very few cases, the theft cases were referred to the police or the Irrigation Department.

The village panchayats impose different sanctions on those found guilty of stealing water. The most common type of sanction is the imposition of a monetary fine. Usually the fine amounts to double the cost of the water that was stolen. In some watercourses, the panchayat has fixed minimum and maximum amounts for the penalty, depending upon the severity of the case, ranging from Rs 200 to 500 per case. In watercourse 41L, for instance, if somebody irrigates one acre of land by stealing water, this person will then have to pay the cost of 4 hours of water turn (irrespective of the time consumed for irrigating that particular field). The amount of the fine also depends upon the nature of the case. In watercourse 8L, a fine of Rs 500 was imposed. This amount was demanded by the aggrieved person since he had spent this amount in the process of lodging a case with the police.

Another way of imposing a penalty on a villager is by charging the offender an amount of water to be returned to the wronged party. The convention is to charge double the amount of water stolen, but cases of equal amounts of water being fined were also recorded, depending on the source (canal or tube well) and scarcity of the water.

A third type of penalty that was recorded was the issuing of a verbal warning to the offender. The custom is to give this warning in an open gathering and in the presence of ordinary villagers, which is considered very humiliating.

The fourth penalty imposed by the panchayat is directing the offender to apologize to the aggrieved party. This is usually done after the imposition of a monetary or other penalty. The offender apologizes and if the aggrieved party forgives, the penalty is repealed. Apologizing directly to the aggrieved party was also observed to occur without the intervention of the panchayat.

Decisions of the panchayat are usually accepted, according to the respondents. The villagers consider it to be their moral and ethical duty to accept the decisions of a panchayat to keep harmony within the village. This is reinforced by the belief that it is very uneconomical, cumbersome, and complicated to have cases decided by the police or Irrigation Department. Sometimes, cases that have already been registered with these bodies are withdrawn by the aggrieved party at the request of villagers. Also, cases are sometimes sent back to the panchayat for settlement. Only when no settlement is possible within the village, or when one of

---

24 Literally a body of five, a panchayat is composed of a number of villagers, who are influential and thought to have good judgment.

the parties is not ready to accept the decision of the panchayat, or a recidivist appears incorrigible, these cases are referred to and decided by the legal authorities.

An informal caste-based panchayat of around 10 people exists in chak 6R. When the village panchayat cannot come to a decision on a case, it can refer it to a formal panchayat that has been established at Union Council level (12 villages).

The process of conflict resolution is slightly more complicated in chak 8L. Although a number of conflicts have been settled by the informal panchayat in the past, cases are quite frequently referred to legal authorities. When the case concerns water, the Irrigation Department will address this problem consulting the biggest landlord of the village, who is also a member of the panchayat.

Major conflicts, erupting frequently during the time of (local) elections, are reported for chaks 27R, 29R and 46L. In chak 27R, this appears to be mainly a clash of influentials, all trying to extend their sphere of influence. The different biradaris within the Arain caste are the main groups involved in this struggle. One of the village influentials attempted to establish a permanent panchayat, but his efforts were thwarted by the other influentials and the panchayat ceased to exist after only one year. Presently, an informal panchayat exists, made up mainly of the village influentials. A number of conflicts in the village, however, have remained unresolved, as they were originated by one of the influentials (or his servants/tenants) and the panchayat was unable to deal with this.

In chak 29R, rivalry exists mainly between the different castes of the village (Jat, Sial, and Arain), who make up about equal portions of the village. An informal panchayat exists, made up of the representatives of the different castes, but many of the minor cases are dealt with by one farmer, who is thought to have good judgment. According to respondents, the number of cases regarding water theft has decreased dramatically with the spread of private tube wells.

An ongoing conflict in 46L between two numberdars is contained by the presence of a religious leader as well as a powerful caste leader, both participating in the formal panchayat of the village. The panchayat, made up of 11 members, generally does not convene as a whole for the minor cases. However, some important issues have been dealt with by this panchayat, including two murder cases.

4.5 Cooperative Works

In most of the sample villages, common projects, which were felt to be of general importance, have been carried out by (groups of) villagers. These projects are usually development works, for which money is either contributed by the villagers or sought from other sources (in most cases, the government). Works that have been undertaken in the sample villages include the construction of mosques and other religious places, pavement of roads, and the construction of village drains, schools and clinics.

Almost all the projects were short-term construction projects with a clear target. Villagers organized themselves, decided the objectives, collected or obtained money, and dissolved this informal organization once their targets were achieved. In this light, it is not strange that WUAs are seen by farmers as development organizations that can be dissolved after lining the watercourse.

In the sample villages, there are only two examples of organization that were set up with the intention of serving as vehicles for longer term cooperation. In chak 27R, a social welfare committee was established with the efforts of one of the village influentials. Villagers were called to a meeting where the committee was established, consisting of ten persons from different geographical blocks of the village. Money was collected for the first project of the committee, the construction of village drains, which commenced shortly thereafter. At the same time, other projects such as the pavement of roads and construction of a mosque were undertaken. However, soon conflicts erupted regarding the routing of the drain and the location of the waste water pond, leading to the demise of the committee.

A more successful example of a long-standing committee is found in 46L, where a social welfare committee[25] was established more than 30 years ago and is still functional. The main objective of the committee, which is officially registered with the government, is to obtain concessions on the purchase of agricultural inputs for the committee members and to facilitate loans on agricultural equipment and inputs.

Other works can be undertaken by the village as a whole or are carried out by specific groups of villagers (e.g., castes). Table 10 gives an overview of the projects carried out in the sample villages.

Table 10. History of cooperative works in the sample villages.

Cooperative works	Sample village					
	6R	8L	27R	29R	41L	46L
Completed projects	3	0	5	2	3	4
Abandoned projects	0	0	1	1	0	0
Group projects	0	5	0	0	0	0

In chak 8L, there is no example of a common project in the history of the village. A few groups of farmers, however, have constructed a total of five mosques that are used by the different castes in this village. The lack of leadership is often quoted by villagers as a reason for the poor record of cooperative works. On the other side of the scale is 46L, where four common

25 The committee is called Anjuman-e-Imdad-e-Bahimi Kashtakaran (farmers' society of mutual cooperation) and was set up before partition in 1947. It was registered legally in 1962.

projects have been successfully completed; two primary schools, a road and a (government-funded) veterinary clinic.

In general projects once started tend to get successfully completed. Only two examples are quoted by respondents of projects that were aborted during implementation. The failure of the drainage project in chak 27R appears to be much related to the way the organization was formed on the instigation of one influential. Interestingly, the watercourse 27R was lined under the OFWM program. None of the village influentials played a role in the WUA that was set up for the lining. The second failure is reported for 29R, where farmers attempted to line their watercourse. One of the village influentials was instrumental in organizing the WUA, but the WUA was confronted by a large group of farmers that were unwilling to contribute to the project. The tension among the three main castes is given as a reason for this by respondents. A second important reason is the large number of tenants/lessees in this watercourse, who are not ready to invest much money in the hardware of their irrigation system.

4.6 Social Capital

In the preceding sections, a number of social characteristics of the six sample villages have been presented. In this section, an attempt is made to synthesize this information by allotting a label (-1, 0, or, +1[26]) to each parameter for the sample villages. The selection of parameters as listed in table 11 (i.e., a, b, c, d and g), is partly derived from Merrey (1986), who used them to characterize watercourses that would be able to form a WUA and line the watercourse. We propose to add two denominators on the existence of major conflicts in a village and the ability of a village to resolve conflicts. While the former parameter is largely based on farmers' responses, the latter can be evaluated more objectively from the past record of conflict resolution of the village panchayat. Also, a parameter based on the number of *masjid* (mosque) committees is added. The existence of more than one mosque (committee) in a village is taken as having a possible negative influence on farmers' organized behavior.

A parameter that is omitted is the pattern in which farmers have settled in the area. In four villages, almost 100 percent of the inhabitants have settled in the area after introduction of the establishment of the LCC system, whereas in 29R and in 46L, a large number of people were living in the area prior to the introduction of large-scale irrigation (75 and 50 percent, respectively). The pattern of establishment is further complicated by the fact that after partition, large numbers of farmers have settled in the area. Farmers agreed that the village of origin (e.g., in east Punjab) was of importance for relationships between families, but indicated that caste/biradari was a much stronger determinant for social relations. During the course of the study, the exact establishment pattern could not be documented because of its complexity and, therefore, it is not included in this comparative analysis.

Presently, a substantial number of villagers have been employed abroad, mainly in the oil-producing countries. The affluence brought about by the influx of money is reportedly influencing social relationships in the sample villages. One of the characteristics associated with

[26] -1 indicates that this particular characteristic is likely to have a negative impact on farmers' ability to organize themselves for irrigation activities, 0 indicates very little impact, while +1 is allotted when a characteristic is likely to have a positive impact.

village leaders is personal wealth, traditionally based on the income obtained through agriculture, but increasingly earned through other sources. The number of villagers that have worked abroad is different for the sample villages. In 8L, 125 villagers have worked abroad, while the numbers in the other villages are less than 30.

Table 11. Social capital of sample villages: A synthesis.

Social parameter	Rating					
	6R	8L	27R	29R	41L	46L
a. castes, biradaris	0	0	-1	-1	-1	0
b. land distribution	-1	-1	-1	-1	0	+1
c. tenancy	+1	0	0	-1	0	0
d. leadership	0	-1	-1	-1	0	+1
e. conflicts	0	0	-1	-1	0	-1
f. conflict resolution	+1	-1	-1	0	0	+1
g. cooperative works	+1	-1	-1	-1	+1	+1
h. masjid committee	+1	-1	+1	-1	-1	+1
Score	+3	-5	-5	-7	-1	+4

Notes:

a.

Merrey (1986) took the presence of a single biradari in a watercourse/village as a factor contributing towards successful organization of farmers in WUAs. Since the objective of the paper is to identify links between social parameters and irrigation practices, only those biradaris belonging to agricultural castes are counted. The existence of more than a single biradari can be seen as potentially divisive. The number of biradaris in the sample villages is invariably greater than 1, ranging from 4 (6R) to 10 (46L). For this reason, the label '1' is not attributed to any of the villages. However, there are differences in the way caste/biradari antagonisms are reported for the sample villages.

In chak 29R, important differences are perceived to exist between different castes, while in chak 27R and chak 41L, there appears to be a permanent schism within the Arain caste between different biradaris. A label of '-1' is, therefore, allotted to those watercourses. Interestingly, the caste leader in chak 46L appears to be playing a unifying role for the different biradaris of the Mayo caste. Whether or not this is sustainable is not clear and the label '0' seems to be appropriate here.

b.

Land distribution is often considered related to power/influence relationships among farmers. Equitable distribution of land is seen as a factor contributing to farmers' cooperation (Merrey 1986), while the presence of a lot of small farmers combined with a few landlords can impact negatively on cooperation. Here, farmers in chak 8L have complained that there is no leader to organize them, because of the fact that the majority of the farms are very small (less than 1 ha) and fragmented. Even though land distribution is fairly equitable, 6R and 8L will, therefore, be labeled '-1.' The average farm size in watercourse 41L is not much bigger than that in 6R and 8L, but the number of farmers with marginal farm sizes (less than 1 ha) is much smaller, which justifies the label '0.' 29R has a number of absentee landlords and an inequitable land distribution, evidenced by a high Coefficient of Variation (CV). For this reason '-1' is awarded. 27R has the highest CV, because of the presence of a few big landlords (one farmer has 80 ha) and is given '-1.' Only 46L receives '+1' as the majority of the farmers (more than 60 %) have lands in the range of 2-5 ha and the biggest landlord in the village has only 40 ha.

c.

Related to the land distribution is the status of the farmers. A high number of tenants and lessees can have a negative impact on the long-term collaboration between farmers, especially because they have less incentive to invest in land. In most of the sample watercourses, the percentage of land on contract or cultivated by a tenant is about 30. 8L, 27R, 41L, and 46L are given '0.' 29R has an unusually high percentage of tenants/lessees and gets '-1' while 6R gets '+1.'

d.

The leaders in 27R and 29R are absentee landlords, who are often competing for influence. These chaks are given a '-1' rating. In 8L, farmers are complaining about the lack of leadership, which they claim is not unrelated to the land distribution. This chak is, therefore, also awarded '-1.' In 46L, very clear leadership is displayed by a religious leader in collaboration with the leader of the main caste, obviously giving this chak a '+1' rating. In 6R and 41L, leaders are, although not very prominent, able to influence organized behavior of farmers, according to the respondents. The label '0' seems appropriate here.

e.
Conflicts are reported to exist for all chaks, so that it does not seem to be justified to award a label of '+1.' In addition to that, major conflicts are reported for 27R, 29R, and 46L, which are allotted '-1.' The others get '0.'

f.
Not unrelated is the way that these conflicts are resolved, generally through the panchayat. In 6R and 46L, conflicts are dealt with in a regular forum, while respondents express their general satisfaction regarding the functioning of these panchayats, which yields '+1.' On the other side of the scale are 8L, where the panchayat does not have the necessary standing to resolve conflicts, and 27R, where the official panchayat was dissolved because of conflicting interests, thus scoring '-1.' In 29R and 41L, the panchayats are functioning reasonably well albeit informally, which gives '0.'

g.
The history of cooperative works is a good measure of the ability of villagers to organize themselves to undertake a project to achieve a common goal. Following table 10, 8L, 27R, and 29R are given '-1,' as common projects have either not been undertaken or have not been successfully completed. All the other villages have successfully completed 3 to 4 different projects and are allocated '+1.' In 6R, 27R, and 46L, there is one single mosque and a masjid committee for the entire village, which yields '+1.' In 8L and 41L, there is more than 1 masjid committee, while farmers in 29R are unable to form such a committee. In all three cases '-1' is given as a label.

The final score underlines the favorable environment for farmers' organized behavior in 6R and 46L, while it is unfavorable in 8L, 27R, and 29R. In 41L, the indications are less clear.

The social parameters (or social capital) are very strongly correlated. When performing a regression on the results of table 11, taking **a** to **d** as independent parameters and **e** to **h** as dependent parameters, a satisfactory relation can be established with an R^2 of 0.74.

5. IRRIGATION ACTIVITIES AND FARMERS' INVOLVEMENT

5.1 Irrigation Activities

In this section, how the social capital, defined in the preceding section, influences the way farmers in the sample watercourses organize common irrigation activities is evaluated. The underlying hypothesis is that a higher social capital will result in farmers being able to organize common irrigation activities more effectively.

Warabandi

Warabandi as an institution dates back to the early period of irrigation development by the British (1850s), but the concepts underlying warabandi could well have its origins much earlier than that (Bandaragoda and Rehman 1995). Although the concepts (especially equitability in distribution) of warabandi have been infringed upon, farmers expressed satisfaction with the present setup, clarifying that warabandi was no more unfair than institutions in other sectors of the rural economy (ibid 1995).

The vast majority of watercourses have a pukka warabandi at present, in order to have more secure water rights. Since warabandi is made pukka by the Punjab Irrigation and Power Department, even if only one farmer in a watercourse asks for it, the conversion cannot be easily attributed to farmers' organized behavior. However, the process by which the conversion has taken place is of interest. In 6R, 41L, and 46L, the villagers applied jointly for pukka warabandi for all the watercourses related to their villages. In 6R, a minority of influentials opposed the change, as katcha warabandi gave them a higher degree of freedom. In the other three watercourses, the conversion was made because of watercourse-specific issues. In 8L and 27R, a small group of tail-end farmers applied to the Punjab Irrigation and Power Department, as they felt that the water distribution was abused by larger farmers.

Farmers in the sample watercourses are generally content with the functioning of their warabandi. The satisfaction of farmers can be largely attributed to the clear set of rules and boundary conditions (Ostrom 1992) that govern warabandi: a specified time is allocated to a single farmer, irrespective of the discharge. Also, a clear hydraulic boundary,[27] the watercourse command, delineates the warabandi.

Interestingly, conflicts that are generated by a warabandi are by and large referred to the village panchayat, another traditional institution, but not related to the hydraulic boundary. Water disputes (mainly stealing) occur in all sample watercourses occasionally, but are recurrent only in 8L. In the other watercourses, the combination of clear rules and effective conflict resolution has led respondents to express satisfaction with the warabandi system.

This analysis confirms the adverse effect of the poor social capital of 8L on this irrigation activity. The effect is much less clear for the other watercourses, although the process of conversion from katcha to pukka warabandi for 6R, 41L, and 46L (the villages with the highest organizational densities) gives us an indication of the ability of farmers to establish a temporary forum to discuss and decide on a common problem. The conversion was an individual process in 8L and 27R.

Alterations in Mogha Size

One of the most common ways of improving access to canal water is to have the size of the outlet changed to increase the discharge of the outlet. This requires some organization as resources have to be mobilized and officials approached. The sample outlets are all fairly close to the design values. The only difference is found for 27R, where the crest level is about 12 cm

---

27 This is advocated by many authors as a prerequisite for effective farmer organization (Uphoff 1986 and Ostrom 1992).

higher than design and for 46L where the crest level is 7 cm lower than design. None of the moghas show any tampering. At 29R, farmers have collected some money, but actual changing of the outlet has not happened yet. This irrigation activity tells us very little about the effect of social capital on farmers' collective action in this case study.

Watercourse Lining and Water Users Associations

Much has been written on the OFWM projects and on watercourse lining in Pakistan (see also earlier sections). A host of reasons for the collapse of WUAs, once the physical works for watercourse lining have been completed, has been given in the literature, both related to external conditions (sociocultural milieu, law) as well as internal structure (objectives not clear for long-term organization). However, mobilizing resources and labor for establishing a WUA and agreeing to a new (straightened) alignment of a watercourse is a common irrigation activity that requires cooperation of farmers in a watercourse. Uphoff (1986) states that the urge for farmers to organize for irrigation activities (if this is considered to improve access to irrigation water) has a curvilinear relationship with the water supply with little incentive at both extremes (i.e., very little water and an abundant water supply) for farmer organization. Given the water scarcity in the Punjab, farmers are not likely to be in the "wet" extreme of the function. It is only in watercourses where the canal water supply is very little, that farmers are unlikely to take the trouble of lining their watercourse. Such is the case in 46L.

Two sample watercourses have been lined under the OFWM program, 27R and 41L. Both WUAs have been dissolved after the completion of the improvement works. In these watercourses, farmers have reverted back to their pre-WUA organization for cleaning of their watercourses. Farmers in 41L have expressed dissatisfaction over the lining, as they feel that due to a lower bed level, the sediment intake of the outlet has increased, thus increasing the frequency of cleaning. Also, farmers have dug a parallel watercourse for the SCARP tube well in the command area.

In 29R, a WUA was established in 1992 but it has not been successful in lining the watercourse. The five-man board of the association is trying to collect money for the improvement of the watercourse, as well as the widening of the outlet. The failure of the WUA is attributed by farmers to the large percentage of tenants in the watercourse and the feuds among the three village castes. Also, the board comprises just one of the village influentials and other influentials are reportedly not ready to cooperate.

The low social capital in 29R seems to explain the failure of farmers in this watercourse to establish a WUA. However, the organizational densities do not readily explain the lining process in 27R. Interestingly, none of the village influentials participated in the board of the WUA, possibly because of the work it entails. It is hard to draw any conclusions regarding the failure of the WUAs in 27R and 41L to sustain themselves after the lining was completed, since this is a general phenomenon.

Watercourse Cleaning

Desiltation has traditionally been an important feature of the irrigation canals in the Indus Basin, because of the high sediment load of canal water. Tertiary outlets have been designed in such a way that they draw the maximum possible sediment load to prevent the distributaries (the desiltation of which is the responsibility of the government) from silting up. Cleaning usually consists of removing sediment from the bed of the watercourse and vegetation from the sides to improve the flow of water. Also, banks of the watercourses are strengthened, particularly at nakkas and field inlets, where banks are naturally weaker than at other places. While cleaning of the main watercourse (or *sarkari khal*[28]) is a collective responsibility, various individual arrangements exist for cleaning of branch watercourses. Intensity of cleaning is usually marginally lower for branch watercourses.

The intensity of cleaning of the sarkari khal in the sample watercourses is quite high[29] (see table 12) and watercourses are in a reasonably good physical state. Watercourses are desilted, on average, once a month, with a slightly higher frequency in kharif, when the sediment load of a canal is higher. In 41L, the frequency of cleaning is higher than in other watercourses. Farmers attribute this to the fact that the bed level of the lined watercourse is too low, which has increased the silt draw of the outlet, necessitating a very frequent watercourse cleaning. In 29R, farmers have difficulty in organizing themselves for cleaning their watercourse.

Table 12. Intensity of cleaning for sample watercourses (per year).

Watercourse	6R	8L	27R	29R	41L	46L
Intensity	12	12	12	6	17	12

The initiative for undertaking watercourse cleaning is taken frequently by watercourse tail enders. Only 6R and 41L have a permanent leader for watercourse cleaning, who decides the time of cleaning. Announcements for cleaning are made through the loudspeakers of the village mosque by the *wagari.*[30] Respondents say that most farmers participate in the cleaning, while those who do not have to pay a fine. It is the prerogative of the cleaning leader to penalize villagers for not showing up for the work. The fines are spent on refreshments for participating farmers or for other purposes (e.g., the entertainment of government officials when visiting the village or covering the traveling expenses of farmers who go to government offices for village matters). The fines range from Rs 5 per acre at 46L to Rs 10 per acre at 6R, 8L, and 27R. A fine of Rs 50 is fixed for each defaulter of the 29R and 41L watercourses.

While 6R and 41L have permanent work supervisors, farmers in 29R and 46L usually select their supervisor at the start of each cleaning. In 8L, four farmers are selected to represent the different castes. In 27R, no supervisor is selected.

---

28 *Sarkari* means government, *khal* means channel.

29 In the literature on water management at tertiary level in Pakistan, published in the 1970s, frequency of cleaning is quoted to be invariably lower than reported here. Increasing demand for water may have led to this increase.

30 A *wagari* (time-keeper) keeps track of time and is often consulted by farmers for the timings of their water turns.

There are two standard rules for division of work among farmers. The most common of these two is the allocation of work proportional to the holding size. The other is cleaning of watercourse from the nakka (division structure) to the upstream nakka by the farmers who share this structure. The latter system is less popular, as it involves a second division of work at the nakka level. Disputes are rife in the cleaning of watercourses: "small and big farmers do not cooperate."

These disputes occur mainly in 8L, 27R, and 29R, villages with the lowest organizational densities, while watercourse cleaning in the other three watercourses is better organized with permanent work supervisors in 6R and 41L and a temporary work supervisor in 46L.

Distributary Maintenance

Distributary cleaning has traditionally been the responsibility of the Irrigation Department (ID). Precluding the involvement of farmers at this level was thought essential to maintain a "fair" distribution of water (Gilmartin 1994). However, farmers in the sample areas have frequently participated in the cleaning of Junejwala minor, sometimes at the request of the department,[31] while farmers (particularly those at the tail-end villages) have also often taken the initiative themselves. In the latter case, the Irrigation Department is usually asked for permission. Farmers generally use spades and tractors with mounted blades.

Farmers in all the sample villages have at one time or another participated in the cleaning of Junejwala minor. They are contacted by Irrigation Department staff through the village numberdar or other influentials. While farmers from villages located at the head of the minor are generally not keen on participating (and only show up when strongly "encouraged"), as the cleaning is (at best) not directly in their interest and often even decreases canal supplies to their watercourses, farmers from tail watercourses are readily available to contribute

The poor maintenance and desiltation are partly responsible for the inequity that exist between head and tail reaches of distributary canals. In the parent channel of Junejwala minor, Pir Mahal, farmers of the tail area blocked the channel in 1991 to protest the low water supplies at the tail. This effort of the farmers was rewarded by the Irrigation Department during the annual closure of 1992, when the head portion of Pir Mahal distributary was desilted heavily (mechanically).

Also, during the self-help desiltation campaign of the Punjab Chief Minister, Junejwala minor was targeted. A length of about 11 km, starting from the head was desilted by ID, as head-end farmers are generally reluctant to participate. The minor was reopened after closure, but the farmers of the tail area did not see satisfactory improvement and requested the Punjab Irrigation and Power Department for permission to do some desiltation themselves. Farmers were allowed to do so and given specifications of width and depth of the channel to be maintained. The farmers worked for one day and desilted a portion of about 1.2 km. The desiltation of 1992 has improved the surface supplies at the tail of Junejwala minor considerably (see section 3).

---

[31] During the "self-help" desiltation campaign launched by the Chief Minister of Punjab in 1992, about 100 farmers from tail-end villages have participated in the cleaning of Junejwala minor. The campaign has been documented in van Waijjen and Bandaragoda (1992).

In addition to the regular maintenance and repair during the annual closure period, there are cuts and breaches in the banks of the channels that need attention during the year. Cuts and breaches are due to several reasons; especially, cattle entry and human intervention. The usual practice regarding the repair of breaches is that farmers try to inform the Irrigation Department of the occurrence of breaches, upon which the channel is generally closed immediately at the head. After that departmental laborers get together and reach the affected location for repair work. This second step usually takes 2 to 3 days. Farmers are playing an important role in repairing the breach points, particularly the small ones, which are repaired by the farmers without even bringing them to the notice of the department. In case of large-size breaches when a departmental labor force is at the site, farmers are generally found helping them, since the department has no machinery to close breaches.

Farmer-organized behavior for this irrigation activity is short-lived, with a clear common goal, for which considerable potential exists. Since the interest is obviously much location-specific, no conclusions can be drawn regarding the effect of social capital on organization of this irrigation activity.

Private Tube Wells and Water Markets

Groundwater has increasingly become an important source of irrigation water in Pakistan's Punjab. This common resource is exploited quite individually. Malik and Strosser (1993) show that PTO (power take-off) and diesel-driven tube wells are used less than 10 percent of the time, while electric tube wells are used on average 40 percent of the time. Farmers tend to prefer to have their own tube wells, thereby reducing interactions with other farmers. This is also the case in the sample areas, where only in a few cases tube wells are shared by more than one owner. Tube wells with multiple owners are found in three sample watercourses, five in 46L, four in 8L, and two in 29R. Owners are generally related (family, biradari). Other ways to have access to groundwater without having a tube well is through water markets. Water markets are an important feature of contemporary irrigated agriculture in the Punjab, where farmers want a certain flexibility in their canal water supplies and where non-tube well owners want to have access to groundwater resources. However, recent research has given some evidence that tube-well owners obtain better yields than tube-well water purchasers, indicative of the fact that tube-well owners will serve their own interests first (Strosser and Kuper 1994).

Tube-well densities are in the range of 8 to 10 per 100 ha of irrigated area, which conforms with data collected elsewhere in the Punjab (Malik and Strosser 1993). A lower density is found in 29R (5 per 100 ha), probably because of the inequity of landholding distribution with a few big farmers and a large group of tenants, who are naturally reluctant to invest in a tube well. A lower groundwater quality may also contribute to the lower density. A density of 14 tube wells per 100 ha is found in 41L, which can be attributed to the large number of farmers (60% of the farmers have a landholding of between 1 and 5 ha).

Private tube-well water is traded throughout the year in all sample watercourses. The variation between watercourses and between seasons is considerable. The transaction rate is highest in 8L, where 47 percent of the private tube-well water is traded in kharif and 50 percent is traded in rabi. The transaction rate is lowest in 6R and 41L, where 4 and 3 percent are traded in kharif, and 2 and 3 percent in rabi, respectively (table 13).

On average, electric tube well water constituted the largest part of the water transactions (60 %). In 1991, the average number of operation hours sold per electric tube well was 307, which is 9 percent of the total operation hours. The average number of hours sold by diesel tube wells is 54 hours, which is 15 percent of the total operation hours. The PTO bores sold 8 percent of the operation per tube well, which is just 22 hours per tube well for the whole year of 1991.

Table 13. Water transactions in the sample watercourses of Junejwala minor.

Water transactions	Sample watercourse					
	6R	8L	27R	29R	41L	46L
Hours sold per 100 ha CCA						
Kharif 1991	196	2118	461	470	290	965
Rabi 1991-92	38	665	149	50	93	492
% of the operational hours						
Kharif 1991	4	47	11	14	3	12
Rabi 1991-92	2	51	23	29	3	20

Although the Canal and Drainage Act of 1873 specifically states that trading of canal water is not allowed, it is not an uncommon feature in the Punjab (Strosser and Kuper 1994). In some watercourses (e.g., 6R), turns are sold for the entire season by tail enders, who would receive very little water anyway, due to losses in the watercourse. However, most of the trading of canal water is limited to exchanges of water. Farmers who are irrigating a field but cannot complete watering of an entire field or group of fields, try to continue irrigating using another farmer's turn, which they will compensate for in their next water turn. Sometimes, canal water is exchanged for tube-well water, usually on a 1:1 basis, but in 6R and 41L on a 1:1.5 basis, as more value is attached to canal water for its good quality and fertility. Also, when a farmer does not need water at the time of his turn, he will give it to other farmers who can make better use of it.

Exploitation of the groundwater resource is generally done on an individual basis. Farmers who are able to obtain credit and good groundwater quality will install tube wells, rather than relying on water markets, which seems justified under present conditions. Presently, groundwater exploitation is not regulated by the government and no restrictions are placed on farmers who install tube wells. Given that groundwater tables in the Punjab in fresh water areas are generally going down, farmers are likely to face constraints on the utilization of groundwater. Taking Uphoff's inverted U shaped relationship between water availability and farmers' cooperation, it is likely that a certain degree of organization among farmers is going to be required soon.

In our analysis of the effect of social capital on farmers' organized behavior, the effects of private tube well ownership and water markets are not readily explained, given the relative abundance of the resource. Explanations are likely to be found in other factors, such as landholding size, tenure type, groundwater quality, etc., which is not the scope of this paper.

5.2 Factors Influencing Farmer Organizations

The analysis of section 5.1 shows clearly that irrigation activities in the study area show very little sustained interaction or organized behavior.[32] Century-old irrigation institutions such as warabandi have developed into arrangements with very clear rules and boundaries to minimize conflicts between affiliated groups of farmers.

The analysis of section 5.1 shows that only four irrigation activities[33] could be identified with some form of organized behavior. These activities were evaluated for their degree of organization by farmers in the different sample watercourses, by attributing a label (-1, 0 or +1) similar to the synthesis carried out in section 4.6 for the social capital. The results of this analysis are summarized in table 14.

Table 14. Irrigation activities and organized behavior in the sample watercourses in Junejwala minor.

Irrigation activity	6R	8L	27R	29R	41L	46L
a. warabandi	+1	-1	-1		+1	+1
b. mogha alterations						
c. watercourse lining			+1	-1	+1	
d. watercourse cleaning	+1	-1	-1	-1	+1	+1
e. distributary maintenance						
f. water markets	-1	+1	0	0	-1	0
Total	+1	-1	-1	-2	+2	+2

32 In fact, Gilmartin (1994) argues that the design concept of the irrigation system was to have the social setup not interfere with the water allocation and distribution for fear of distorting the principles of equitability.

33 An irrigation-related activity that has not been described here is the collection of irrigation fees by Irrigation Department staff. They work through the numberdar, a villager who has been appointed by the government to liaise between farmers and Irrigation Department.

Notes:

a.

The conflicts regarding water distribution in 8L and 27R, leading to individual farmers initiating the conversion to pukka warabandi, justify the label '-1,' while the joint application of 6R, 41L, and 46L demonstrates that farmers are capable of organizing themselves for a perceived common interest.

b.

Farmers in the study area have not (yet) gotten together to approach the Irrigation Department for changes in outlet dimensions, which are having an impact on the supply to their watercourses. No scores can be attributed on the basis of this study.

c.

In 27R and 41L, farmers have successfully lined their watercourse, while in 29R, the process failed. Hence the allotted labels.

d.

In 29R, the intensity of cleaning is very low, because of difficulties of becoming organized. In 8L and 27R, cleaning is a fragmented and complicated process. All three watercourses get '-1.' In 6R, 41L, and 46L, cleaning is a joint process, which is well organized, yielding '+1.'

e.

No sustained organization is present to carry out yearly maintenance to Junejwala minor, although it is clear that farmers in tail watercourses participate more often in this activity. Not enough evidence of farmers' collective action could be traced, which is why no scores have been attributed.

f.

In 6R and in 41L, the number of water transactions is surprisingly low, vindicating the score of '-1.' On the other side of the scale 8L can be found, where about 50 percent of the tube-well water is traded, for which reason '+1' is given. In the other watercourses, water transactions constitute about 10-30 percent of the tube-well water.

Although it is difficult to test a methodology only on four parameters for six watercourses, the results correspond reasonably well with the organizational densities that were found for the six sample villages. The sample villages can be separated into two main groups. Where in 6R, 41L, and 46L (villages with the highest organizational densities) on the one hand, farmers are able at least to create lasting institutions to deal with irrigation activities (e.g., watercourse cleaning), farmers in 8L, 27R, and 29R face a large number of problems in organizing common irrigation activities. In 8L and 29R, these problems seem to be caste based, which is in the case of 29R further complicated by the large number of tenants/lessees with their short-term interests. In 27R and 29R, leadership is another major problem with a limited number of village influentials competing for control. All these factors contributed to the failure in 8L, 27R, and 29R to undertake/complete common projects, the high number of disputes over water, and the lack of effectiveness in organizing common irrigation activities.

When relating the values of table 14 to the parameters of table 11, which make up the social capital, a reasonable correlation is found. Taking the total scores of the social capital as independent parameters and the values of table 14 as dependent parameters, an R^2 of 0.72 can be found. When looking in more detail at the hypotheses of section 1.2, it appears that leadership and the history of cooperative works are the most significant social parameters influencing the organization of irrigation activities. Hypotheses 4 and 6 are, therefore, accepted (see table 15).

Effective conflict resolution in combination with the credibility of the punishment awarded to offenders appears to be more important in sustaining farmers' organizations than the existence of major conflicts in a village, when comparing table 11 and table 14. This leads us to accept hypotheses 10 and 17 and reject hypothesis 16. Also, a high number of tenants was shown to have an adverse impact on the ability of farmers to carry out communal projects, which means that hypothesis 15 is accepted.

When correlating the land distribution to the organized behavior of farmers (table 14), no straightforward relation is found, even though the disparity in holding (expressed through standard deviation) gives slightly better results (R^2 is 0.13). Results may be better if data for the entire village are used rather than watercourse-level data. The presence of one or two individuals with very large holding sizes appears to be negatively related to farmers' organized behavior (see table 9), effectively qualifying hypotheses 1, 2, and 13.

The presence of a single caste/biradari in a watercourse/village seems hypothetical in present day Punjab. However, in four of the six sample villages, one agricultural caste is clearly dominating, leading in three cases to relatively well-organized common irrigation activities (6R, 41L, and 46L). The reason hypothesis 5 needs to be qualified is that in the case of 27R intra-caste disputes disrupt organized behavior. There appears to be much less correlation with the biradari setup.

The size of villages and watercourses appears to be not very much related with the organizational behavior of farmers, thereby rejecting hypothesis 8 for the sample. Similarly, hypothesis 18 can be rejected.

No information was collected on the progressiveness of the communities and the level of education of villagers, which is why hypotheses 3 and 7 cannot be tested.

Two types of formal organization were identified in the sample villages. Obviously, only in the case of 46L did farmers perceive a relative benefit in sustaining a formal farmer organization (cooperative), while the potential benefits were not enough for farmers in other villages. The farmers' cooperative was not the focus of the study, and not enough is known to test hypothesis 9. Also, hypotheses 11, 12, and 14 cannot be investigated with the available data. The other formal organizations that were found were the WUAs, of which the relative benefits of sustained life are known to be nonexistent.

Table 15. Social factors contributing to effective organization of irrigation activities.

Factor		Accepted	Rejected	Need to qualify
1	equitable landholding distribution			x
2	equitable distribution of power and influence			x
3	progressiveness of the community			?
4	history of cooperation on community projects	x		
5	one single biradari in a village or watercourse			x
6	leadership	x		
7	education			?
8	a small group size		x	
9	high relative benefits			?
10	credibility of punishment	x		
11	the sense of ownership			?
12	built on existing organizations			?
13	homogeneity of background			x
14	accountability			?
15	a small number of tenants	x		
16	no major conflicts		x	
17	effective conflict resolution	x		
18	single masjid committee		x	
Total		5	3	4

6. CONCLUSIONS

1. Informal organizations of farmers are established for specific common projects with limited duration and are dissolved when the targets are achieved. The study shows that irrigation activities, which need long-term association of groups of farmers (warabandi, watercourse maintenance) are organized in such a way that interactions (and possible disputes) are minimized through clear rules and boundary conditions. These arrangements, which appear to be the solution farmers have found to deal with the large heterogeneity in the farming community (landholding size, tenure status, education, wealth, influence), seem to function surprisingly well. A balance is found with which most farmers are content even though the end result (e.g., water distribution) may not be "equitable."

2. Increased farmers' participation is going to be pilot-tested on a few distributaries in Pakistan in the near future in an attempt to address the low performance of irrigated agriculture in Pakistan. The experiences of the On-Farm Water Management (OFWM) projects that have been implemented in Pakistan have shown that establishing formal, sustainable farmers' water management organizations in rural, factional Punjab is not an easy task. A good understanding of the process by which existing arrangements for common irrigation activities have evolved would help in defining an approach that would be more robust.

3. The hydrological boundaries of the irrigation system in Pakistan do not coincide with social (e.g., village) or administrative boundaries. In practice, however, the two systems are highly interactive. The study shows evidence of the fact that the social characteristics of a village influence the effectiveness of common irrigation activities, which take place within the boundaries of hydraulic units. Water disputes occurring at the watercourse level, for instance, are solved by the village panchayat. In recent proposals, farmers' participation in irrigation management in Pakistan is generally thought to have to follow hydrological boundaries, thereby following the original design concept of the irrigation system, albeit at a different (secondary) level. If farmers' participation in irrigation management is considered, it would be advisable to consider the village a possible level of organization for farmers.

4. In this case study, only some of the hypotheses that have been formulated in the past regarding external and internal conditions for successful farmers' organization could be tested. A perceived successful history of cooperation on common projects, presence of leadership, the credibility of punishment, and a small number of tenants were shown to have a positive impact on farmers' organization. At the same time, farmers were able to effectively organize common irrigation activities even when major conflicts existed, there was a large group size, and there was more than one mosque in the village. The rejection of these hypotheses may be related to the nature of existing organizational arrangements for common irrigation activities, where farmers avoid close association.

5. During the conceptual phase of the development of the canal systems in the Indus Basin, irrigation engineers favored exclusion of farmers from the operation and maintenance of the

main and secondary systems in order not to have them interfere with a "scientific" equitable water distribution (Gilmartin 1994). Farmers have increasingly become involved at higher levels of the irrigation system, mostly for individual gains, contributing to tail shortages and inequity. Given the historical concept and the negative experiences with farmers' interventions, the irrigation agency has expressed fear for farmer participation in irrigation management, which is presently advocated by donors and the federal government. Redefining the roles of Irrigation Departments and farmers will, therefore, prove to be a difficult process, as there is no perceived successful history of farmer participation in irrigation management.

ACKNOWLEDGMENTS

We would like to acknowledge the contributions of Messrs. Muhammad Ashgar, Aziz Ahmad, and Muhammad Afzal in the field survey that was carried out in 1993/1994. The paper benefited from discussions we had with colleagues. We thank Tissa Bandaragoda, Cris de Klein, Pierre Strosser, Doug Merrey, and Gaylord Skogerboe for their critical comments. Finally, we thank Ruth Meinzen-Dick for inspiring us to analyze, interpret, and document this case study.

Literature Cited

Ahmad B., M.A. Ali, and A.R.A. Khan. 1993. *Pattern of flow variations in distributaries and reach-wise supply to outlets.* Proceedings of the Irrigation Systems Management Research Symposium, Lahore, Pakistan.

Bandaragoda D.J. and S.U. Rehman. 1995. *Warabandi in Pakistan's canal irrigation systems: Widening gap between theory and practice.* IIMI-Pakistan Country Paper No. 7. Colombo, Sri Lanka: International Irrigation Management Institute.

Bhutta M.N. and E.J. Vander Velde. 1992. *Equity of water distribution along secondary canals in Punjab, Pakistan.* Irrigation and Drainage Systems; Vol. 6, No.2; pp 161-177.

Byrnes, K.J. 1992. *Water users associations in World Bank-assisted irrigation projects in Pakistan.* World Bank Technical Paper 173. Washington D.C., U.S.A.: World Bank.

Freeman, D.M. and M.K. Lowdermilk. 1976. *Community and irrigation in the Pakistan Punjab -- physical and sociological dimensions of the water management problem.* Paper prepared for the Annual Meeting of the Association for Asian Studies, Toronto, Canada.

Gilmartin, David. 1994. Scientific empire and imperial science: Colonialism and irrigation technology in the Indus Basin. *The Journal of Asian Studies.* 53, No. 4: 1127-1149.

Hafiz Ullah M. 1994. *Participatory irrigation management: A case study of Azim Distributary.* Government of the Punjab, Irrigation and Power Department, Bahawalpur, Pakistan.

Ireson, W.R. 1988. *Farmer participation in irrigation management, limited roles In Pakistan.* Paper prepared for the 7th World Congress for Rural Sociology, Bologna, Italy.

Johnson R.L. 1989. *Private tube well development in Pakistan's Punjab: Review of past public programs/policies and relevant research.* Country Paper - Pakistan No.1. Colombo, Sri Lanka: International Irrigation Management Institute.

Kuper, M. and J.W. Kijne. 1992. Irrigation management in the Fordwah Branch command area, South-East Punjab, Pakistan. *Paper presented at the IIMI Internal Program Review, December 1992.* Colombo, Sri Lanka: International Irrigation Management Institute.

Kuper M., Habib Z. and P.O. Malaterre. 1994. System objectives and localized control: Equity versus adequacy. *Paper presented at the IIMI Internal Program Review.* Colombo, Sri Lanka: International Irrigation Management Institute.

Malik S.M. and P. Strosser. 1993. *Management of private tube wells in a conjunctive use environment: A case study in the Mananwala distributary command area, Punjab, Pakistan*. Working Paper No. 27. Colombo, Sri Lanka: International Irrigation Management Institute.

Meinzen-Dick R., M. Mendoza, L. Sadoulet, G. Abiad-Shields and A. Subramanian. 1994. Sustainable water users associations: Lessons from a literature review. *Paper presented at World Bank Water Resources Seminar, Lansdowne, Virginia, USA*.

Merrey, D.J. 1979. Irrigation and honor: Cultural impediments to the improvement of local level water management in Punjab, Pakistan. *Water Management Technical Report No. 53,* Colorado State University, Fort Collins, Colorado, USA.

Merrey, D.J. 1986. Reorganizing irrigation: Local level management In The Punjab (Pakistan). In *Irrigation Management In Pakistan: Four Papers,* by D.J. Merrey and J.M. Wolf. Research Paper No. 4. Colombo, Sri Lanka: International Irrigation Management Institute.

Merrey. D.J. 1990. Warabandi in Pakistan. Chapter 28 in *Management of Farm Irrigation Systems*. American Society of Agriculture Engineers.

Mirza, A.H., D.M. Freeman and J.B. Eckert. 1975. Village organizational factors affecting water management decision making among Punjabi farmers. *Water Management Technical Report No. 35*, Colorado State University, Fort Collins, Colorado, USA.

Mirza, A.H. and D.J. Merrey. 1979. Organizational problems and their consequences on improved watercourses in the Punjab. *Water Management Technical Report no. 55,* Colorado State University, Fort Collins, Colorado, USA.

Mirza, A.H. 1989. The dilemma of organizing water users associations in the Punjab. In *Societal Dynamics and Irrigation Systems* by J. Tirmizi and B. Parlin (eds.). Islamabad, Pakistan.

Murray-Rust D.H. and E.J. Vander Velde. 1992. Conjunctive use of canal and groundwater in Punjab, Pakistan: Management and policy options. *Paper presented at the IIMI Internal Program Review 1992*. Colombo, Sri Lanka: International Irrigation Management Institute.

Punjab Provincial Assembly. 1992. *Motions No. 75 and No. 174, presented in the Assembly in October 1992.*

OFWM. 1991. *On-Farm Water Management Program Punjab: Review of Progress 1990-1991*. Lahore, Pakistan.

Ostrom E. 1992. *Crafting institutions for self-governing irrigation systems*. San Francisco, USA: Institute for Contemporary Studies.

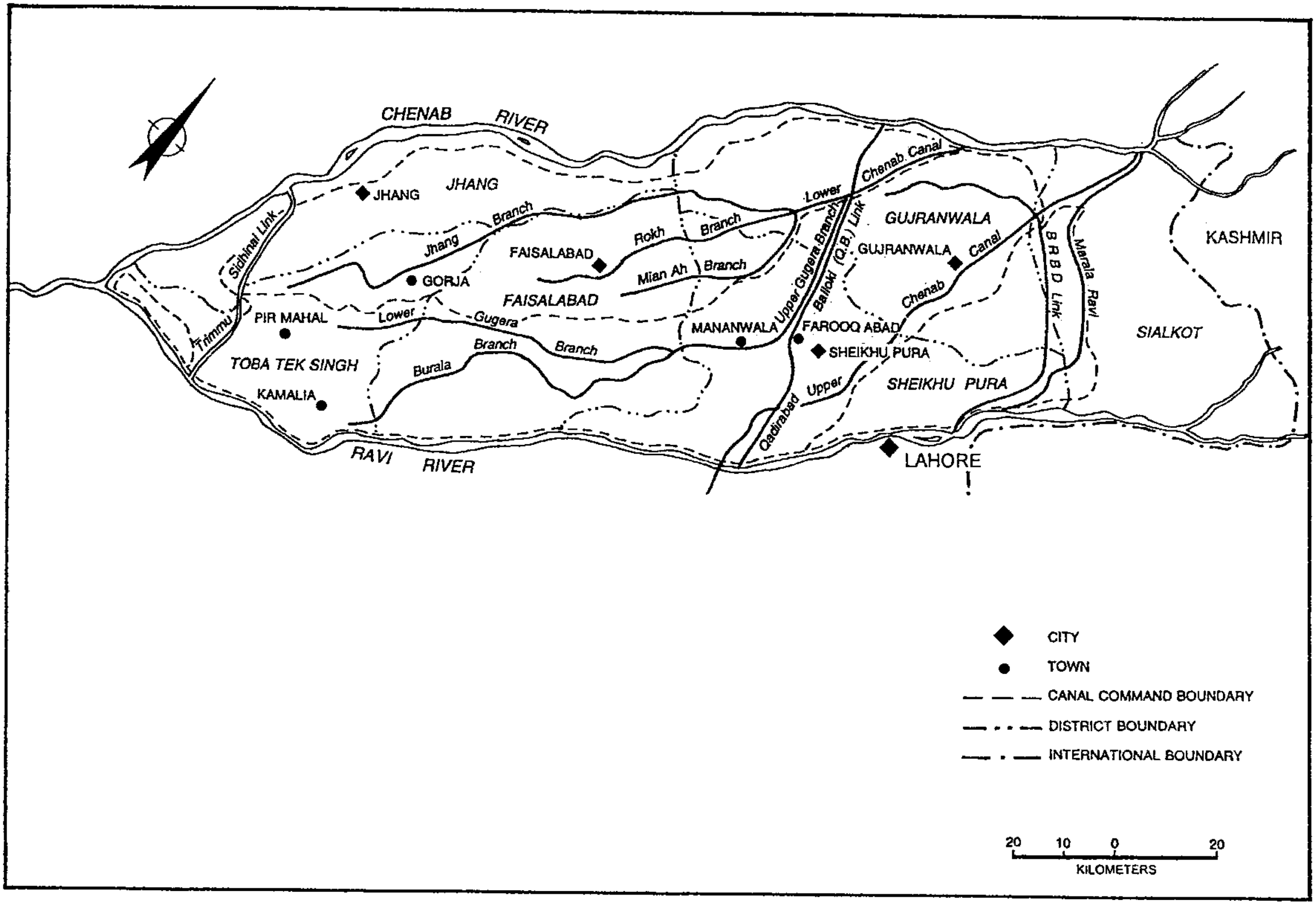
Strosser P. and M. Kuper. 1994. *Water markets in the Fordwah/Eastern Sadiqia area: An answer to perceived deficiencies in canal water supplies?* Working Paper No. 30. Colombo, Sri Lanka: International Irrigation Management Institute.

Uphoff N. 1986. *Getting the process right: Improving irrigation water management with farmer organization and participation.* Working Paper prepared for the Water Management Synthesis 2 Project, Cornell University, Ithaka, USA.

van Waijjen E.W. and D.J. Bandaragoda. 1992. *The Punjab desiltation campaign during 1992 canal closure period.* IIMI-Pakistan Discussion Paper No. 7.

World Bank. 1994. *Irrigation and drainage: Issues and options.* Pakistan Sub-Sector Report. Washington D.C., USA: World Bank.

LOCATION MAP OF LOWER CHENAB CANAL



LOCATION MAP OF SAMPLE VILLAGES IN JUNEJWALA MINOR AREA