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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

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

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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

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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]

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[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.

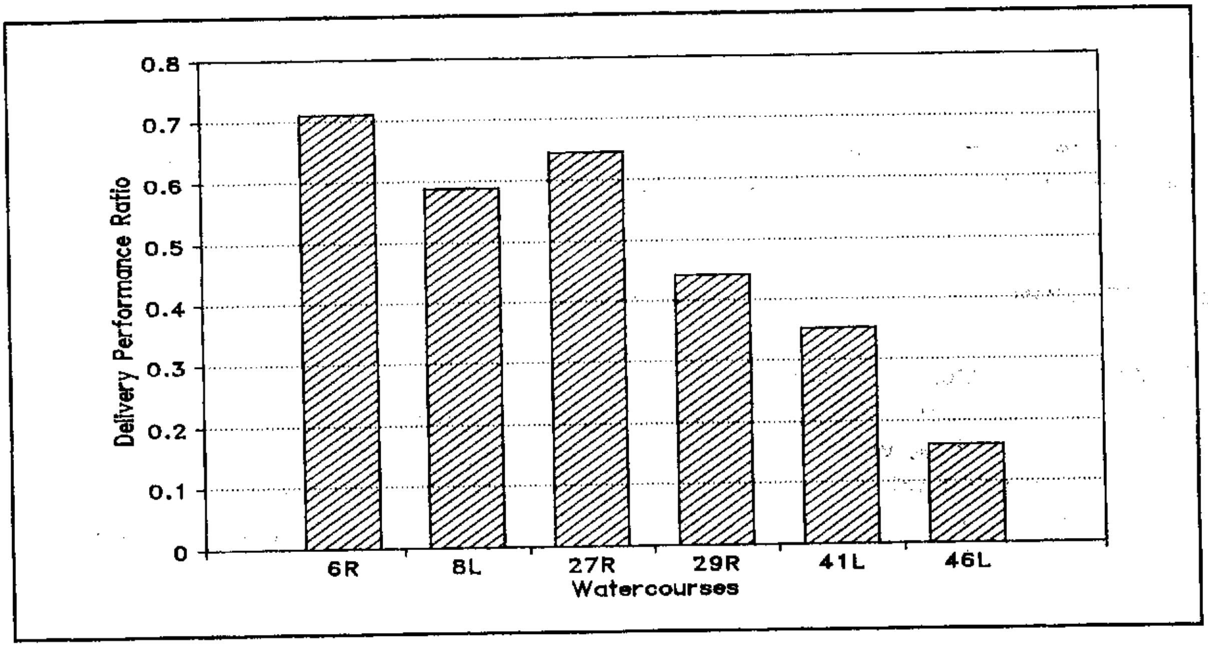

Table 3. Percentage of dry days for sample watercourses.

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

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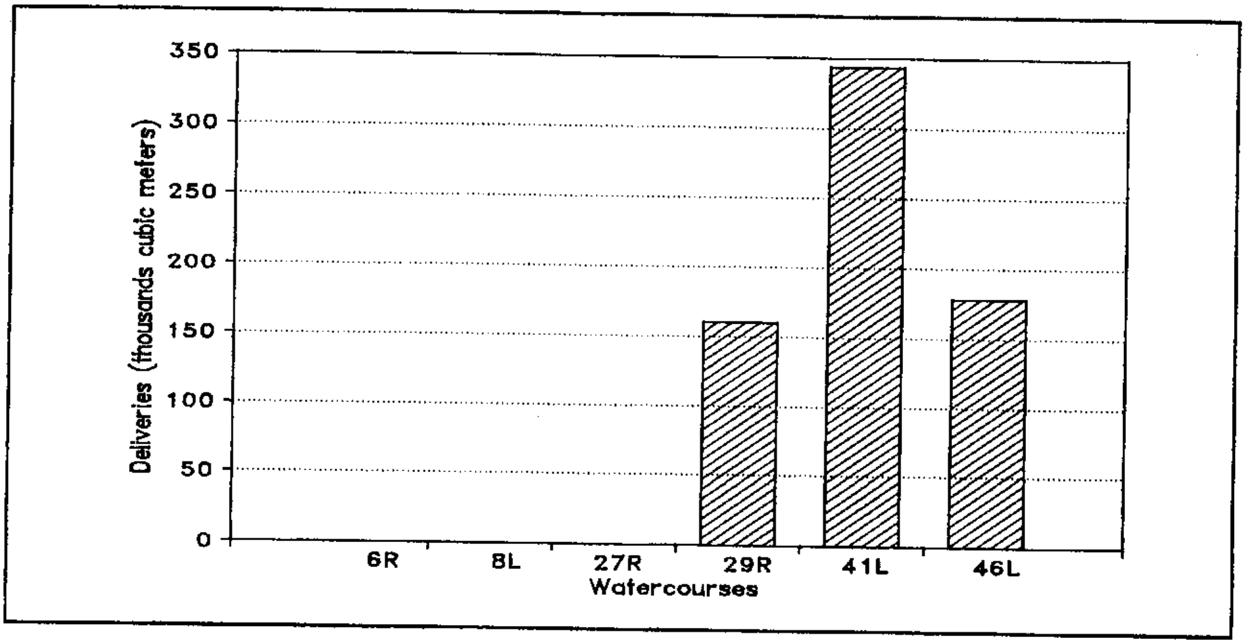
15 According to data collected by the Tube Well Wing of the Irrigation and Power Department, the utilization rate of public tube wells in SCARP 1 has gone down from 70 percent in 1960 to less than 45 percent in 1985 (Malik and Strosser 1993).

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.

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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.

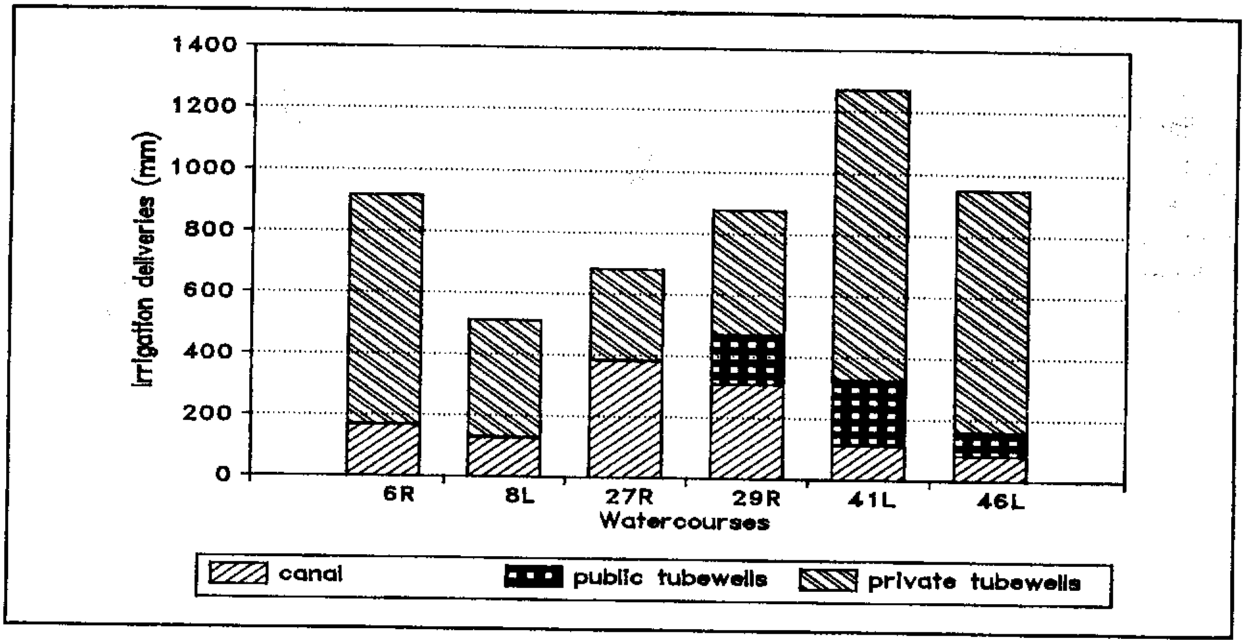


Table 5. Castes in sample villages as a percentage of the total population.

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]

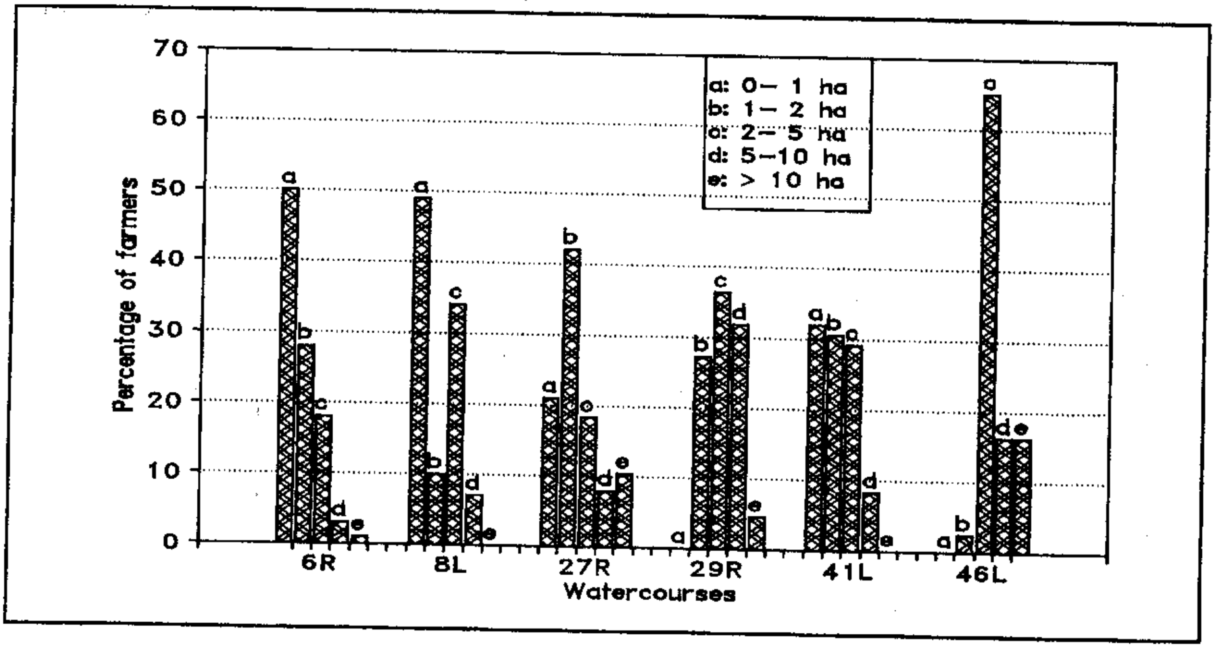
[18] Farmers indicated that the main reason that their efforts to line the watercourse ultimately failed was the presence of such a large group of lessees/tenants, who were not ready to invest in this project.

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.