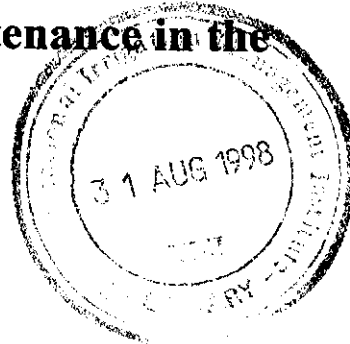


**MANAGING IRRIGATION FOR
ENVIRONMENTALLY SUSTAINABLE AGRICULTURE
IN PAKISTAN**

**INSTITUTIONAL AND PHYSICAL
DETERMINANTS OF WATER MANAGEMENT
PERFORMANCE AT THE TERTIARY LEVEL:
The Dynamics of Watercourse Maintenance in the
Pakistan Punjab**



by
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**JUNE 1998
PAKISTAN NATIONAL PROGRAM
INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE**

TABLE OF CONTENTS

TABLE OF CONTENTS.....	I
LIST OF TABLES	III
LIST OF FIGURES	III
LIST OF MAPS.....	III
GLOSSARY.....	IV
FOREWORD.....	VI
ACKNOWLEDGMENTS.....	VII
ABSTRACT.....	VIII
1 INTRODUCTION.....	1
• 1.1 STUDY BACKGROUND AND OBJECTIVES	1
1.2 CONTEXT OF THE STUDY	1
1.3 REVIEW OF EARLIER STUDIES.....	2
1.4 RESEARCH LOCALE.....	7
1.5 SAMPLE WATERCOURSES	7
1.6 METHODOLOGY.....	15
1.7 APPROACH.....	15
2 THE ORGANIZATION OF WATERCOURSE MAINTENANCE.....	17
2.1 WATERCOURSE MAINTENANCE: WHOSE RESPONSIBILITY?	17
2.2 WATERCOURSE MAINTENANCE AND PERFORMANCE OF THE SYSTEM.....	17
2.2.1 <i>The need for maintenance at the watercourse level</i>	17
2.2.2 <i>Farmers' perception of required routine maintenance</i>	17
2.2.3 <i>Comparison of the researchers' and the farmers' perspective on required maintenance</i>	19
2.2.4 <i>Farmers' motivations for performing different maintenance activities</i>	24
2.2.5 <i>Indicators of the need for watercourse cleaning</i>	27
2.2.6 <i>Frequency of watercourse cleaning</i>	29
2.2.7 <i>Leadership in initiative-taking</i>	33
2.3 THE PROCEDURE FOR DIVISION OF THE WORK	38
2.3.1 <i>Rules for allocation of the work</i>	38
2.3.2 <i>Leadership for allocating and supervising the work</i>	45
2.4 RESOURCE MOBILIZATION	49
2.4.1 <i>Labor</i>	49
2.4.2 <i>Mobilization of funds</i>	52
2.4.3 <i>Mobilization of kind</i>	52
2.5 COMMUNICATION	52
2.6 RULE ENFORCEMENT	53
2.6.1 <i>Legal basis</i>	53
2.6.2 <i>Absenteeism</i>	53
2.6.3 <i>Sanctions</i>	55
3 CONCLUSIONS AND RECOMMENDATIONS.....	56
3.1 CONCLUSIONS.....	56
3.1.1 <i>The occurrence of collective action</i>	56
3.1.2 <i>Required conditions for collective action</i>	57

3.2 RECOMMENDATIONS.....	64
REFERENCES.....	67
ANNEX 1: QUESTIONNAIRES	69
ANNEX 2: HISTORY OF ALLOCATION OF WORK.....	80

List of tables

Table 1. Physical characteristics of sample watercourses.	11
Table 2. Social characteristics of sample watercourses	13
Table 3. Expected effects of watercourse cleaning watercourse wise.	27
Table 4. Required and actual number of cleaning operations in sample watercourses.....	29
Table 5. Attributes of initiative takers for watercourse cleaning (mentioned by shareholders). ...	34
Table 6. Persons responsible for taking the initiative for watercourse cleaning.....	35
Table 7. Tasks of initiative takers of desilting activities.	37
Table 8. Basic rules for the allocation of work for watercourse cleaning.	40
Table 9. Criteria for person who allocates the watercourse cleaning work.	46
Table 10. Persons responsible for the division of work in watercourse cleaning.....	47
Table 11. Tasks of the person who divides the work for watercourse cleaning.	48
Table 12: Labor input during a watercourse desilting activity in H10-R watercourse.	50

List of figures

Figure 1. Problem areas in a watercourse according to the farmers' and researchers' opinions. ...	21
Figure 2. Trends in conveyance losses in sample watercourses.	23
Figure 3. Farmers' perceptions of the status of deferred watercourse maintenance.....	31
Figure 4. Frequency of desilting in lined, and unlined, watercourses.	32
Figure 5. Actual division of work for watercourse cleaning in 101-R Watercourse, Hakra 6-R... 43	
Figure 6. Head-tail differences in labor input for watercourse cleaning.	51
Figure 7: Occurrence of collective action for watercourse maintenance.....	56
Figure 8: Lack of maintenance and number of shareholders.....	58

List of maps

Map 1: Fordwah Eastern Sadiqia.....	8
Map 2: Location of sample watercourses in Hakra 6-R Distributary Command.....	9
Map 3: Location of sample watercourses in Chishtian Sub-division.....	10
Map 4. Layout and command area of 101-R Watercourse.	20

Glossary

Abiana	Water tax
Begari	Peon of the <i>numberdar</i>
Baradari	Kinship group, or a sub-division of a caste group, or a fragment of identifiable and nurtured kinship and social bonds
Chak	Tertiary irrigation command
Chowkidar	(Watchman) Assistant of <i>numberdar</i>
Daranti	Sickle
Dera	Farmhouse, meeting place, drawing room, or a place owned by a certain person where informal meetings are held, and where the owner entertains visitors
Hukkah	Water pipe
Izzat	Honor, esteem, status, face
Kan or Kanah	Stick of any size, used to distribute work during watercourse desilting
Katcha	Unofficial, informal
Karam	1 <i>karam</i> = 5.5 feet
Kharif	Summer crop season (officially from mid April to mid October)
Kassi	Spade
Mogha	Outlet
Muhajir	Migrant. In this context, a person who migrated from India after 1947
Nakka	Farm inlet
Numberdar	(or <i>Lambardar</i>) Headman of the village responsible for collection of <i>Abiana</i> or a notable of a village nominated to collect revenue, from farmers
Patwari	Revenue official who keeps record of the crops & <i>warabandi</i> schedules, etc.
Panchayat	Traditional system of conflict resolution in which elders of respected people of village take decisions
Pakka	Official, formal
Ramzan	9 th month of Islamic Hijri calendar year, in which Muslims fast everyday from sunrise to sunset
Rabi	Winter crop season (officially from mid October to mid April)
Tibba	Sand dune
Warabandi	A rotational method for distribution of irrigation water, with fixed time allocation based on the size of landholdings of individual water users within a watercourse command area. <i>katcha warabandi</i> is decided by the farmers solely on their mutual agreement, without formal involvement of any government agency. <i>Pucci warabandi</i> is decided after field investigation and public inquiry by the Irrigation Department

Zid

when disputes occur, and issued in officially-recognized
warabandi schedules

Being stubborn, being destined

Foreword

This report is the result of a collaborative effort between: (1) Department of Irrigation and Soil and Water Conservation, Wageningen Agricultural University; (2) Department of Water Management, University of Agriculture, Peshawar; and (3) Pakistan National Program, IIMI. Under this program, two studies were to be undertaken in North West Frontier Province (NWFP) by the Department of Water Management and two studies in Punjab Province by IIMI.

A comparative study on collective action at the watercourse level was planned in collaboration with the WAMA Project in the Water Management Department of NWFP Agricultural University, Peshawar, in 1996. The study was designed to find the determinants of the collective action within the tertiary units, which could help any agency involved in the turnover of irrigation systems in Pakistan. Since, it has been felt that an external turnover model and blueprint approaches will have more risk of failure, as has happened in the past.

In IIMI-Pakistan, two researchers, Cris de Klein and Robina Wahaj, have worked on this study, one (Cris) full time, whereas, the other one (Robina), is also working on her Ph.D. on Irrigation System Performance Below the *mogha*. The main objective of the research on collective action was to develop an approach (e. g. a set of guidelines) for rapid appraisal of the potential of collective action for water management. Whereas, the main question dealt with in the Ph.D. research is "how do farmers' actions shape irrigation system performance at the watercourse level?"

The two researchers worked at different sites, one (Cris) in Faqirwali on Hakra 6-R Distributary offtaking from Hakra Branch Canal, while the other (Robina), worked in Hasilpur on Fordwah Distributary and Mahmood Distributary offtaking from Fordwah Branch Canal. In NWFP, work was done in Sheik Yousaf Minor and Pabbi Minor; however, the extent of data collection was different. The researchers involved from WAMA were Hammond Murray-Rust, Michael de Bont, Zubair Khan and M. Jamal Khan.

I applaud the two researchers for their efforts. This report represents scholarly research, for which Cris de Klein and Robina Wahaj can be proud. Interesting reading!

Prof. Gaylord V. Skogerboe
Director, Pakistan National Program
International Irrigation Management Institute

Acknowledgments

A proper data collection is not a sufficient, but definitely a necessary, condition for writing a research report. We, therefore, acknowledge the crucial task that has been performed by the field staff. In the IIMI-field station Faqirwali, we could build on the continuous helpfulness of Fayyaz Ahmad Ch., Muhammad Abid, Zaheer Abid and Manzoor Ahmad, and in the IIMI-field station, Hasilpur, Asif Yaqub, Munnawar Shah and Muhammad Fiaz.

We thank Shaukat Ali Khan and Muhammad Jehangir, MSc students from the Water Management Department, N.W.F.P. Agricultural University, Peshawar, for their contribution towards collecting and processing much of the field data. We also thank Asma Bashir for her continuous input in our research in terms of data entry, and Samia Ali, Asghar Hussain and Yann Chemin for producing maps. The secretarial assistance of Mr. M. Iqbal Khan is also thankfully acknowledged.

Words of thanks to those who inspired us to conduct this research and with whom we had numerous discussions about underlying objectives and methodologies; Arjen During, Pierre Strosser, Annemiek Terpstra and our collaborators from the Water Management Department (WAMA) in Peshawar, especially Dr. Muhammad Jamal Khan and Dr. Hammond Murray-Rust.

We were very glad to receive valuable comments on the report from Doug Merrey, Linden Vincent and Prof. G. V. Skogerboe, who also did the final editing.

Last, but not least, we would like to thank the farmers of our sample watercourses for their endless patience in answering our questions. The hope is that future developments in Pakistan's irrigation system will improve their living conditions.

1 Introduction

The lesson for the future is that lasting institutional development needs first to recognize and understand existing institutions, and whenever possible build on them, rather than go through the process of apparently constructing a whole new institutional arrangement which unknowingly merely duplicates the existing indigenous institutions.

- World Bank, 1996 -

1.1 Study background and objectives

The International Irrigation Management Institute (IIMI) Pakistan conducted a study on the potential of farmers' collective action for water management at the tertiary level. This study was conducted within the water management and the institutional development components of the Netherlands-funded project on 'Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan'. The study is conducted in twelve watercourses in two canal command areas in the Punjab, differing in terms of physical conditions and social settings.

The objective of this study is to learn water management from existing forms of farmer organization in order to provide guidelines for improving farmer participation in irrigation management. Watercourse (operation and) maintenance is the main activity mentioned when talking about farmers' involvement in irrigation management. This paper aims to provide insights into the ways in which farmers organize themselves for maintenance activities at the watercourse level and assesses the potential of the same, as well as to identify potential improvements. The hope is to identify diversity, if any, in patterns of organization between different watercourses. With this attempt, the authors hope to sketch a realistic picture of the 'social capital' available and the patterns of cooperation, that are expected to form the basis for a 'new-style' of farmers' organizations.

The first section of this paper introduces the context in which the study took place, briefly reviews earlier research efforts, and describes the research locale and research methodology. In the second section, the main findings are presented, such as requirements for maintenance, performance of required maintenance and the actual organization of watercourse maintenance. Based on the experiences in the different watercourse command areas, the main conditions influencing the potential for collective action for maintenance are presented in the third section. This section further reflects on the necessity of external intervention to organize farmers to undertake maintenance activities at the watercourse level. Furthermore, it assesses whether maintenance could serve as a suitable entry point for other institutional interventions.

1.2 Context of the study

Around 90 percent of Pakistan's agricultural output depends entirely on irrigation. The World Bank, in a report, mentions the main problems faced by the irrigation system. These are

waterlogging and salinity, over-exploitation of fresh groundwater, low efficiency in delivery and use, inequitable distribution, unreliable delivery and insufficient cost recovery. The assumption is that decentralization of irrigation management, from government agencies to the irrigators, is one of the necessary solutions to these problems. A number of institutional changes are proposed, such as the establishment of Farmer Organizations (FOs). One of the immediate tasks of these farmer organizations would include organizing farmers to carry out operation and maintenance at the distributary level (World Bank, 1994). With the passing of the Punjab Irrigation and Drainage Authority (PIDA) Bill in June 1997, it seems that several institutional reforms are actually going to be implemented.

One of the questions that arises is the potential of farmers to organize themselves for operation and maintenance of the irrigation system. Successes of Participatory Irrigation Management (PIM) and Irrigation Management Turnover (IMT) in other countries are sometimes referred to as if they are a guarantee for similar success in Pakistan. In many cases, however, the consequences of these interventions, and the underlying dynamics of these institutional changes, are still in the process of being evaluated and understood. Merrey, who studied the social organization of local water management in the Pakistan Punjab, warns about the 'engineering mentality' in this regard (i.e. an assumption that inadequate organization can be solved by installing a new farmer organization). He further states that there has been no consideration of the dynamics, the adequacy, or the consequences of the present organization of the irrigation system. He stresses the need for a great deal more research on the organization of the system at all levels, and especially on social constraints and cultural perceptions and motivation. Such research can be used to develop a more comprehensive and realistic model of how the Indus Basin Irrigation System actually operates (Merrey, 1986).

In one of its reports, the World Bank reviews the theoretical and empirical literature on Water Users Associations, and addresses the question, 'under what conditions are WUAs most effective in irrigation management?' The report discusses a number of internal structural features of WUAs, which improve their effectiveness, on external factors, which affect their viability and sustainability, as well as implications for constructive interaction between irrigation agencies and WUAs. One of the final conclusions of this study is that WUAs are stronger if they can build upon existing 'social capital', or patterns of cooperation (World Bank, 1994).

1.3. Review of earlier studies

Many scholars question the sustainability of user organizations for common pool resources, such as a Water Users Organization for irrigation management. Oftentimes, the major aim of these studies is to identify the main factors that influence collective action and the conditions that are required for successful organizations. A whole list of factors can be drawn on the basis of this body of theoretical and empirical research literature, the combination of which, however, would never appear in a real situation. A number of these factors (social, economic, physical, etc.) will be dealt with in this section.

One of the requirements often mentioned is that new farmer organizations are more likely to be viable and sustainable if they build on existing organizations, or at least take them into account (Uphoff 1986: p.127; Mirza 1989: p.15; Meinzen-Dick et. al 1994: p.56; World Bank 1996: p.74 and 81). This implies that it is important to get a better insight into the organizational principles

that underlie farmers' irrigation management. Factors other than that of an organizational nature may explain why a certain organization comes into being and persists, since they will influence farmers' motivation, awareness, benefit, potential, etc..

In literature on decentralization of irrigation management, two models are mentioned: the Asian model and the World Bank model (Merrey 1997: p.9). No single model is perfectly suitable. In following the 'Asian model', one wants to work from the grass-roots level and is, therefore, more interested in the situation already existing, and the conditions that lead to more, or less, collective action. Merrey suggests that policy objectives, and a long-term policy for carrying out necessary reforms and changes to achieve these objectives, should capitalize on the country's existing traditions, strengths, and assets that enable the development of effective institutions, but also with high-level support (Merrey, 1997: p.11).

However, there is a likelihood that part of Pakistan's irrigation system has to be 'turned over' from the government to the farmers at a higher speed than the Asian model would suggest. The "Big Bang" approach (as happened in countries like Mexico) as suggested by the strong involvement of the World Bank in Pakistan's economy, can no longer be denied. This is what Merrey calls the "World Bank Model". The paradox is that the World Bank strives for rapid and profound changes, and therefore, farmers' participation (so-called Participatory Irrigation Management, PIM) at the same time.

Worldwide, much research has been done with the objective to identify principles and lessons that can be used to promote, or improve, farmer organizations in large government systems. Merrey (1997, pp. 3-5) synthesizes the major principles emerging from the most recent work¹ aimed at identifying the institutional principles characterizing successful self-governing systems.

- 1 A supportive policy, regulatory and legal environment that recognizes the irrigation community's water rights.
- 2 Capacity to mobilize resources adequate to meet the costs of operations and maintenance including emergency repairs;
- 3 Benefits exceed costs of participation, with proportional equivalence between benefits and costs for each irrigator – that is, those with larger benefits pay a larger share of the costs;
- 4 Effective collective choice arrangements or 'organizational control of water' by users, which will normally have the following characteristics:
 - Organizational autonomy;
 - Financial autonomy;
 - Single organizational entity manages a single infrastructural system;
 - Maintenance and conflict resolution are tightly connected to the allocation and distribution of water and the organization can enforce rules among its members;
 - Transparent arrangements for monitoring performance; and

¹ Ostrom 1992, Uphoff 1986; Vermillion 1991; Yoder 1994b; Svendsen and Vernillion 1994; Vermillion and Johnson 1995; Freeman 1989; Frederiksen.; Ostrom, Schroeder, and Wynne 1993; Hunt 1989 and 1990; Vermillion 1991; Carcés-Restrepo and Vermillion 1995; Small and Carruthers 1991. (See Merrey 1996: pp.4-5.)

- Nested (or federated) organizational structure.

He further mentions some principles where universality is less certain. These are:

- Graduated sanctions;
- Maintenance of written accounts and records;
- Water sufficient to meet crop water demands;
- General assembly of members that chooses a committee of officials;
- Use of specialized paid staff for regular maintenance;
- Local recruitment of staff; and
- Leadership. But this he does not consider an institutional variable. He states that although leadership can substitute for good organization in the short run, dependence upon individuals' leadership qualities alone in the absence of strong institutions threatens the sustainability of an organization (p.5).

Ostrom (1992) mentions six design principles for sustainable Appropriator Organizations (in Bromley, 1992, pp. 304-308) where are:

1. Small set of simple rules;
2. Enforcement of these rules;
3. Internally adaptive mechanisms;
4. Legal claims as owners of the Common Pool Resource;
5. Nested in a set of larger organizations, perceived legitimate; and
6. No rapid exogenous change.

Mirza (1975), in a study on organizational factors affecting water management decision-making in Pakistan's Punjab, describes decision-making processes with regard to watercourse maintenance.² After having studied watercourse maintenance in 15 villages, some of his conclusions are³:

- 1) higher numbers of shareholders lead to increase difficulty to get people to agree to a single formula;
- 2) the following villages mobilize with less effort in terms of man days/miles/years employed to clean the watercourse;
 - a) with a double caste as compared to a single, or multiple, caste structure;
 - b) having an incidence of factionalism; and
 - c) one single individual, rather than an elected *Panchayat*, dominating decision-making for collective actions;
- 3) Factionalism and lack of well-defined leadership leads to a lack of consensus for any collective decision and, therefore, results in less effort for watercourse cleaning; and

² He considers the following elements of decision-making: 1) felt need; 2) articulation of the problem; 3) evaluation of alternative solutions; 4) aggregation of consensus; 5) selection of authority; 6) actual implementation; and 7) evaluation.

³ His major finding, however, is that the presence of public tube wells (the major independent variable in his study) is a disincentive to willingness to improve on-farm water management. Public tube wells are not present in any of our sample watercourses.

- 4) Farmers in the tail reach receive less quantity of water, because of poor watercourse maintenance quality. Such farmers must work harder, while obtaining less service.

Factors other than that of a socio-cultural nature (except for the supplementation of canal water by tubewell water) are not considered in this study.

Mirza and Merrey (1979) conducted a study in ten reconstructed watercourses in the Punjab to identify those sociological characteristics of rural society that both promote, and inhibit, effective cooperation on watercourse rehabilitation and maintenance. The better-maintained watercourses tend to have all, or most, of the following characteristics:

- 1 A large percentage of farmers with land holdings in the 2.5 to 10 hectare range;
- 2 Relatively equal distribution of power and influence among farmers on a watercourse; a large percentage of farmers being perceived by fellow shareholders as having some influence and power;
- 3 Concentration of power and influence at the tail, or at the tail and middle, of the watercourse;
- 4 Progressiveness of the community;
- 5 Previous history of cooperation on community projects, and lack of serious recent conflict;
- 6 A small number of shareholders on the watercourse; and
- 7 Membership of most of the shareholders in a single *baradari*.

Their study shows that the quality of improvement and maintenance is closely related to sociological characteristics of the watercourse, but shows that present forms of organization are not adequate to insure good maintenance of the system, even on relatively conflict-free watercourses (Merrey, 1986b). In the Pakistan Punjab, however, conflict-free watercourses are hard to find, according to Merrey (1979; 1992). Although his write-ups are, for a large part, based on an in-depth study in one village in the Punjab, he found that the struggle for honor and respect ('izzat') is inherent to the Punjabi culture and can explain much of farmers' non-cooperative behavior.

Byrnes, on the other hand, is more optimistic about the farmers' potential to maintain their watercourses, especially after watercourse improvement. For the World Bank, he evaluated the effect of Water Users Associations (WUAs) on the organization of irrigation management in 11 improved watercourses in Punjab and NWFP. The OFWM-I Project envisioned that the WUAs would be responsible for operating and maintaining improved watercourses, and that enacted legislation (WUA ordinances) would provide sanctions to ensure that farmers maintain their watercourses. In all of the visited WUAs, he found that watercourse cleaning - after watercourse improvement - was needed less frequently, and that cleaning took less time and/or less labor. Whether or not the improvement of watercourse maintenance is due to the establishment and involvement of the WUAs Executive Committee (EC) in watercourse cleaning, remains largely unclear. The increased willingness of farmers to participate in watercourse cleaning, after the improvement, is probably mainly because it requires less labor and is thus easier to organize. In most cases, the members of the EC are those who were also actively involved in organizing watercourse cleaning before its improvement. The study also illustrates that water management functions, such as watercourse cleaning, may, with the passage of time, continue to be organized by traditional institutions, with the WUA never developing as an active organization within the village (Byrnes, 1992: pp.46-49).

Arshad Ali and A.H. Mirza, in an evaluation of the performance and potential of WUAs, also conclude that 'after the improvement of watercourses, the WUAs no longer remain viable and cease to function in any capacity. The farmers, therefore, again resort to their traditional mode of watercourse cleaning and maintenance. They mentioned that as a consequence of this, the quality of watercourse maintenance becomes as poor as it used to be before improvement, leading to increased seepage losses (1994 Institutional Reforms to Accelerated Irrigated Agriculture, Vol. II, Study 1, pp.6).

Malik *et al.* (1996), in a study on farmers' organized behavior in six watercourses in the Punjab, tested the influence of a number of sociological variables, that were assumed to be important (based on earlier research). Watercourse cleaning is one of the irrigation activities in which farmers' involvement is evaluated. They observe that the intensity of watercourse cleaning is quite high and that the watercourses are in a reasonably good physical state.. Contrary to the studies mentioned above, this study determines physical explanations for the frequency of watercourse cleaning, which is said to be influenced by the amount of silt in the water and the height of the outlet. The importance and influence of social variables, however, remains mainly undiscussed (e.g. why, in one of the watercourses, farmers experience difficulty to organize themselves for watercourse cleaning). Although, in the conclusions, a number of social factors are mentioned in order to contribute to effective organization of irrigation, their influence on the performance of this one specific activity (cleaning) is not clear. Social factors that are 'accepted' as having influence on irrigation activities in general are:

- 1) history of cooperation on community projects;
- 2) leadership;
- 3) credibility of punishment;
- 4) a small number of tenants; and
- 5) effective conflict resolution.

Factors that are 'rejected' as having influence are: 1) a small group size; 2) no major conflicts; and 3) single mosque committee. One of their main conclusions is that informal organizations of farmers are established for specific common projects with limited duration (such as cleaning of the watercourse) and are dissolved when the targets are achieved.

Although much of the literature tries to explain why watercourse maintenance is performed well, or poorly, the same literature did not clarify how the performance of watercourse maintenance was measured. Mirza and Merrey (1979) did assess the quality of the maintenance by observing the condition of banks, bed, etc. of the watercourse. This, however, was done only at one moment in time and the maintenance condition was assessed in relative terms. Whether (and why) maintenance had a negative effect on agriculture was not dealt with.

1.4 Research locale

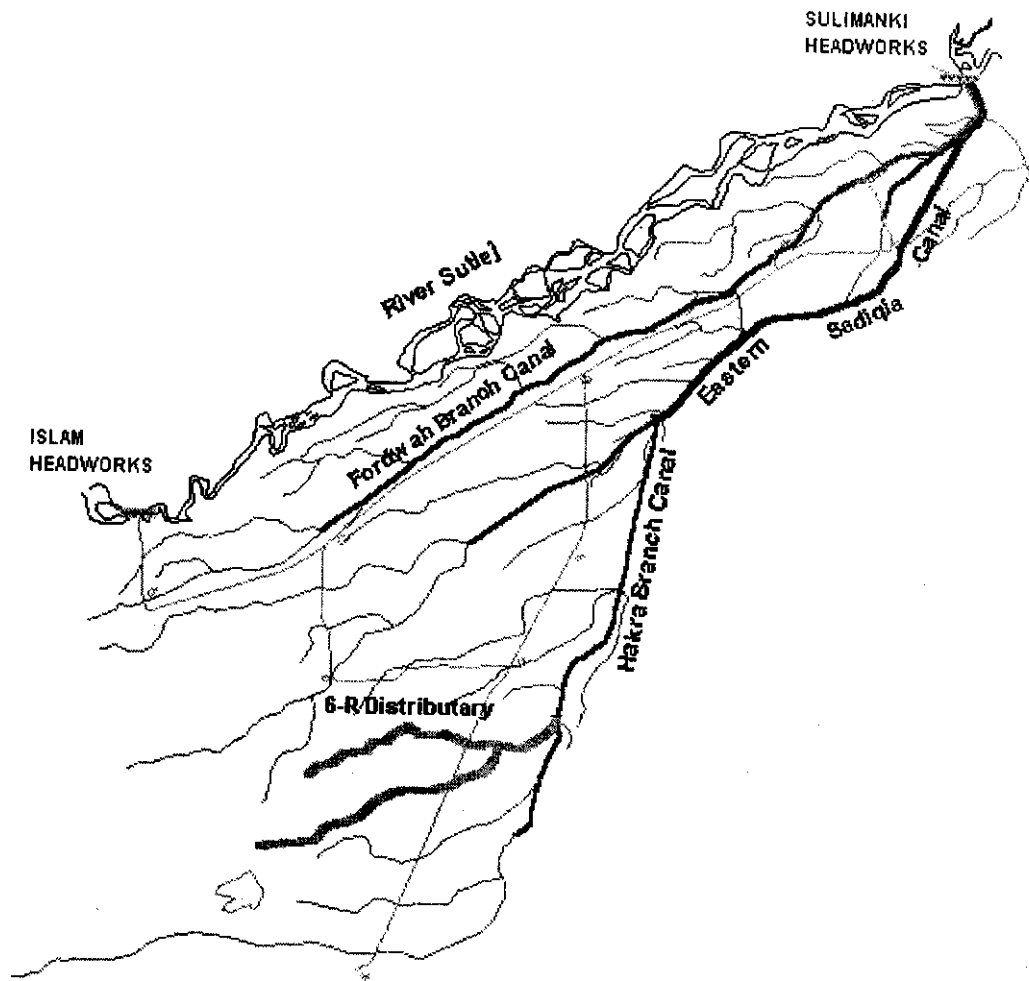
The findings presented in this report are based on fieldwork conducted in 12 watercourses in the command area of Fordwah Eastern Sadiqia Irrigation Project, southeastern Punjab, Pakistan. The Fordwah and Eastern Sadiqia Canals originate at Sulemanke Headworks, constructed along the Sutlej River. Six of the watercourses are located along 6-R Distributary, off-taking from Hakra Branch under Eastern Sadiqia Canal. The other six watercourses are located along Fordwah and Mahmood Distributaries, off-taking from Fordwah Branch of Fordwah Canal: four off-take from Fordwah Distributary and two from Mahmood Distributary (see Map 1).

The climate in the area is characterized by large seasonal fluctuations in temperature and rainfall. Average annual rainfall in this arid area is around 200 mm. The ground water table, that used to be up to 100 feet below the surface before the introduction of the canal irrigation system, has risen drastically and is between 0 and 5 feet below the surface in around 70% of the area (WAPDA, 1987).

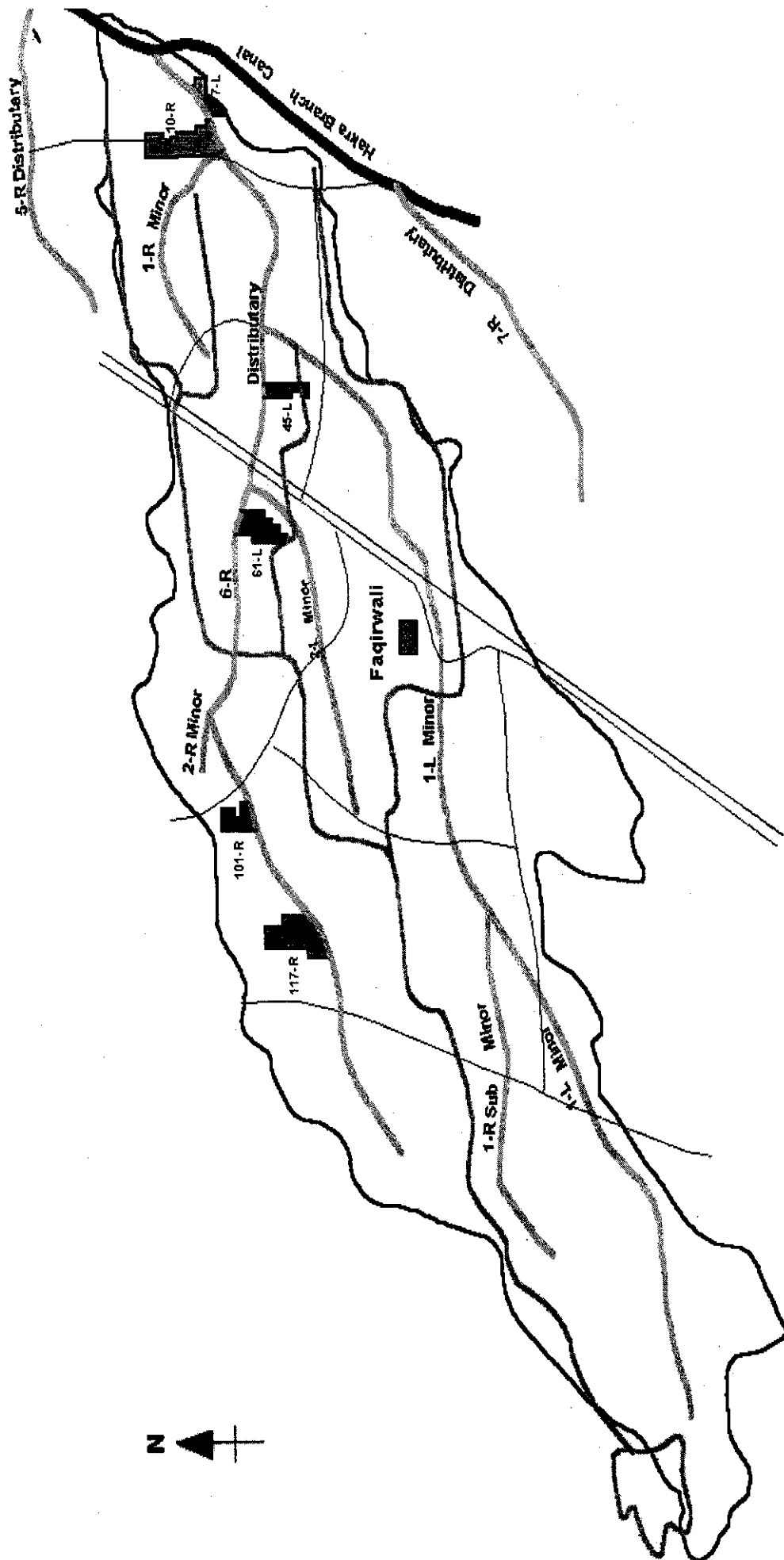
The main crops of the area are cotton in the *kharif* (summer) season, wheat during the *rabi* (winter) season and sugarcane and fodder in both seasons. The annual cropping intensity is 127% (60.4 in *kharif* and 66.6 in *rabi*) (WAPDA, 1987), with 169% in Fordwah Eastern Sadiqia (South) FES(S), according to WAPDA (1990).

1.5 Sample watercourses

The research was conducted in the sample watercourses that were selected for the study on Collective Action for Watercourse Management below the Outlet (in Hakra 6-R Distributary) and for the study on Irrigation Performance below the *mogha* (in Fordwah and Mahmood Distributaries). This means, that no sample watercourses were selected especially for the study of watercourse maintenance. The twelve watercourses had been selected on the basis of differences in physical and social characteristics. The locations of the sample watercourses are indicated on Map 2 and Map 3 respectively. A number of main physical and social characteristics are given in Tables 1 and 2 (it goes without saying, that at the time of selection of the sample, not all of the details were known).

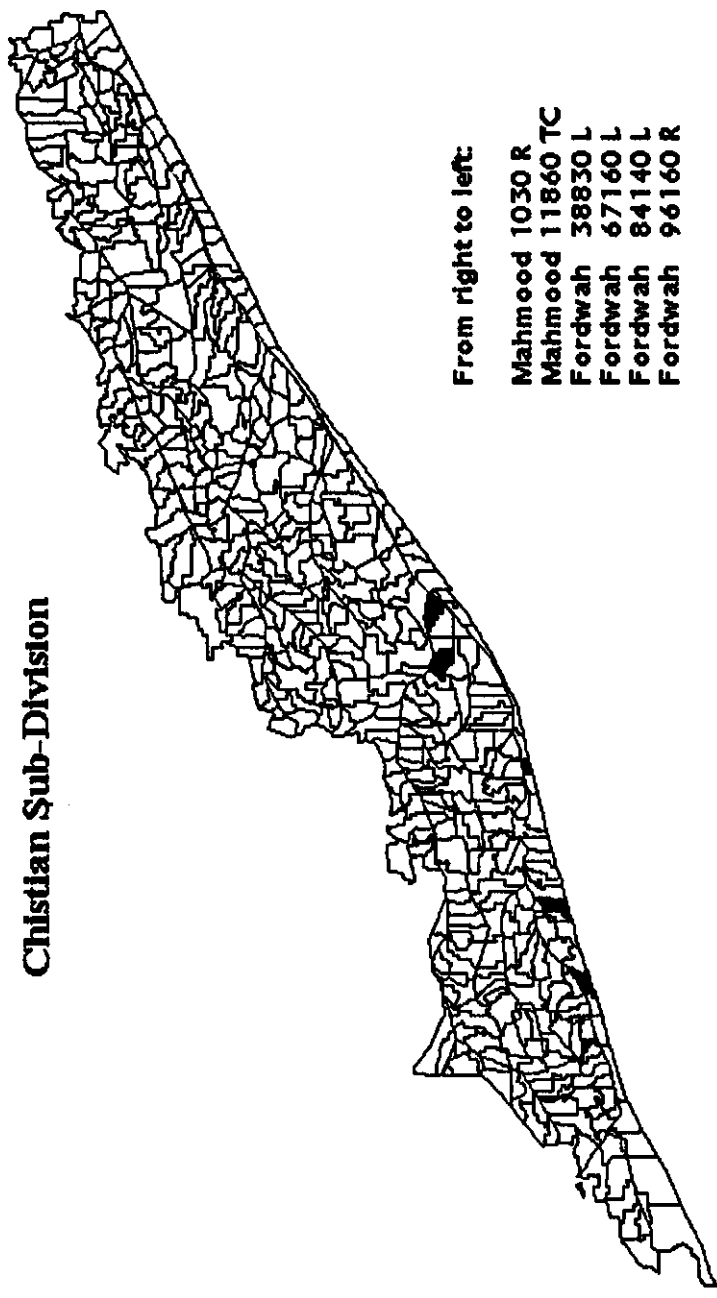


Map 1: Fordwah Eastern Sadiqia



Map 2: Location of sample watercourses in Hakra 6-R Distributary Command

Chistian Sub-Division



Map 3: Location of sample watercourses in Chistian Sub-division.

Table 1. Physical characteristics of sample watercourses.

Watercourse ¹⁾	H7-L	H10-R	H45-L	H61-L	H101-R	H117-R	MD1-R	MD11-TC	FD38-L	FD67-L	FD84-L	FD96-R
Location along the distributary	Head	Head	Middle	Middle	Tail	Tail	Head	Tail	Head	Middle	Middle	Tail
Design CCA (in acres)	331	618	467	556	275	451	350	412	105	385	264	170
Design Q (in cusecs)	1.19	2.22	1.68	2.14	1.3	2.22	1.49	1.75	0.38	1.38	0.95	0.64
Design allowance (l/s/ha) ²⁾	0.25	0.25	0.25	0.27	0.33	0.35	0.25	0.25	0.25	0.25	0.25	0.25
Actual average Q ³⁾	1.65	5.6	2.2	3.0 - 4.9	2.8	3.7	1.88	2.10		0.6	0.38	0.41
Actual allowance (l/s/ha)	0.35	0.64	0.33	0.38 - 0.62	0.72	0.58	0.30	0.30	0.25	0.25	0.25	0.4
Area affected by waterlogging and/or salinity ⁴⁾ (% of CCA)	79	15	60	84	11	4						
Main <i>kharij</i> crops (% of CCA actual cultivated)	Cotton 34 Fodder 28	Cotton 72 Fodder 16	Cotton 55 Fodder 30	Cotton 42 Rice 21	Cotton 76 Fodder 12	Cotton 71 Fodder 10						
Main <i>rabi</i> crops	Wheat 80 Fodder 13	Wheat 84 Fodder 9	Wheat 73 Fodder 20	Wheat 62 Oilseed 26	Wheat 81 Fodder 10	Wheat 89 Orchard 20 ⁵⁾	S/cane 36 Wheat 35	S/cane 4 Wheat 39	Wheat 58 S/cane 24	Wheat 70 Fodder 31	Wheat 66 Fodder 15	Wheat 50 Fodder 29
Watercourse improvement	Unlined	Main w/c 40% lined	Unlined	Main w/c 100% lined	60% lined	Main w/c 100% lined	Main w/c 20% lined	Main w/c 20% lined	Unlined	Lined	Unlined	Unlined
Length of main w/c (m)	1800	4200	3150	2690	1540	1500	1590	2040	1320	1950	1320	2010
Conveyance losses (on average, from head to tail, %)	42	44	40	19	Not available	4						
Slope (m/1000m)	0.56	0.22	0.83	0.81	0.99	0.62	0.71	0.81	0.47	Not	0.03	0.93

Watercourse ¹⁾	H7-L	H10-R	H4S-L	H61-L	H101-R	H117-R	MD1-R	MD11-TC	FD38-L	FD67-L	FD84-L	FD96-R
Number of <i>nakkas</i> per 100 m along longest branch	3.7	1.1	1.0	1.2	1.0	1.5	0.9	0.6	0.8	1.1	1.0	0.7
<i>nakkas</i> in good condition (%)	46	62	53	59	44	83				82		

¹⁾ H refers to Hakra 6-R Distributary; MD refers to Mahmood Distributary; FD refers to Fordwah Distributary. The number stands for the Reduced distance (Rd) from the head of the distributary. 1 Rd = 1000 feet. L indicates that the watercourse off-takes on the left bank of the distributary and R the right bank. TC stands for Tail Centre.

²⁾ Allowance in l/s/ha is calculated as follows: $Q*28.3/(CCA*0.4)$.

³⁾ In this figure it is not taken into account, that the watercourse does not receive water during certain periods due to rotation in the distributary. For the watercourses in Hakra 6-R, e.g. the actual amount of water received is better be multiplied with 2/3, since according to design (and mostly in practice as well), the distributary, in principle, does not receive water for 8 days after every 16 days. Data for Hakra 6-R are for *kharij* '96. Farmers of H61-L managed to get an outlet enlargement when they shifted to rice cultivation after the cotton crop had been destroyed due to (standing) rain water.

⁴⁾ Data in watercourses in Hakra 6-R are based on farmers' salinity mapping exercises. The design CCA is used. At the time of report writing this information was not available for the other sample watercourses.

⁵⁾ A higher percentage of land under orchard (out of which much is orchard in combination with an other crop, e.g. 19 acres is orchard+wheat) is probably due to an arrangement between the *patwari* and a few individual farmers. If a farmer has orchard, he is entitled to a higher per acre time of water turn. Therefore, this information can be used only as an indication.

Table 2. Social characteristics of sample watercourses.

Watercourse	H7-L	H10-R	H45-L	H61-L	H101-R	H117-R	MD1-R	MD11-JC	FD38-L	FD67-L	FD84-L	FD96-R
Number of shareholders	31	64 ¹⁾	64	30	23	33	70	76	2	52	56	29
Caste composition (the three main groups, in %)	Arain 35 Joiya 23 Rajput 10	Arain 83 Jat 8	Jat 95	Jat 60 Rajput 13 Malik 13	Arain 78	Jat 39 Joiya 24 Rest mix	Rajar Khichi Arain	Joiya 25 Kulaira 16 Lakwaira (Joiya) 13	Pathan Arain	Arain 77 Khokhar 16 Syed 4	Lobana (Gujar) 52 Arain 32 Jat 5	Mostly Arain
Migration												
Locals (%)	0	0	0	0	4	12	Mostly muhajirs	Mostly muhajirs	Migrants	Mostly local (Khokhar and Syed)	Mostly muhajirs	Mostly muhajirs
Migrants (%)	26	32	66	20	56	85						
Muhajirs (%)	73	68	34	80	39	3						
Land under tenancy status ²⁾												
OC (%)	53	46	78	50	48	32	73	65	50	19	31	35
T (%)	29	26	4	28	43	59	2	14	0	55	43	39
L (%)	18	28	18	22	9	9	25	21	50	26	26	26
Average land holding size owned in sample w/c by cultivators	5.2	5	5.3	8.8	6.2	3.7	4		47	4.0	2.6	4.4
Average land holding size cultivated (ac) ³⁾	11.3	12.0	7.8	18.4	12.0	11.5	3.5	5.5	47	8.1	5.3	2.9

Watercourse	H7-L		H10-R		H45-L		H61-L		H101-R		H117-R		MD1-R		MD11-TC		FD38-L		FD67-L		FD84-L		FD96-R	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Land ownership ⁴⁾	14	45	35	55	22	34	14	47	7	30	19	58	31	50	22	42	0	0	10	52	13	66	3	21
0-2.5 acres	6	19	8	13	15	23	8	27	5	22	4	12	21	34	15	28	0	0	2	11	3	17	6	43
2.5-5 acres	5	16	9	14	21	33	5	17	3	13	5	15	7	11	9	17	0	0	7	37	2	11	4	29
5-10 acres	4	13	9	14	4	6	2	7	6	26	5	15	1	2	6	11	0	0	-	-	1	6	1	7
10-20 acres	2	7	3	5	2	3	1	3	2	9	-	-	2	3	1	2	0	0	-	-	-	-	-	-
20-40 acres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	100	-	-	-	-	-	-
>40 acres																								
Cultivators for whom crop from land in this w/c is main source of income (% 5)	61		78		44		50		74		82													

¹⁾ The actual number of shareholders is 65, but one cultivator was missed in the survey.

²⁾ Land under tenancy status: data for all the sample watercourses is for *rabi* '96-'97.

³⁾ Average land holding size cultivated means: the average area cultivated by the cultivators of this watercourse inside this watercourse.

⁴⁾ Land ownership here means: the area that the actual cultivators (not the owners) own in this watercourse command area. Therefore, big landowners who do not cultivate land themselves, are not included. Data for Hakra 6-R are based on the survey information and represent *kharij* '96 season. The information about the sample watercourses in Mahmood and Fordwah distributaries for *rabi* '96-'97.

⁵⁾ Detailed information is not available for the other sample watercourses.

1.6 Methodology

The qualitative data were collected from July 1996 to February 1997 in the watercourses along the Hakra 6-R Distributary and from January to October 1997 in the watercourses in the tail distributaries of the Fordwah Branch Canal. The quantitative data were collected before, during and after these time periods.

Most of the information on the organization and implementation of maintenance activities was collected through interviews with farmers. In the initial stage of the research, semi-structured and informal interviews were conducted at the time of, and in between, desilting activities. These informal encounters took place during the daily visits of the field staff to the watercourses. During these visits the watercourse situation and on-going activities could be monitored. In each of the watercourses, farmers were asked about, among other things, the need and program for desilting and the problematic reaches along the watercourse in terms of the deposition of silt and vegetative growth.

In each of the watercourses, key-informants were interviewed following a structured questionnaire in the case of the watercourses along the Hakra 6-R Distributary, and with the use of a checklist in the watercourses served by Fordwah Branch (see Annex 1). The key informants were those who were found to be the most active persons with regard to watercourse desilting activities. In a later stage of the research, structured interviews were also conducted during the desilting activities. The number of respondents depended upon the total number of cultivators of the watercourse or (main) branch being desilted, and varied from 2 to 8. Representation of cultivators from different reaches (head, middle and tail) of the watercourse, or branch, was considered. An attempt was made to include one of the real head enders, as well as the last farmer of the watercourse, or branch (see Annex 1).

Farmers were asked to clarify the pattern of allocation of work (stretches to be cleaned) by use of a map showing the layout of the watercourse and branches. This was done for three of the watercourses along the Hakra 6-R Distributary (detailed) and for four watercourses served by Fordwah Branch Canal. Quantitative data were mainly related to the layout of the watercourse, conveyance losses and elevations of the watercourse bed, banks and fields along the watercourse.

1.7 Approach

As one of the major objectives of this report is to learn from existing forms of farmer organization for water management, the authors argue that water management should (first) be understood from the farmers' point of view. Therefore, the farmers' perspective plays an important role in this report.

Although, in the literature review, many factors that are thought to have influence on water management are listed, the authors have not specifically selected a list of factors as working hypotheses. The reason behind this is that their initial aim was to understand the dynamics and the underlying internal structures of watercourse maintenance. Undoubtedly, throughout the

report, the main influencing factors, as they appear in the sample sites, will be dealt with, and so, if desired, the reader can compare these with earlier research findings.

Looking from the farmers' perspective partly explains, for example, why, how well, or how bad, farmers maintain their watercourses were not measured. On the other hand, the difficulty to measure the quality of maintenance objectively is one of the main reasons to opt for more emphasis on the farmers' perspective. This approach focuses more on the on-going processes than the final outcome of the process. The expected research outcome, however, remains the same, namely to gain better insights into the physical and social conditions that explain why maintenance is done and how it is organized.

2 The Organization of Watercourse Maintenance

2.1 Watercourse maintenance: whose responsibility?

In the Canal and Drainage Act, 1873, it is stated that 'The Government is not responsible for the maintenance of the watercourse, but that it is the responsibility of those who use it, whether on existing Government, or private, land'. A watercourse is defined as 'any channel which is supplied with water from a canal, but which is not maintained at the cost of the Provincial Government, and subsidiary works belonging to any such channel'. The watercourse excludes the 'sluice or outlet' through which water is supplied to such channels.

Maintaining a watercourse is one of the main irrigation management responsibilities of the farmers. Since, normally, a group of farmers share the right to the water supply through the watercourse, maintenance becomes a group responsibility.

2.2 Watercourse maintenance and performance of the system

2.2.1 The need for maintenance at the watercourse level

The watercourse carries the water from the outlet to the farmers' fields, and is, therefore, of indispensable importance to irrigated agriculture. Researchers indicate the necessity for proper maintenance of the tertiary canals. Sediment, that is drawn along with the water from the parent channel, deposits on the bed and along the sides of the watercourse, resulting in distortion of the cross-section, and therewith, a reduction of its carrying capacity. The embankments of the watercourse need strengthening to avoid breaches and seepage. Furthermore, vegetation in the watercourse hampers the flow of water, leading to an inadequate discharge capacity (Skogerboe and Merkley, 1996).

The need (and thus also the amount of labor and financial input required) for watercourse maintenance depends on several factors. These may be the slope of the bed of the watercourse, whether the watercourse is lined, or unlined, the length of the watercourse, the amount of sediment in the parent channel, and the actual discharge at the outlet.

2.2.2 Farmers' perception of required routine maintenance

The need for watercourse maintenance is recognized by (at least most of) the farmers. During the annual canal closure, meant for maintenance of the major canals and water controlling structures, watercourses do not receive water from the parent channel. During this period, farmers have the opportunity to perform routine maintenance activities. Maintenance works, that farmers (would like to) carry out during the year, but especially during this period, are:

1. Cleaning of the main watercourse. This entails removing sediment (usually called silt) from the bed and sides of the official (main) watercourse and removing weeds from the official watercourse. In lined watercourses, with a good slope and a high discharge,

sedimentation is less, and due to this, less vegetation grows in the watercourse. Desilting and removing of weeds becomes, therefore, less important in these channels.

2. Cleaning the banks of the watercourse. Removing weeds and bushes from the banks of the watercourse. This maintenance activity was found to be important in all of the watercourses.
3. Repair of the banks of the watercourse. This includes filling of the banks in those watercourses where (e.g. due to high banks) earth eroded, and removal of silt from the banks in those watercourses where emergency maintenance made temporary deposition of silt on the banks necessary.
4. Repair and installation of *nakkas* along the main watercourse. This includes, repair, or replacement, of both, officially approved and unofficial *nakkas*, and *pakka* (concrete) and *katcha* (earthen) *nakkas*, that are found to be in a poor condition. Especially in the case of *pakka nakkas*, for its construction, there should be no water in the watercourse and, therefore, this maintenance can best be done during the annual canal closure.
5. Repair of the bed of the watercourse. Sometimes the bed of the watercourse is damaged, but it was not possible nor desirable, to repair it immediately. This work, then, is postponed until the annual closure period.
6. Construction and repair of culverts.
7. Desilting and cleaning of farmers' watercourses. Although this is regularly done by individual farmers during the year, it can be done more profoundly, and easily, during the canal closure period when the soil is dry.
8. Desilting of the parent canal. Some of the farmers mentioned that their village participated in the desilting of the distributary under the Chief Minister's Campaign a few years back. Although this is not maintenance at the watercourse level, the communities of the tertiary units were organized to perform this task.

Furthermore, farmers mentioned that the tasks of the Irrigation Department during the annual canal closure period 'on their watercourse' are: repair of the outlet and changing the size, or the type, of the outlet.

For several reasons, in this and the following sections, the main focus will be on the cleaning of the watercourse. Removing silt and vegetation from the watercourse is considered the most important maintenance activity in terms of its expected effect on the performance of the system.⁴ A second reason for selecting watercourse cleaning, as the main activity for further study, is that this is the maintenance activity for which the highest degree of organization is required and, therefore, most suitably recognizing the objective of this study. Furthermore, this specific maintenance activity lends itself best for the comparative analysis, since it is the only activity that is considered a collective activity by farmers from all of the sample watercourses.

⁴ In lined, relatively short watercourses, with a good slope and a discharge higher than as per design, this activity was found to be less important than in other watercourses, but still the main maintenance activity. Farmers from all sample watercourses recognize that a clean watercourse increases a smooth water flow and reduces the chance of overflowing of water in the head reach. This is especially the case when the fields in the tail are elevated.

2.2.3 *Comparison of the researchers' and the farmers' perspectives on required maintenance*

How much watercourse cleaning is desired, depends on a number of factors. A high discharge (wetted perimeter), low slope of the watercourse, long length of the watercourse, condition of the watercourse (improved or not), layout of the watercourse (curves) and number and condition of *nakkas*, are likely to increase siltation. This (and earlier mentioned factors) leads to higher conveyance losses and increases the need for watercourse cleaning. From the sections above, it becomes clear that the farmers' perception of the improvement in water supply after watercourse cleaning is similar to the researchers' perspectives on the necessity to transport water through clean watercourses. Hereafter, two case studies are presented to make a comparison between the farmers' and researchers' points of view. The first case illustrates the farmers' excellent knowledge about the condition of their system. The second case shows the effect of farmers' actions (in terms of watercourse cleaning) on conveyance losses and, thus, on the water supply.

Watercourse cleaning in 101-R Watercourse

For a more detailed analysis of the need for watercourse cleaning, the 'problematic areas' in one of the watercourses as indicated by the farmers, are compared with the problematic areas that could be indicated on the basis of a survey of the watercourse. The watercourse that has been selected for this is 101-R of Hakra 6-R Distributary. In this watercourse, one would expect low conveyance losses for the following reasons: the watercourse is relatively short (1.5 km); the slope is good 0.99m/1000m; 60% of the watercourse is lined; the density of *nakkas* per 100 m is low (1.0) compared to other watercourses. (However, only 44% of the *nakkas* were considered to be in a good condition.)

Two tail end farmers were asked about the 'problem areas' in the watercourse. Their answers are given in Box 1. On Map 4, the location of their land and the square, and field, numbers that they refer to, are indicated.

Box 1: Farmers' knowledge about the watercourse condition

Farmer 18 stated that the watercourse silts up more in Square 39 at Fields 15, 16 and 25. He gives the following explanation for this: up to Square 39, Field 25 the watercourse is *pakka*. The watercourse is *katcha* along Square 39. After the *pakka* watercourse, the slope of the watercourse decreases and, therefore, the silt settles down in the first reach of the *katcha* watercourse. Furthermore, three acres below the start of the *katcha* reach (at the end of Field 15), there is a *nakka*. Due to the *nakka*, the water level in this reach rises, which leads to silting up of the watercourse. Farmer 22 expressed the need to spend more time on desilting the reach 39/15,16,25. The reason he mentions is that the bed of the *pakka* watercourse is elevated compared to that of the *katcha* watercourse.

Another problematic reach in the watercourse that is mentioned by both farmers is situated in Square 25 at Fields 15, 16 and 25. This *katcha* reach is problematic because it is elevated. In this reach, there are many rat holes in the banks of the watercourse, as well as an abundance of weeds. Due to this, the watercourse sometimes breaches at this point, also having an effect on the water flow. Due to these reasons, they have to desilt that reach of the watercourse twice as often as the rest of the watercourse. Farmer 18 specifies that the watercourse along Field 5 in Square 39 overflows because here the bank is weak. When the water turn is in the tail, the water level rises, and the banks are not high. That is why the water overflows at that point.

Farmer 22 concludes that, overall, the slope of the watercourse has no problem.

Map 4. Layout and command area of 101-R Watercourse.

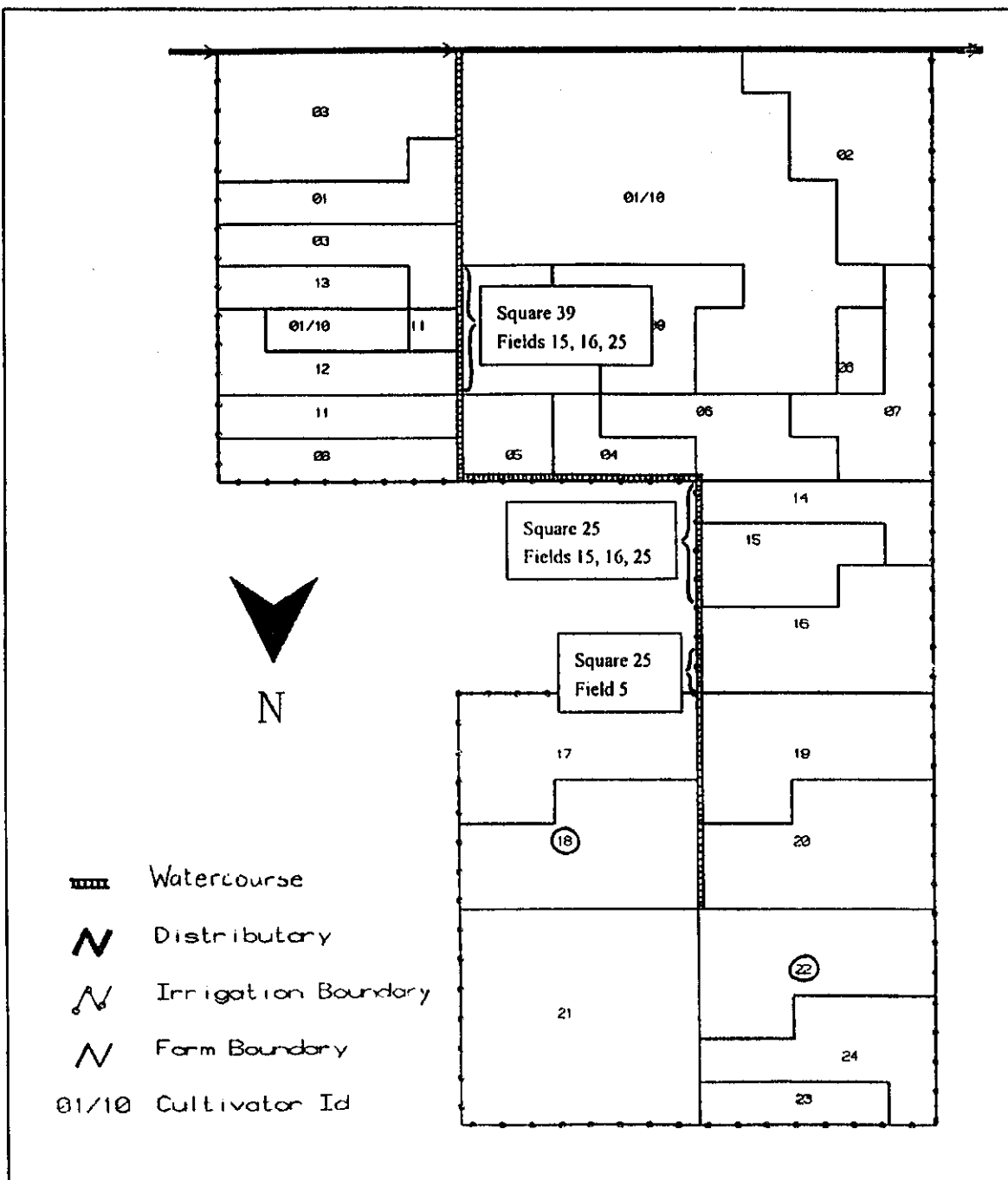
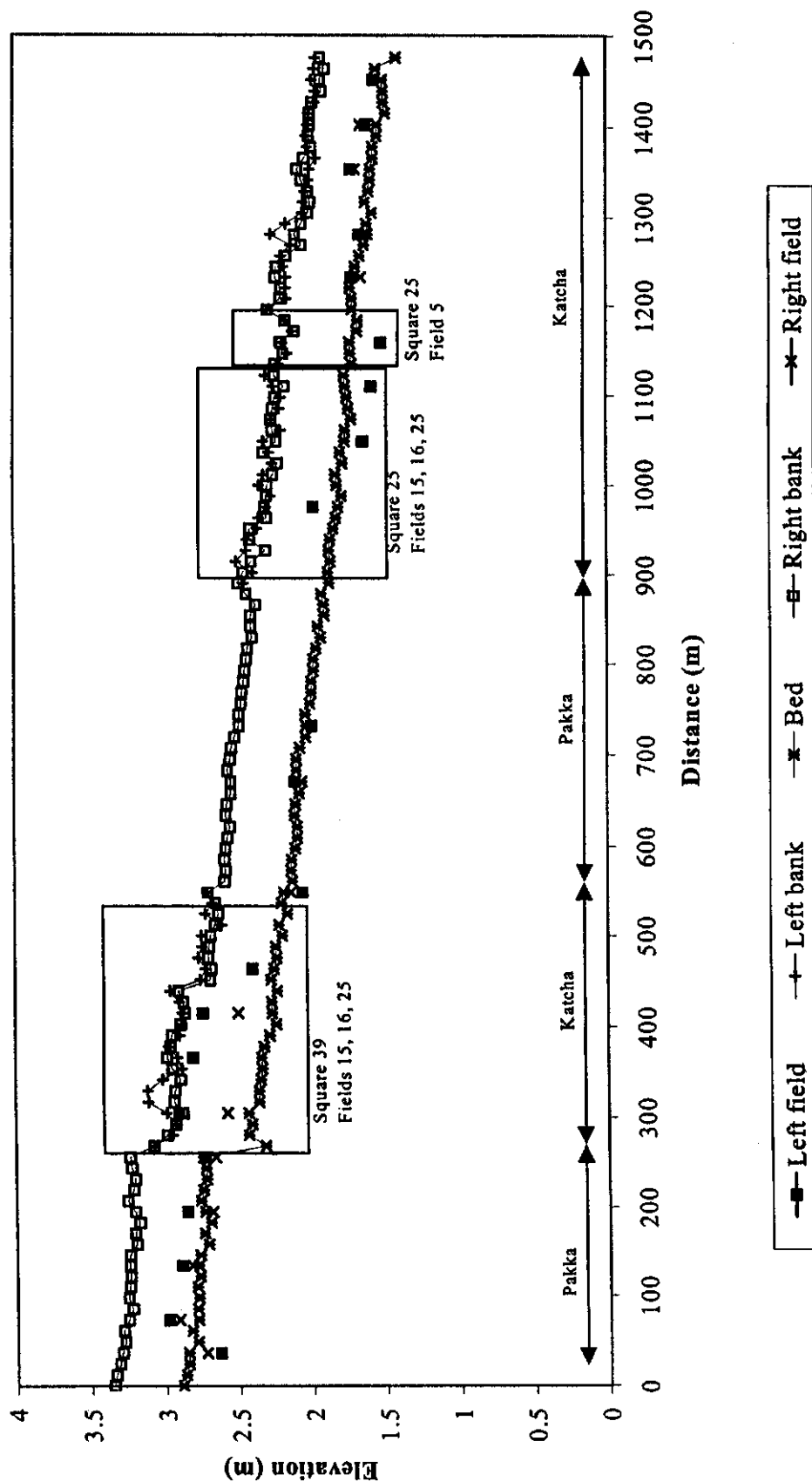


Figure 1 shows the slope of 101-R Watercourse from head to tail. These data on the bed, banks and field elevations coincide with, and support, the farmers' opinion about problematic reaches in the watercourse, their reasons and consequences.

Figure 1. Problem areas in a watercourse according to the farmers' and researchers' opinions.

Slope of 101-R watercourse, Hakra 6-R Distributary



Conveyance losses

The assumption is that conveyance losses will increase if the watercourse is not desilted. At a certain point, farmers will feel the need for desilting. This might be because they perceive that the conveyance losses have increased, or for any other reason, or expected effect.

An attempt was made to measure the conveyance losses before, and after, the desilting operations in the sample watercourses. For several reasons, this seemed to be a very difficult job. First of all, it is never known in advance when the farmers will clean their watercourse. Consequently, a watercourse might have been desilted without having measured the conveyance losses before the desilting operation. Secondly, and this will appear from the data below, conveyance losses have a strong positive correlation with the discharge at the head of the watercourse. Therefore, to indicate the relative change in conveyance losses, these should be measured at points in time when the discharge at the outlet is the same. Thirdly, in almost all of the watercourses that were observed for this purpose, farmers did not desilt the entire watercourse in one go, but in stretches spread over several days. Due to these reasons, the relation between conveyance losses and desilting operations is difficult to measure. Some of the findings are presented in Figure 2.⁵

Watercourse MD1-R

- No conveyance losses were measured before and after desilting; the last desilting was done in April 97.
- The graph shows that the conveyance losses are increasing with time at a very high rate. However, one factor that explains the conveyance losses, is discharge. The second time when conveyance losses were measured, the discharge was 70 % more than that of the first, which is a main factor in higher conveyance losses. Similarly, the discharge was more, or less, the same as the second one during the third conveyance losses test.

Watercourse MD 11-TC

- Again no conveyance losses' tests could be done before and after desilting, with the last desilting being done in May 97.
- The explanation of the graph is the same as for MD 1-R. During the second measurements, the discharge was almost half of the discharge during the first measurements. Therefore, the conveyance losses are almost half of what they were before.

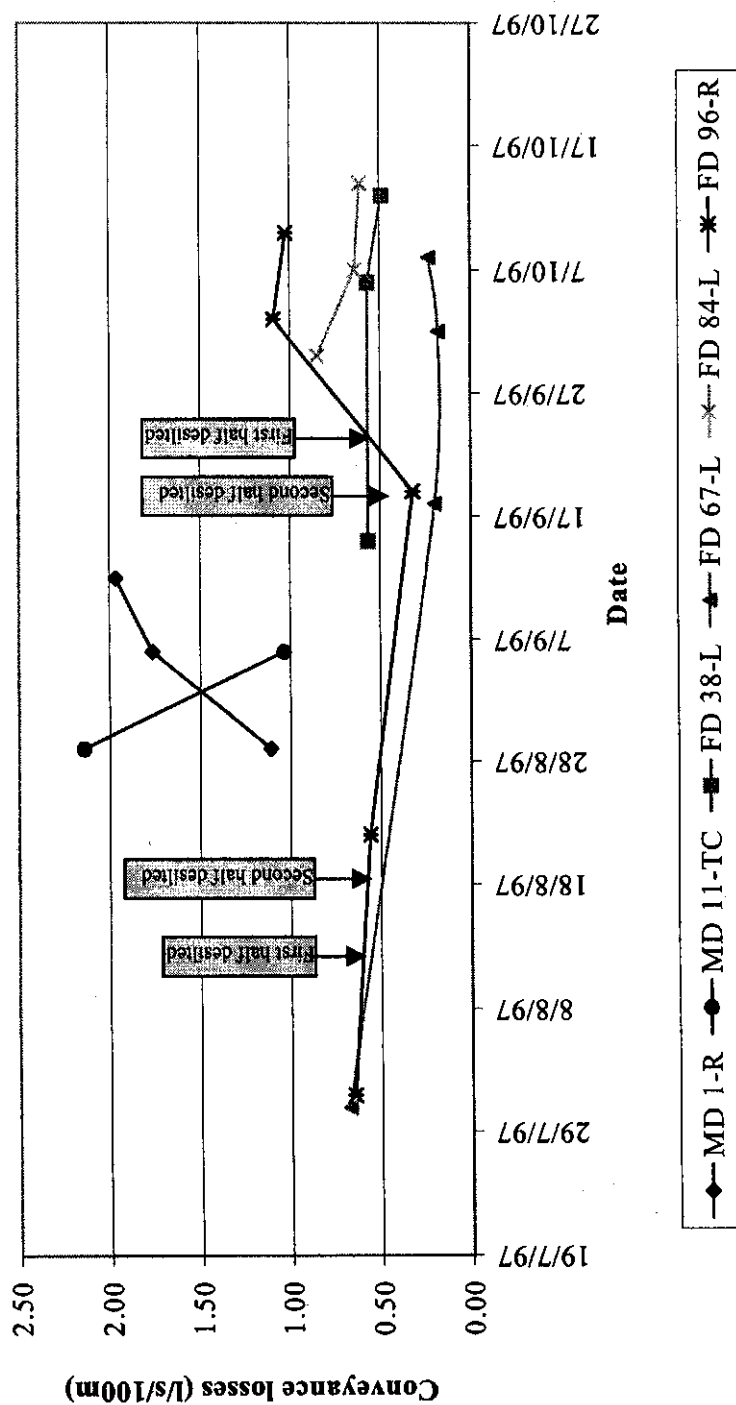
Watercourse FD 38-L

- FD 38-L is a very short watercourse, and most of the time the first acre is cleaned because of the fact that the watercourse is elevated. Silt deposition changes the flow condition at the outlet from orifice modular to submerged, which ultimately reduces the discharge to the watercourse. Therefore, farmers clean that one acre more often, and the influence of that cleaning is next to impossible to show in the conveyance losses.

⁵ Data on conveyance losses were collected by M.Jehangir, MSc student of the Water Management Department of N.W.F.P. Agricultural University, Peshawar (thesis forthcoming). The information presented here should be considered a preliminary analysis of some of the data.

Figure 2. Trends in conveyance losses in sample watercourses.

Conveyance Losses in the Sample Watercourses of Fordwah Irrigation System



Watercourse FD 67-L

- No desilting was done during this research period.
- The first time the conveyance losses were measured, many *nakkas* were leaking and the walls of the lined watercourse showed leakage/seepage. Moreover, farmers were not in need of water, and therefore, did not take care to strengthen the sides of the watercourse, nor to block leakage through their *nakka*. They would have done it if they needed water. The slight variation in the magnitude of conveyance losses is probably due to the different discharges.

Watercourse FD 84-L

- One measurement before and after desilting was taken, that is, for the second and the third conveyance losses' tests. Although the difference is not very obvious, the conveyance losses after desilting are slightly lower. This discharge at the head of the watercourse was higher during the third test than during the second.
- During the first conveyance losses measurements, farmers were not in need of irrigation water and several *nakkas* upstream had leakage.

Watercourse FD 96-R

- The 'first half' refers to that part of the watercourse that runs through the first 19 acres, which is approximately equal to 1216 meters, the second half refers to the watercourse in 13 acres, which is equal to 832 meters.
- Conveyance losses were measured before and after desilting.
- A decrease in conveyance losses can be seen between the first and second measurements. In between, both, the first and second reaches of the watercourse, were desilted. The conveyance losses were measured with the same discharge at the head of the watercourse.
- The first part of the line in the graph shows that the conveyance losses were reduced by 0.9 l/s/100m and the conveyance efficiency improved by 5% (from 42 to 37%) This 5% increase in irrigation water from the canal can make a significant difference to the tail end farmers.
- The third test shows very little conveyance losses because of two factors. Firstly, the discharge at the outlet was much less than before (84% of the earlier discharge). Secondly, this test was done just after a rainfall when the fields were saturated and less seepage occurred.

In conclusion, it can be said that due to difficulties in collecting the right field data, not enough evidence could be found to clearly indicate a correlation between an increase in conveyance losses and the performance of watercourse cleaning, nor between a decrease in conveyance losses after a desilting operation. Therefore, the farmers' perception that desilting leads to 'less water getting lost during transport through the watercourse' could not be compared with the researchers' findings.

2.2.4 *Farmers' motivations for performing different maintenance activities*

Planning and performing maintenance works evolves from expectations farmers have about the effect of specific maintenance works on the performance of the system. In most cases, this

concerns a direct effect on the physical performance of the irrigation system. Hereunder, the different maintenance activities and their expected effects are discussed.

Cleaning of the main watercourse

According to the farmers, removing silt and vegetation from the watercourse has the following consequences on the water delivery (see also Table 3):

- Velocity will increase⁶;
- Water will not be blocked;
- No wastage of water during transport; and
- Reduction in time to irrigate unit area.

Following from that, the (direct and indirect) effects that farmers expect from cleaning the watercourse are related to three different aspects of irrigation, as cited below.

1. Improved (more) water supply

- An increase in the discharge. Weed growth, or siltation, inside the watercourse occurs mainly in the head reach and this has a bad effect on the discharge. This is especially the case in unlined watercourses, which do not have much elevation difference and therefore, have a backwater effect on the outlet.
- An increase in irrigated area. They will get more water, and thus, more land can be irrigated when there will not be any silt, weeds and grass in the watercourse.⁷ If the discharge increases, farmers with elevated fields are more likely to be able to irrigate their lands.

2. Risk prevention

- Prevention of a breach in the watercourse. Silt and vegetation block the water flow. After cleaning, the water will flow easily and as a result, there will be less chance of a breach in the watercourse. This was mentioned by farmers of watercourses where the flow condition at the outlet is always, or sometimes, submerged.
- A reduction of the chance of a breach of *nakkas*. *nakkas* in the head reach tend to breach more easily when water is in the tail reach of a watercourse, where the water does not flow smoothly.
- A reduction of the chance of overflowing of water from the watercourse. This happens especially when farmers in the tail reach have their water turns, in a watercourse command where the lands in the tail reach are somewhat elevated.
- Prevention of any legal conflict. In case of a watercourse breach, the affected person can take this matter to court.

⁶ Interesting to mention is that farmers in FD67-L prefer not to clean the middle section of their watercourse, as they are afraid that an increase in the velocity will result in the concrete bed of the watercourse (which is not of a good quality) being damaged.

⁷ Information on increased irrigated area was not collected systematically. Field notes mention the following: One farmer, with 25 acres in the tail reach of the lined Watercourse H61-L, mentioned that he could irrigate 0.5 – 0.75 of an acre more if the watercourse is cleaned (time/acre allocation is 17 minutes per acre). A farmer in FD84-L mentioned that after a desilting, he is able to irrigate twice as much area that before desilting.

3. Convenience

- Facilitation of irrigation. Water that does not overflow is easier to handle. Less water will get lost.

The expected effects of watercourse cleaning in the different watercourses are given in Table 3.

Repair and installation of *nakkas*

Maintenance of *nakkas* is done for the following reasons:

- To mitigate damage to crops and land. In case of leaking *nakkas*, two parties suffer. Most of the damage is to the farmer whose turn it is, because he cannot irrigate with the full supply discharge. The second party that is affected is the farmer whose *nakka* is leaking, because water may damage his crops and land (in case he does not need that water).
- If *nakkas* are in a good condition, it is easier to change water turns.

Repair of banks

For a number of reasons, the farmers consider it important that the banks of the watercourse are in a good condition:

- To prevent overflowing of the watercourse and thus, loss of water and damage to crops and land.
- To make it easy and safe to walk along the watercourse to the outlet, which facilitates patrolling to see if there is a breach, or if water is overtopping, or being stolen
- When the banks are clean, rats will not damage the watercourse so much.
- To facilitate other maintenance works on the watercourse. If the banks are clean and strong, the desilting of the watercourse is easier.
- Strengthening of the banks secures the safety of the watercourse.

Repair of the bed of the watercourse

- Mitigation of the danger of a breach in the watercourse. This would harm both parties involved; the person whose water turn it is, and the person whose land will be flooded.
- Reduce, or stop, the leakage of water.

Culverts

- To reduce wastage of water. If carts and cattle cross the watercourse at a point where no culvert is constructed, that place becomes wider and water will be wasted.
- For convenience. Some farmers say that a culvert makes crossing the watercourse easier; instead of that it has a direct effect on water.

From the above, it is clear that, overall, maintenance activities are found to be necessary to ensure or improve, water deliveries in order to sustain, or increase, agricultural productivity. Furthermore, it is geared towards crop and land protection, as well as conflict prevention.

From the above, a number of factors that influence the necessity for maintenance, according to the farmers' perception, can be extracted. The main physical factors are: slope of the watercourse; whether or not the watercourse is lined; elevations of the fields; conveyance losses; discharge at

the head; and the present condition of the watercourse and subsidiary works, such as *nakkas* and culverts. A few 'non-technical' factors were mentioned. One is related to the legal context; namely, the fear of water users that during their turn a breach would appear and the affected person would take legal measures against him. The other one is maintenance with the aim to increase convenience.

Table 3. Expected effects of watercourse cleaning, watercourse-wise.

Watercourse	H7-L	H10-R	H45-L	H61-L	H101-R	H117-R	M1-R	M11-TC	FD38-L	FD67-L ¹⁾	FD84-L	FD96-R
Increase discharge at the outlet	X	X	X						X	X		
Prevent breach in w/c	X		X									
Smooth flow (prevent breach)	X	X	X	X		X			X			X
Get more water to the tail								X		X	X	X
More area irrigated	X	X		X			X	X		X	X	
Prevention of legal conflict in case of breach	X	X	X								X	
That water doesn't get lost during transport		X	X						X		X	X
To get more water		X		X	X (katcha)			X				
Prevent overflowing in head			X	X	X	X	X		X	X	X	
Increase velocity		X					X	X	X			
Prevent flooding of fields			X	X			X					

X = Mentioned by at least one of the shareholders.

¹⁾ The information of FD67-L is related to the time period before the watercourse was lined.

Source: Key informants (at least one per watercourse), farmers from head, middle and tail reaches (at least one for each reach) of each watercourse, and other field notes.

Although many of the expected effects mentioned in Table 3 can probably be related to each other (e.g. an easy flow leads to more discharge and it also reduced the chance of breach). In Table 3, the farmers' exact or "verbatim" answers are given. This is to ensure that the researchers' perception of cause-effect relationships does not prevail.

2.2.5 Indicators of the need for watercourse cleaning

Knowing the positive effects of watercourse cleaning, and actually cleaning the watercourse, are two different things. Recognition of the need for watercourse cleaning seems to depend largely on a number of immediate causes. In most of the watercourses, it was found that a cleaning operation

of the watercourse was not initiated until the effects of deferred maintenance became visible. The immediate causes or 'signs' that lead to the farmers' decision to clean the watercourse are:

- An abundance of grass and weeds inside the watercourse (in unlined watercourses), or when long grasses on the banks of the watercourse are hanging inside the watercourse;
- A high amount of sediment deposition in the watercourse;
- Silt obstructs the flow;
- Less area irrigated than when the watercourse is clean;
- Less water in the tail reach;
- Water is overtopping the banks of the watercourse; and
- A breach in the watercourse.

These immediate causes are a necessary, but often, in sufficient reason, for farmers to actually clean the watercourse. The main circumstance that influences the decision to clean the watercourse, mentioned by farmers in all of the watercourses, is the demand for water. If there is no demand for water due to the period of time during the growing season, or the condition of the lands (waterlogging), the concerned farmers have no, or less, interest in maintaining the watercourse. The water demand is especially high at the time of sowing of cotton and just before the start of the rainy season. Another related factor is rainfall. High rainfall in areas with a high groundwater table reduces the interest of farmers to clean their watercourse.

Even if the above conditions are met (i.e. certain physical indicators appear and there is a demand for water), the actual occurrence of a desilting activity is not guaranteed. For farmers to get organized for this activity, the timing also has to be convenient. A number of physical, agronomic and cultural aspects have an influence on the determination of the timing of desilting and may, therefore, explain why desilting still does not take place even if the above-mentioned conditions are met.

The day of the week. Normally, the watercourses are desilted in entirety, head to tail. Therefore, the best day(s) for the cleaning operation is/are, when the water turn is used by farmers in the head reach. In case a watercourse splits in two branches, the one branch can be cleaned when the water is diverted into the other branch and vice versa.

During annual canal closure. A few days before the water flows into the channel again. In those days, the soil is dry and this facilitates the cleaning process. Farmers do not clean at the beginning of the canal closure, because by the time the water will come again, the watercourse will again be filled with sand due to the passage of cattle, and leaves.

After annual canal closure. In tertiary units, where the groundwater is suitable for agriculture, tubewells are operated especially during the period of canal closure. Irrigators from these watercourses postpone the cleaning of their watercourse till after the closure period.

Outside the growing season. After the harvesting of wheat, because in this period the fields are empty, and the silt can be thrown onto the lands.

Rotation in the parent channel. In case the parent canal does not supply water continuously, farmers prefer to clean their watercourse in those days, because there is no water in the watercourse and the silt is dry. Especially in watercourses that have just one branch, it is difficult to clean the watercourse without closing the outlet and some farmers might miss their water turn.

Ramzan. During this time of fasting, it is not easy for farmers to do much physical labor. The cleaning activity will be postponed till after the celebrations at the end of *Ramzan (Eid)*.

Marriages and deaths. In watercourses where the majority of the shareholders belongs to the same caste, organizing a desilting activity at the time of a marriage, or death, ceremony would lead to an unacceptable high number of absentees and will, therefore, be postponed.

2.2.6 Frequency of watercourse cleaning

In Table 4, the number of cleaning operations is given per watercourse. A distinction is made between the required frequency, which is based on farmers' opinions, and the actual number of cleanings. Information about the latter is obtained through field observations and farmers' interviews. The number of times a watercourse is cleaned varies from 1 to 12 times per year.

In unlined watercourses, or branches of watercourses, the necessity for frequent watercourse cleaning is higher than in watercourses that are fully lined. In unleveled, unlined watercourses, there is more need for regular cleaning than in leveled unlined watercourses.

Desilting, especially of the head reach, is also required more in the case where the outlet is installed too low, because then it draws more silt from the parent canal. Farmers of H45-L Watercourse mention that in earlier days the outlet was installed too low and, therefore, they had to clean their watercourse after every 8 to 15 days and the head reach (2/3 of the first square) every 8 days. They contacted the overseer and SDO of the Irrigation Department and paid them Rs 1000 to have the pipe installed somewhat higher. Now, the outlet draws less silt and desilting only needs to be done after every month.

During *kharif*, there is more need for watercourse cleaning than in the *rabi* season. According to the farmers, this is due to a higher amount of silt in the canal water, more weed growth due to more sediment in the channels, and a higher demand for water.

Table 4. Required and actual number of cleaning operations in sample watercourses.

Watercourse ,	Lined / unlined	Average required number of desiltings per year	Actual number of desiltings per year	Before lining ¹⁾
H7-L (East&West branches)	Unlined	6	4	N.A.
H10-R	Lined	3	2	26
H10-R katcha reach	Unlined	17	12	N.A.
H45-L	Unlined	12	1-2 ²⁾	N.A.
H61-L	Lined	3-4 ²⁾	2	12-52 ³⁾
H101-R	Partly lined	2	2	26
H117-R	Lined	1-2 ²⁾	1 ⁴⁾	17
H117-R katcha branch	Unlined	6	6	N.A.
MD1-R	Partly lined	9	4	Not available
MD11-TC	Partly lined	9	3	Not available
FD38-L	Unlined	9 ⁴⁾	7 ⁵⁾	N.A.
FD67-L	Lined	0	1	26
FD84-L	Unlined	4	4	N.A.
FD96-R	Unlined	6	5	N.A.

- 1) N.A. means not applicable, because the watercourse or branch is not lined.
- 2) In the summer every 7-8 days and in winter every month.
- 3) For Figure 3 the average of these numbers is taken.
- 4) This is only cleaning of the banks; there is hardly any silt to be removed.
- 5) The head reach needs to be (and is) cleaned more often. This is included in this figure.

Figure 3 illustrates the gap between required and actual watercourse cleaning according to the farmers' views.⁸ The authors opined that they were not able to draw the line for required maintenance from the researchers' point of view, since the different factors influencing conveyance losses and the need for maintenance are many, and their weights differ. Besides, the conditions at the individual field level were insufficiently known to make an estimation of the exact number of required desilting activities. Furthermore, in the literature it was not found how many times a watercourse, having certain characteristics, needs to be cleaned. Mirza and Merrey, who studied the condition of watercourse maintenance just before the On-Farm Water Management-I program took off, state that farmers maintained their watercourses badly (Mirza and Merrey, 1979). Their assumption, on which much of their report is based, is based on one-time field observations. Time and staff limitations did not allow them to measure water losses in the watercourse, and they do not indicate how many times a watercourse should be cleaned to keep it in good shape, or how many times farmers actually clean their watercourse. Therefore, it seems more worthwhile to rely on the farmers' view. The numbers given in Table 4 are based on the answers of several respondents from the head, middle and tail reaches from each watercourse or branch.

From Figure 3 it can be seen that, in most of the watercourses, the number of actual times the watercourse is cleaned, from head to tail, is lower than the number of times farmers say their watercourse should be cleaned. This means that even if the effect of maintenance is recognized, the watercourse requires desilting, and the time seems right, there are some other factors influencing collective action for maintenance. Possible reasons for this will be discussed in a later section.

Whether or not a watercourse is lined, is one of the main factors influencing the (required) frequency for watercourse cleaning. Farmers from lined watercourses say that the main reason for having the watercourse lined was an expected decrease in the need of watercourse desilting. The relation between watercourse improvement (lining) and frequency of cleaning is illustrated in Figure 4. Watercourses that are 100% lined, need to be desilted less frequently. From Table 4, it can also be seen that (reaches of) the watercourses with a relatively high desilting frequency have been lined.

⁸ Farmers have mentioned that there is maintenance work other than watercourse cleaning that should actually be done, but is lagging behind. Since this report focuses on watercourse cleaning only, other deferred maintenance is not dealt with.

Figure 3. Farmers' perceptions of the status of deferred watercourse maintenance.

Status of deferred maintenance in sample watercourses

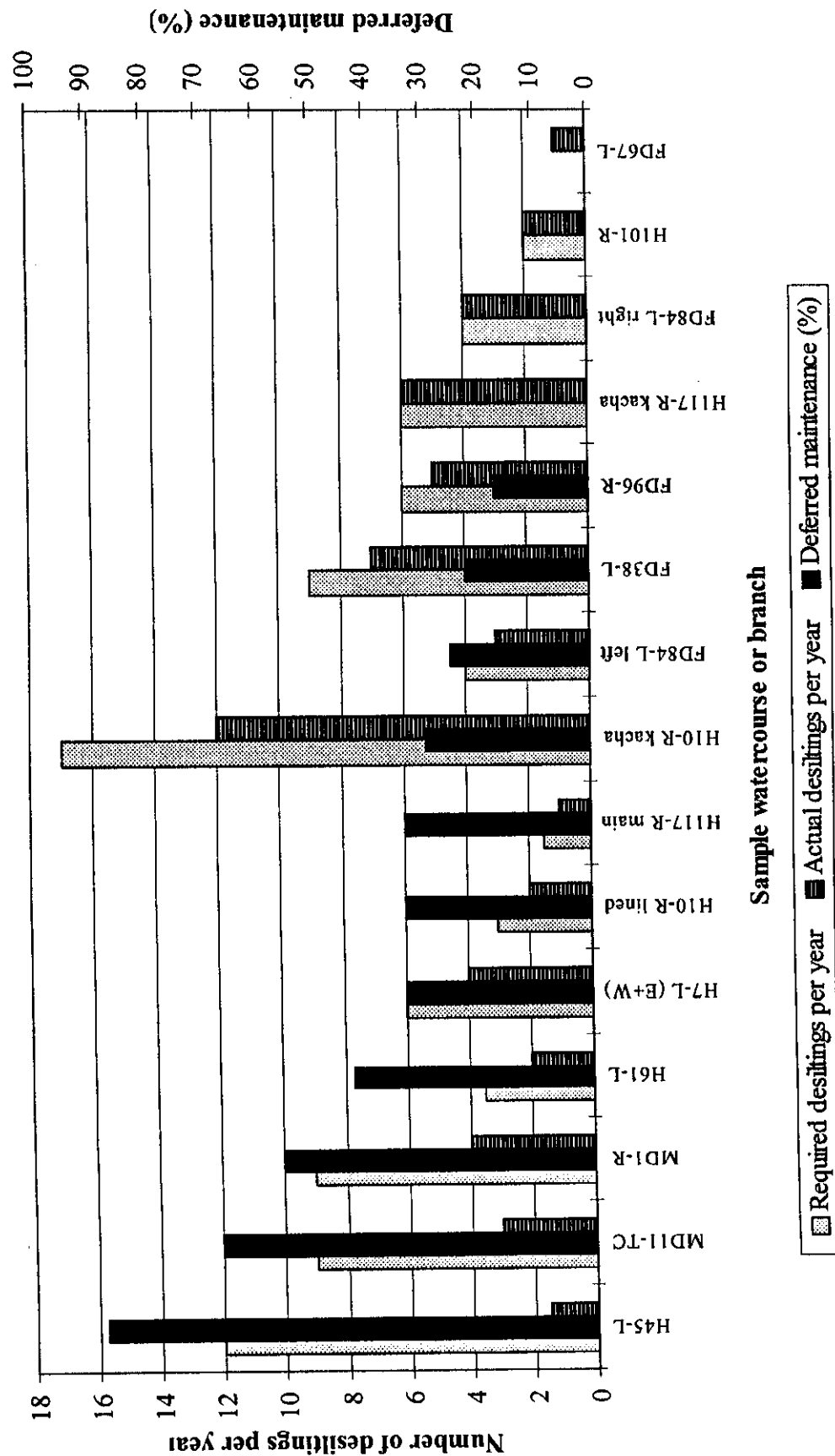
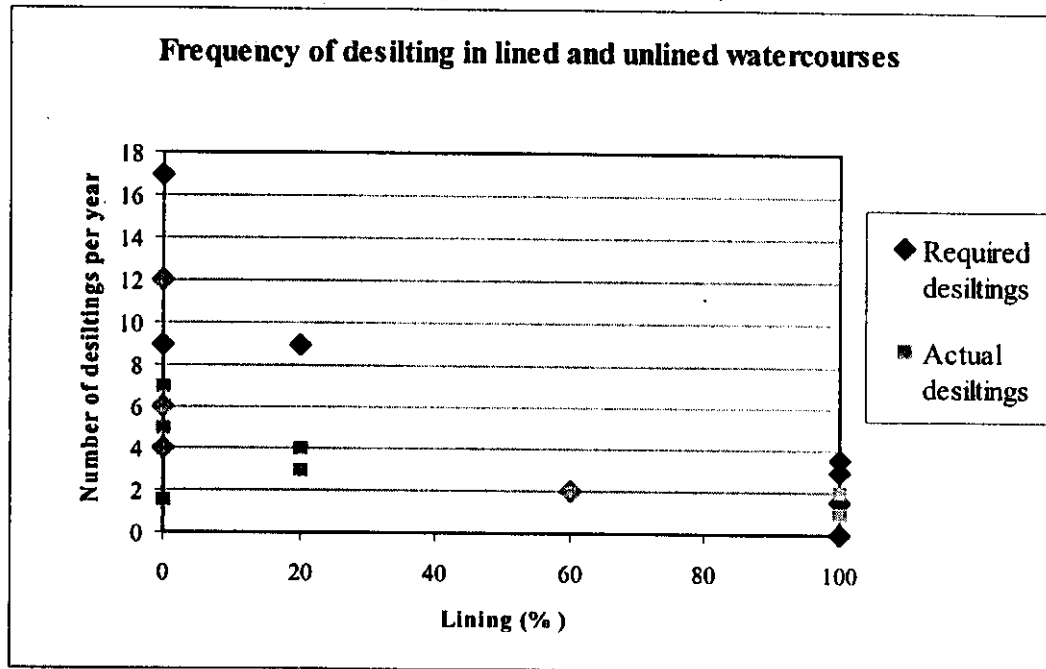


Figure 4. Frequency of desilting in lined, and unlined, watercourses.



In none of the cases, watercourse cleaning is institutionalized⁹ to such an extent that farmers clean their watercourse when it was not really necessary. An exceptional case, however, is FD67-L. Here, the farmers removed the farmyard manure that normally falls into the first portion of the watercourse, after they had decided to have their outlet enlarged to increase their discharge. Normally, they prefer not to clean their watercourse, in order to keep the velocity low (see Section 2.2.4).

Factors other than the percentage of lining seem to have an influence on frequency of desilting, such as the slope of the bed and the length of the watercourse. Unlined FD96-R has a good slope (0.93m/1000m) and therefore needs to be cleaned only 6 times per year, which is below average for unlined watercourses. The unlined branch of H117-R, on the other hand, is only 600 m in length. Why FD84-L needs to be desilted only 4 times per year according to the shareholders, cannot be explained by the data, as it is unlined and has a very low slope.

None of the watercourses have a fixed time schedule for cleaning of the watercourse. Even though all the farmers claimed that they would desilt the watercourse during the annual canal closure, in many cases, it was postponed until after this period. Still, it could be said that, up to a certain level, cleaning of the watercourse is a maintenance activity that is institutionalized. When asked about the number of cleaning operations per year, some farmers answered that they would do it if there would be a need, but many farmers referred to a certain schedule, such as: during annual canal closure, after every 3 water turns, after every 21 days, and 6 times per year. Clearly, however, institutionalization of this maintenance activity follows the physical necessity for the performance thereof. Even after the lining of the watercourses, farmers did not continue to clean their watercourse according to the old schedule, but adapted and again institutionalized a new pattern.

⁹ 'Institutionalization' is here defined as: the process, as well as the outcome of the process, in which social activities become regularized and routinized as stable, social-structural features.

In watercourses with several branches, farmers that have their *nakkas* from the smaller branch, participate in desilting their own branch, as well as that of the main branch, starting from the *mogha* up to the point where their own branch takes off. Most of the time, the smaller branches are desilted around the same time (on the same day, or a few days before, or after) as the main watercourse. In this way, farmers from the smaller branches benefit most from their cleaning efforts. Normally, the smaller branches are unlined and require more frequent cleaning. Therefore, these branches are also cleaned independent from the main branch.

On one watercourse, having two branches that serve two different villages, desilting of one branch is done separately, though not independently from the other. At one time, one village organizes a desilting activity and cleans the head reach that is used by both villages. The next time, the other village desilts its watercourse and also takes care of the head reach. In that way, the first 200 feet of this watercourse, which is unlined and prone to sedimentation, is desilted regularly. This illustrates collective action between two villages sharing the same outlet.

2.2.7 Leadership in initiative-taking

Anyone who feels the need to desilt the watercourse, can take the initiative to mobilize all the concerned shareholders for a cleaning activity. In practice, this normally means that it is the tail end farmers who indicate that the desilting of the watercourse is needed. In most of the watercourses, this person, then, will consult with other farmers about whether the watercourse should be cleaned or not. So, the final decision to clean the watercourse is a group decision. In some watercourses, or branches of the watercourse, where normally, one or two persons are known as initiative-takers, the decision is taken by the individual, without consultation of others. Only one watercourse was found where it is always the same cultivator who takes the initiative and who always consults with others about the organization of the desilting activity. The other persons in this case are the representatives of the main sub-castes in the watercourse.

In each watercourse the situation differs and therefore, the person who takes the initiative, or is expected to do so, has different characteristics. The attributes that an initiative-taker has, or is expected to have, are mentioned, watercourse-wise, in Table 5.

Table 5. Attributes of initiative-takers for watercourse cleaning (mentioned by the shareholders).

Attributes of the initiative taker	H7-L	H10-R	H45-L	H61-L	H101-R	H117-R	MD1-R	MD11-TC	FD38-L	FD67-L	FD84-L	FD96-R
He is the actual cultivator (OC/LT)	X	X	X	X	X	X	X	X	X	X	X	X
He has land at the tail	X			X	X		X	X	N.A.	N.A.	X	X
His fields are elevated				X		X			N.A.	N.A.		
His land is in the head reach, so his field are in danger if a breach occurs		X								N.A.		
He faces problems in water supply	X		X		X			X	N.A.	N.A.		
He (his family) has been an established a leader for a long time			X	X				X	N.A.	N.A.		
He is able to organize a collective activity and can make sure that all shareholders participate			X	X		X		X	N.A.	N.A.	X	X
He is an elder, respected by the people, with good public dealing. He has good relations with the other shareholders of his branch		X						X		N.A.	X	X*
He has a lot of land, so that the benefit for him is high		X		X						N.A.		
He lives in the village where most of the shareholders live		X					X	X	X	N.A.	X	X
He feels responsible and realizes that if he does not take up this task, no one else will, and as a consequence, everyone will suffer			X				X	X		N.A.	X	X
He is a representative of his sub-caste in the watercourse		X					X	X		N.A.	X	
He is active in other work on the watercourse		X		X						N.A.	X	X
He is willing to spend some extra time and does not expect any compensation			X					X		N.A.	X	X
He realizes he gains prestige and honor by playing this role				X				X		N.A.	X	
He normally does it		X								N.A.		
He went abroad					X					N.A.		
Is knowledgeable about division of work		X								N.A.		

* One of the initiative takers is an older person; the other one is not an elder, but has good public dealing.

Certainly, the ideal initiative-taker, having all the attributes cited in Table 5, does not exist. In practice, one, or a few, of these characteristics might be enough for people to consider themselves, or someone else, as a leading person in taking the initiative. The initiative takers in the 12 sample watercourses are mentioned in Table 6.

Table 6. Persons responsible for taking the initiative for watercourse cleaning.

Watercourse or branch	Cultivator Identification Code of person who takes the initiative¹⁾	Tenure status of this person in sample watercourse²⁾	Location of the land of this person
H7-Least	CID01 CID02/19/21 CID04 CID10 CID12/15 Anyone who faces problem	OC T OC L OC/L	Head Head/Middle/Tail Head Tail Middle/Tail
H7-Lwest	CID24/36 CID26 CID27 CID31/33 CID34 Anyone who feels need	OC/L/T OC OC OC T	Middle Middle Middle Middle/Tail Middle
H10-R ³⁾	CID01 CID14/26/32/39 (1) CID17/47 CID42 CID46 CID65 CID69 CID70 (1) CID80 Anyone	OC OC/T OC OC T T OC OC OC	Head Head/Middle Tail Tail
H45-L	CID38/61 (1) CID26 (always with CID38/61) No one ⁴⁾	OC OC	Middle Middle
H61-L	CID18/33 CID30 CID35 (1) CID42 (for tail reach) Anyone	OC OC OC/T [L?] OC	Middle/Tail Tail Middle/Tail Tail
H101-R	CID07 (2 nd small branch) CID17 CID18 CID20 CID21 CID24	OC OC/L OC T T OC	Middle Tail Tail Tail Tail Tail
H117-R main branch	OID18 OID19 OID24 CID36	Owner Owner Owner OC	Middle Middle/Tail Tail Tail
H117-R katcha branch	CID03	L	Head

MD1-R main branch	CID01 CID49	OC/L OC	Tail/Head Head
MD1-R right branch	CID22 CID26	OC OC	Middle Middle
MD1-R left branch	CID43 CID09	OC OC	Tail Tail
MD18-TC	CID54 CID14	OC OC	Tail Head
FD38-L	CID1	L	
FD67-L	NA	NA	NA
FD84-L Main	OID49 ⁵⁾	Owner	Tail of right branch
FD84-L right branch	CID53 OID49 CID53 CID15	OC/T Owner OC L/T	Head of right branch Head Middle
FD84-L left branch	CID14 CID56	L OC	Tail/Head Middle
FD96-R	CID06 CID18 CID08	OC/L/T OC OC	Head/Middle Tail Head

¹⁾ The number in brackets after the farmer's name indicates the preference farmers have to let this person arrange the work division.

²⁾ OC stands for Owner Cultivator; T for tenant (sharecropper); L for lessee (who takes land on rent).

³⁾ For two reasons, the list of persons is long. The watercourse has several branches that are (sometimes) cleaned independently and for which there are separate initiative-takers. The second reason is that there are two opposing groups in this watercourse, who each mention the names of their own persons as being the initiative-taker. From this, it can be concluded that taking the initiative for watercourse cleaning is something with which respect ('izzat') can be gained. Both the groups belong to different villages.

⁴⁾ This watercourse is characterized by factions and recent conflicts, due to which the organization of watercourse cleaning is difficult. Most of the farmers acknowledge that CID38/61 always takes the initiative. The farmers in the head reach, who belong to the other group, and from which it is known that they deliberately do not participate in desilting, says there is no one in the watercourse who can motivate all of the farmers (i.e. they do not recognize the authority of CID38/61).

⁵⁾ He is an exception, since he is an owner (share-cropper) but still takes the initiative for desilting activities.

The tasks of the initiative-taker are (watercourse-wise) given in Table 7. To decide on which day the desilting is going to take place is a task that is mentioned in all of the watercourses. To inform the *chowkidar* (village messenger) or *begari* (peon of the *numberdar*) about the date of desilting, and to arrange an announcement is also mentioned in all of the watercourses. It was noted that, in some watercourses, it was noted that the role of the *chowkidar* is considered more important than in others (e.g. in H61-L). To see who the absentees are, and to try to motivate them to come, is a task in some of the watercourses. Supervision of the work is sometimes done by the initiative-taker, and in some cases, by the person who is also selected to allocate the work during the cleaning activity.

Table 7. Tasks of initiative-takers for desilting activities.

	Decide day	Take decision to desilt the watercourse and day together with others	Arrange announcement	Note and motivate absentees	Divide and supervise the work
H7-L East+West	X	X	X		
H10-R	X	X ¹⁾	X		X
H45-L	X	X (representatives of sub-castes)	X	X	X
H61-L	X		X	X (depends on initiative taker)	
H101-R	X	X	X		
H117-R	X	X (2 leaders among themselves)	X		X
MD1-R	X	X	X		
MD11-TC	X	X (leaders among themselves)	X	X	X
FD38-L	X	X	N.A.	N.A.	N.A.
FD67-L	N.A.	N.A.	N.A.	N.A.	N.A.
FD84-L	X	X	X	X	X
FD96-L	X	X (leaders among themselves)	X	X	X

¹⁾ It depends on who takes the initiative. If CID70 decided there should be a desilting, others will follow without any discussion.

Upon monitoring maintenance activities for around one year in the twelve watercourses, it was found that the total number of initiative-takers per watercourse varies substantially. For each branch of the watercourse, the figure varies from one to five. The number of leaders and the number of consulted people depends on several physical and social factors, or a mixture of both. These are:

1. The layout of the watercourse. If a watercourse consists of a number of branches that are sometimes cleaned independently from the main branch, the number of initiative-takers is higher.
2. Topography and layout of the watercourse. If there are big differences between head and tail end farmers, in terms of facing difficulties with water delivery, the initiative-taker is often not a specific person, but 'anyone from the tail reach'. This is especially the case if fields in the tail reach are elevated.
3. Tradition. A family is known for taking the initiative for desilting for a long time. Sons take over this task from their fathers.
4. Earlier experiences. People have become proven leaders.
5. The amount of labor required for desilting the watercourse. The more laborious it is to desilt the watercourse, the higher the chance that more than one person is involved in taking the decision to arrange this activity.

In conclusion, it can be said that in most of the watercourses, shareholders expressed the need for (or appreciated the presence of) a leader to take the initiative and mobilize people for desilting. In some extreme cases, it was said that the work would not be done if there would not be a leader (e.g. in H45-L). In almost all of the watercourses, leading persons were found. In general, the decision of the initiative-taker is respected by others, and followed up.

H61-L is the only watercourse where farmers say that there should be a leader, and where they agree that they have a leader. The remark 'there is always a leader in every watercourse' even implies that they cannot imagine that in some watercourses there is no leader. In H101-R, shareholders say that there is no leader and that also they do not need a leader for desilting. Before they shifted from *katcha* to *pakka warabandi*, one of the shareholders took the lead in several water management activities, but nowadays they 'don't need him anymore'. Organizing the desilting activity is also easier now that the watercourse is lined. Before that, it was such a laborious job, that it was difficult to motivate people. In H117-R, the main watercourse hardly needs any cleaning. Here, the farmers say that nowadays, it would be difficult to organize such an activity, since farmers want to live in comfort. They are not used to very hard work anymore. Everyone wants to be a 'Chaudary' (leader) and if everyone is a leader, then who will work?'

2.3 The procedure for division of the work

2.3.1 Rules for allocation of the work

Although the Canal and Drainage Act (1873) states that the irrigators of a watercourse are responsible for its maintenance, it does not prescribe, in any way, how this should be done. This is a clear example of the fact that the watercourse (below the outlet) is the domain of the shareholders, and in principle the Irrigation Department does not interfere here (see also Section 2.6 on rule enforcement and Annex 2).

The irrigators have developed, over time, the rules and procedures for work at the watercourse level. Farmers in the sample watercourses of Fordwah and Mahmood Distributaries state that the procedure of work division, as it is practiced now, dates back to the beginning of irrigated agriculture in the area. At that time, land was still irrigated by inundation canals. Farmers in Hakra 6-R Distributary utter that the procedure for dividing the work is the same as was introduced by their elders at the beginning of the irrigation system (which was commissioned in 1928). Although the procedure for allocating the work does not change much over time, from this section, it will become clear that rules can, and will, be changed if desired so.

Farmers take part in cleaning that part of the watercourse through which the water has to travel to reach their fields (i.e. from the outlet up to their *nakka*). In principle, all farmers start from the head of the watercourse and work together up to the *nakka* from where the first farmers take their water. Downstream of that point, the group of participants becomes smaller, until at the tail, only those who take water from the last *nakka* remain.

Since the cleaning of the watercourse is done from head to tail, the division of the work starts at the outlet (or, in case of cleaning of a branch, at the beginning of that branch). At the head of the watercourse, or branch, all of the shareholders using that channel participate. The length of the channel from that point, up to the point where the first farmers take their water turn, is divided

among all the shareholders. This is called the first cycle¹⁰. The second cycle starts at the point where the first farmers dropped out, and continues till the *nakka* point where the next farmers take their water turn. If there is still watercourse length remaining after allocation of stretches to all of the shareholders, a second cycle may start before the next splitting point. The number of cycles depends on the number of 'splitting points' and the length of the channel between two splitting points. The persons that take water from the last *nakka* point have to participate in each cycle. Their effort is not remunerated in the form of compensation for workload in each cycle. Therefore, they have to work more. The total length of the cycle is divided into stretches ('*takki*' in Punjabi); one stretch for each shareholder. Details on the different basic rules being used are given in Table 8.

¹⁰ Sometimes a cycle does not end at a *Nakka* point, but after stretches have been allocated to all the shareholders and a new cycle can be started. In that case some farmers may drop out in the middle of a cycle, because they have reached their *Nakka*.

Table 8. Basic rules for the allocation of work for watercourse cleaning.

Watercourse ¹⁾	Basis for labor input	Share	Since	Location of stretches fixed	How location of stretch decided?	Shareholders expected to work at same time?
H7-L-east	Land holding size	8 <i>karam</i> / square (6 in first square, b/c of more silt)	Beginning of canal irrigation system	No	According to <i>warabandi</i> turn ³⁾	Yes
H7-L-west	Land holding size	4 <i>karam</i> / square	Beginning	No	According to <i>warabandi</i> turn	Yes
H10-R	Land holding size (if there is not much work to do, they do not make a division)	3 <i>karam</i> /square (10R ^{new}) 1 stick(<i>kan</i>)/square in head, rest 2 sticks 4 <i>karams</i> decided at spot (old) ²⁾	Beginning of agriculture	No	According to <i>warabandi</i> turn	Yes
H45-L	Land holding size	2 <i>karam</i> /square	Beginning	No	According to <i>warabandi</i> turn	Yes
H61-L-small branch	Land holding size without division	N.A.	Since long (but they want to change)	No	N.A.	Yes
H61-L main branch	Land holding size	Depends on the reach (0.5 to 5 acre/square)	Long time. Introduced by their elders.	Yes	N.A.	No, not needed. Before water comes.
H101-R	Land holding size According to duration of water turn	18 <i>karam</i> / square or 1 <i>karam</i> / 1 hour of water turn	Beginning	No	According to <i>warabandi</i> turn	No, once they know share, they can do it (before water comes)
H117-R main watercourse ³⁾	No division	N.A. (1 <i>kan</i> for 3 hours water turn, before lining)	Lining. Before: on the basis of water turn duration (related to land holding size)	N.A.	N.A.	Yes
H117-R <i>katcha</i> branch	Land holding size	4 <i>kan</i> / square (where <i>kan</i> is defined as 'stick of any size')		No	According to <i>warabandi</i> turn	Yes

Watercourse ¹⁾	Basis for labor input	Share	Since	Location of stretches fixed	How location of stretch decided?	Shareholders expected to work at same time?
MD1-R	Biraderi and land holding size	1 <i>kanah</i> / square	Since the beginning of the system	No	According to <i>warabandi</i> turn	Yes
MD11-TC	Land holding size	1 <i>kanah</i> / square	Since the beginning of the system	No	According to <i>warabandi</i> turn	Yes
FD38-L	Land holding size and water turn	Till 6.5 acres both farmers do equal work with rotation. After that CID2 cleans the rest of 11.5 acres.	Since the beginning of the system	No	<i>Warabandi</i> turn, but not considered applicable, because they are only 2 farmers.	Yes
FD67-L ²⁾	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FD84-L	Land holding size, according to duration of water turn.	1 <i>karam</i> / hour	Since the beginning of the system	Right: No Left: Yes	Right: According to <i>warabandi</i> turn Left: Fixed	Right: Yes Left: No
FD96-R	Land holding size, according to irrigation turn	1 <i>karam</i> / hour	Since the beginning of the system	No	According to <i>warabandi</i> turn	Yes

¹⁾ When no distinction is made between different branches, or reaches, of the watercourse, the procedure is the same as for the whole watercourse (except maybe for a few very small stretches in which only a few farmers participate, and for which detailed information was not collected, or analyzed).

²⁾ Many different answers were given in the case of 10-R Watercourse. More than in other watercourses, it was said that the actual division of work is discussed and decided upon by the shareholders at the time of desilting.

³⁾ These watercourses need not to be desilted.

In all of the 12 watercourses (or at least part of the watercourses) the work is allocated to the shareholders on the basis of their land holding size¹¹. In other words, according to the land holding size, certain lengths of the watercourse are allocated to the different shareholders for cleaning. In exceptional cases the work division is expressed in terms of water turn duration, and in terms of 'number of laborers delivered'. The procedure for appointing the exact stretch each shareholder has to clean, is not the same for all of the watercourses. The main pattern, which was found in 10 of the 12 watercourses, will be described here extensively. Figure 5 shows the details of the allocation of work in H101-R Watercourse during one desilting activity, and represents the process in this, and in the other watercourses, very well. Map 5 displays the layout of 101-R Watercourse, showing the watercourse, off-take points from farmers' field channels (*nakkas*) and the location of the squares. At the end of this section, the other method (which was found in 2 of the watercourses) will be described briefly, as well as possible explanations why the pattern is different.

The length to be cleaned is normally expressed in *karam*/square. One *karam* is equivalent to 5.5 feet. If, in a certain watercourse, the allocated work is 2 *karam* per square, it means that a farmer with 1 square of land has to desilt a length of 2 *karam* (11 feet) in each cycle in which he participates. A farmer with 12.5 acres of land (half a square) has to clean 1 *karam* in each cycle, and someone with 50 acres, 4 *karam*. In the sample watercourses, the lengths of stretches to be cleaned varies from 2 *karam*/square to 8 *karam*/square. In one of the watercourses, where the *kachchi warabandi* is still operational, the stretches are allocated on the basis of water turn time, i.e. 1 *karam* per 1 hour of water turn. Since the water turn time is based on the land holding size (except for those farmers who received extra time for orchard or garden), the basic principle is the same. The lengths to be cleaned are not expressed in *karams* in all the watercourses. In the sample watercourses in the Punjab, where all the land is split into squares and acres ('*killas*'), the acre is not only used as a square measure, but also as a longitudinal measure¹². Therefore, in some watercourses, the lengths to be cleaned can, and are, also expressed in acres. Another longitudinal measure that is being used in some of the watercourses is a so-called '*kan*'. The definition of *kan* given by the farmers from one watercourse is 'a stick of any length just made, or acquired, at that time by any shareholder'. The allocation in one of the watercourses is 4 *kan* per square in one branch, and 1 *kan* per 3 hours of water turn in another branch. In another watercourse, where the lengths are measured in *karams*, the '*kan*' is used as a tool to make equal parts, and here the *kan* needs to have a length of 4 *karams* (22 feet). Another tool to establish equal lengths can be to make steps along the watercourse, and here, 2 steps are equal to 1 *karam*.

The length of that stretch is dependent on the size of the command area of that watercourse, or branch, the length of the channel, the number of shareholders, and sometimes, on the amount of silt in the canal. In 7-L Watercourse, farmers report that the number of *karams* per square is lower in the head reach of the watercourse where there is more silt, so that everyone will have a share in it, and can pay proper attention to it since it is not too big. Another advantage of smaller stretches is that all of the shareholders of that branch can participate, instead of when the stretches would be the normal length (i.e. now all the farmers fit into one cycle).

¹¹ The same procedure was found by Malhotra in North India (Malhotra, 1988).

¹² One acre is equal to 8 *kanal* (both in latitudinal and longitudinal measures), with one acre having a length of 198 feet (if measured from north to south), or 220 feet (if measured from east to west).

Figure 5. Actual division of work for watercourse cleaning in 101-R Watercourse, Hakra 6-R.

Cultivator Identification Code		Kan	Feet
All	↑		
	Square 1		
<i>Nakka 38/21</i>	↓		990
4, 5, 6, 7	↑	18	
8		10	
11, 12		6	
14		5.5	
15		5.5	
16		6	
17		6	
19		7.5	
20		7.5	
18		6	
21		12	
22		6	
23		2	
<i>Nakka 39/6,15</i>	24	4	561
14		5.5	
15		5.5	
16		6	
17		6	
19		7.5	
20		7.5	
18		6	
21		12	
22		6	
23		2	
24	↓	4	374

Continued FIGURE 5: Actual division of work for watercourse cleaning in 101-R Watercourse, Hakra 6-R.

	14		5.5	
	15		5.5	
	16		6	
	18, 19, 20	Square 3	21	Three similar cycles
	21		12	
	22		6	
	23		2	
Nakka 25/25	24		4	1023
	16		6	
	17		6	
	18, 19, 20	Square 4	21	Two cycles
	21		12	
	22		6	
	23		2	
Nakka 25/6,15	24		4	627
	17		8.5	
	18, 19, 20		30.5	
	21		17	One Cycle
	22		8.5	
	23		3	
Nakka 23/10,11	24		5.5	401.5
	18		18	
	20		18	
	21		36	One Cycle
	22	Square 5	18	
Nakka 9/25	24		18	594
	21		36	
	22		18	One Cycle
	24		4.5	
End of W/C	23		13.5	396
			542	4918
			1499 meters	

The sequence for allocating the stretches to the individual cultivators is decided by the *warabandi* schedule. The sequence of the stretches follows the water turn sequence. The person who has the first water turn in the *warabandi* schedule cleans the first stretch, the second person cleans the second stretch, and so forth. In practice, farmers do switch turns and adapt the sequence to a desired situation. This, however, does not happen often.

A few watercourses, or branches, follow a different pattern than from that described above.

Watercourse H61-L:

In the main branch, not only the length, but also the exact location of the stretch that everyone has to clean, has been fixed. This makes division of the work, every time a watercourse cleaning activity takes place, redundant. This has the consequence that farmers do not have to work at the same time. Everyone can do his share at a time that suits him. The only requirement is that the stretches are cleaned before the water comes into the watercourse again (normally it is cleaned when there is no water). All of the farmers know the day that the water is expected. The watercourse is divided into five parts, consisting of one to three squares, and in each part, the allocation per square is different, varying from 0.5 to 5 acres per square.

On the other hand, in the small branch of this watercourse (also lined), farmers all work collectively. They have no division of the work, and all work at the same time, starting from the head of the branch. As in the other watercourses, a farmer 'drops out' when he reaches his last *nakka*. The person who normally takes the initiative for cleaning of this small branch said that nowadays, they are considering changing the procedure for cleaning of the small branch. The reason for this is that since the watercourse has been lined several years ago, a few shareholders have never taken part in desilting. The head reach of the watercourse is desilted by all of the shareholders of the command area, and this is done without any allocation of shares.

Watercourse FD84-L left branch:

Here, the same pattern is followed as in the main branch of H61-L; namely the stretches to be cleaned are fixed and shareholders do not work at the same time.

Watercourse H117-R main branch:

Since this watercourse has been lined, there is no siltation problem. Therefore, nowadays, there is no allocation of work because there is nothing to be allocated. One farmer said that they fill the banks of the watercourse once a year, whereby they collectively work from the outlet to the tail of the watercourse, and farmers stop participating as soon as they reach their *nakka*.

Watercourse FD67-L:

As in watercourse H117-R, desilting in this watercourse is not needed since it has been lined.

2.3.2 Leadership for allocating and supervising the work

After it has been decided that the watercourse will be cleaned, the concerned shareholders will gather at the outlet on the set date. Before they can start the actual desilting and cleaning work, the total workload needs to be divided. Although the exact procedure for this differs from one watercourse to another, some general features can be discerned. These, and the main exceptions, are described hereunder.

With consensus, the shareholders select a person who will allocate the work. Normally, this is the same person, and if he is not available, there is normally a second person that replaces him. Therefore, some farmers say that the person who allocates the work is not selected, but that it is a matter of tradition. The number of possible candidates is limited by the criteria that this person often has to meet. The different criteria mentioned are given in Table 9. The persons responsible for allocating the work in the different watercourses are given in Table 10. The information was available only for the Hakra sample watercourses.

Table 9. Criteria for person who allocates the watercourse cleaning work (according to the shareholders).

Criteria	H7-L East	H7-L West	H10-R	H45-L	H61-L	H101- R	H117- R main	H117- R katcha
Honest and trustworthy	X	X	X		N.A.	X	N.A.	
Knowledgeable about the landholding of each shareholder and the water turn sequence.	X	X			N.A.	X	N.A.	
Tail ender, so that he can divide the work up to the tail.			X	X	N.A.		N.A.	
A person that is obeyed by others;			X	X	N.A.	X	N.A.	
Cultivator of small land holding so that he has to desilt only a small portion.		X			N.A.		N.A.	
An older person, who cannot do too much physical work.			X		N.A.		N.A.	
This person does not need to be a landowner. ¹⁾					N.A.	X	N.A.	

X= This criteria is mentioned by at least one shareholder. If not mentioned, it does not necessarily mean that this criteria is not applied, but is probably less important.

¹⁾ Although in most cases not mentioned explicitly, research results show that this counts for most of the watercourses.

In cases where the shareholders say that they select a person 'at the spot', it is still often the same person who divides the work. In some watercourses, the work does not need to be divided. This is the case in those watercourses where, after the lining the watercourse, does not need to be desilted anymore, and thus, no work needs to be divided. In another case, fixed shares (not only the amount of work, but also the exact location of the stretch to be cleaned) were allocated to each shareholder at the beginning of irrigation in that tertiary unit and this procedure is followed to date. This makes decision-making on the division of work redundant.

Table 10. Persons responsible for the division of work in watercourse cleaning.

Watercourse or branch	Cultivator Identification Code of person who divides share ¹⁾	Tenure status in sample watercourse	Location of the land of this person	Whether or not he gets concession for his task
H7-Least	CID10 (1)* CID01* CID12/15* Anyone	L OC L	Tail Head Middle/Tail	Cleans half his share or no concession
H7-Lwest	CID24/36 (1)* CID34 (2)* CID37/42 Anyone	OC T OC	Middle Middle Tail	Does not desilt his own share
H10-R	CID70 or son (1)* CID74/81+CID77 (day 2) CID33/50/71 CID56 Anyone ²⁾	OC OC+L L OC	Tail Tail Head/Middle/Tail Middle	Does not clean own share
H45-L	CID38/61 (family task)(1)* CID71 (on second day)	OC OC	Middle Middle/Tail	No, is expected to do even more
H61-Lsmall	Nobody (done collectively)	N.A.	N.A.	N.A.
H61-Lmain	Nobody (shares fixed)	N.A.	N.A.	N.A.
H101-R	CID18 (family)* CID22 CID17*	OC OC OC/L	Tail Tail Tail	No, is expected to do even more
H117-R main	CID29/32 (former times)	Owner	Tail	N.A.
H117-R katcha	CID3* CID6	L OC	Tail Head	No.
MD1-R main	CID49	OC	Middle	No
MD1-R Right	CID43 CID09	OC OC	Tail Tail	No
MD-11TC	CID54	OC	Tail	Does not clean his own share
FD38-L	CID1	L	N.A.	N.A.
FD67-L	N.A.	N.A.	N.A.	N.A.
FD84-L Right	CID30	OC/L	Tail	No
FD84-L Left	CID5	L	Tail	No
FD96-R	CID8 CID20	OC OC	Tail Head	No

¹⁾ The number in brackets after the farmer's name indicates the preference farmers have to let this person arrange the work division. The asterisk (*) indicates that this person is also the initiative-taker for desilting activities (not necessarily the same desilting activity).

²⁾ At the time the watercourse was not lined, there was a permanent person who was responsible for the whole activity, but now anyone is selected just at the time when this work is undertaken.

Although in all of the watercourses there is a clear division of work on the basis of land holding size, or duration of water turn, it is not uncommon that the division and allocation of work is again discussed by all shareholders before the actual start of the work. This means that the procedure to be followed during desilting, is discussed and decided upon by all the shareholders at that moment when they are present at the outlet. This was found especially in H10-R Watercourse.

The tasks, that are to be performed by the person who is selected to allocate the shares to the participants, are (see also Table 11):

- To allocate the reaches to every shareholder in the way they had (long time ago) agreed upon. He should do this honestly;
- To see who the absentees are;
- To supervise the work and check the quality of the work;
- To prevent and solve conflicts during the desilting, especially about the division of work; and
- Checking the work. If someone did not do a proper job, then he has to ask that person to do it again. If the person who divides has a concession for his own share, then he will also check; otherwise, everyone will see others work.

In most of the watercourses, where the initiative-taker is also the one who allocates the work, this person carries the full responsibility of the desilting activity. Next to the tasks mentioned above, he is also expected to motivate absentees to attend, to divide the part that should have been done by those who did not come and help in cleaning, and to improve someone else's work if that other person refuses to do a better job. Sometimes, the person who allocates the work is compensated for this task in the sense that he does not have to desilt his entire share, or does not have to clean his share at all.

Table 11. Tasks of the person who divides the work for watercourse cleaning.

Task	H7-L East	H7-L West	H10-R	H45-L	H61-L	H101- R	H117- R main	H117- R katcha
Allocate reaches honestly	X	X	X	X	N.A.	X	N.A.	X
Check the work quality	X	X	X	X	N.A.		N.A.	
Solve/prevent conflicts, especially about division of work	X				N.A.		N.A.	
Supervise the work	X		X		N.A.		N.A.	
Desilt himself (even more than others)				X	N.A.	X	N.A.	
Motivate the absentees				X				

2.4 Resource mobilization

2.4.1 Labor

In principle, all farmers start from the head of the watercourse and work together up to the *nakka* where the first farmers take their water from. Even if farmers do not collectively start at the outlets, the individual farmer has to contribute towards cleaning that part of the watercourse through which the water travels to his fields (i.e. up to his last *nakka*). In either way, downstream of certain *nakka* points, the group of participants becomes smaller, until at the tail, only those who take water from the last *nakka* remain (this was earlier illustrated in Figure 5).

A person in the head reach spends much less time on cleaning his share of the watercourse than a person in the tail. In many watercourses, those cultivators who take their water turn from a *nakka* very close to the outlet, do not even participate. The time it takes to clean a watercourse from head to tail varies from one-and-a-half hours to 12 hours (in the latter case, this is often spread over two or three days).¹³ This is also the time that a tail end farmer spends on desilting his share of the watercourse in case all the shareholders start from the outlet and work up to the tail simultaneously. The variation in time spent on cleaning of the different watercourses depends on whether, or not, the watercourse or branches are lined, on the length of the watercourse, and the slope of the bed.

Shareholders from the head, middle and tail reaches of the sample watercourses were asked during, or shortly after, the desilting activity, how much time it took them to perform their work. In Figure 6, the results are plotted for most of the watercourses of Hakra 6-R Distributary. In all these watercourses the amount of workload depends on the landholding size. The bigger the landholding size, the longer the stretches a cultivator has to clean. In order to study the difference in workload between cultivators in the head, middle and tail reaches, this aspect has to be taken into consideration. Therefore, in Figure 6, for the respondents the time that one spends per acre of land is calculated, instead of considering the total time spent by the respondent. The details for one of the watercourses (the unlined branch of 10-R watercourse, Hakra 6-R Distributary) is given in Table 12. Despite the fact that a big landowner or cultivator has to clean relatively more, the table, and the figure, show that a cultivator with 24 acres in the head reach spends much less time than a farmer with 13 acres of land in the tail reach, i.e. 1,5 and 8,75 hours, respectively. This is 0,06 and 0,67 of an hour per acre, respectively. In other words, this tail end farmer spends ten times more time on watercourse desilting than the farmer in the head reach. This head-tail difference exists in all the observed watercourses. Although, in most cases, a linear trend line can hardly be drawn because of a low number of measuring points, the trend indicates that farmers who have their last *nakka* further away from the outlet, spend more time. The trend lines also indicate differences between watercourses. In 101-R Watercourse, the work is divided more equally, and the measuring points are more scattered. In this watercourse it was observed that some shareholders cleaned their stretches together and/or waited for each other before starting a new cycle. The R^2 of the observations in this watercourse (0,10) is very low, compared to the R^2 in 10-R Watercourse (0,80). The R^2 for the other watercourses is not given because of too low a number of observations.

¹³ A farmer in H61-L Watercourse stated that cleaning the watercourse (the *pakka* reach) is only a two-hour job. One shareholder of H101-R says that they can clean a *pakka* square (990') in 15 minutes easily. The last observed desilting activity in FD87-L left branch continued for seven days, and even then, the work was not entirely finished.

Table 12: Labor input during a watercourse desilting activity in H10-R Watercourse.

CID respondent1)	Farmer's last <i>nakka</i> 2)	Distance from outlet to farmers' last <i>nakka</i> (in feet)	Landholding size (in acres)	Total time spent on this desilting activity (in hour)	Time per acre (in hour)
65	39/5,6	6732	24	1,5	0,06
69	38/15,16	7326	9	1,75	0,19
70	38/25	6930	18,75	2	0,11
77	13/25	9900	18	6	0,33
78/82	12/16,25	11088	13	8,75	0,67
76	13/25	9900	9	5	0,56
72	12/16,25	11088	17	7	0,41

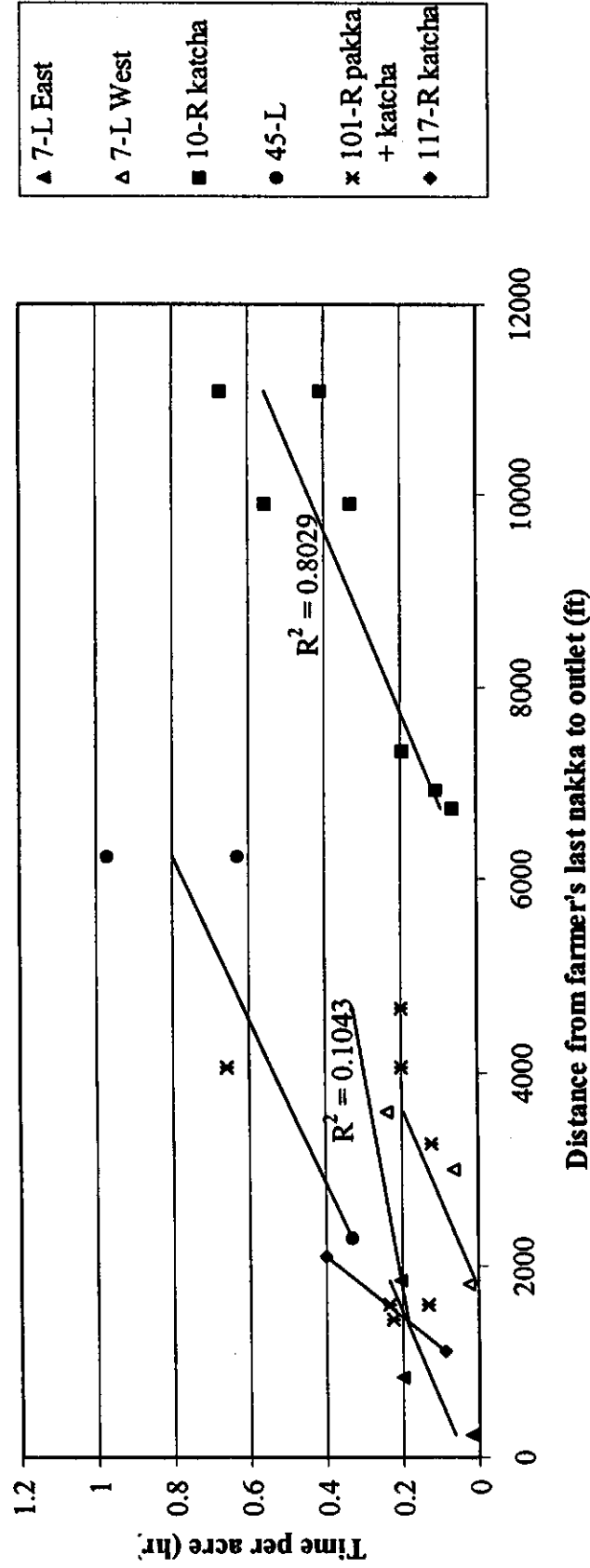
1) CID = Cultivator Identification code.

2) The first number refers to the square number; the second number, or combination, of numbers refers to the field (*killa*) numbers.

None of the cases demonstrate that the extra effort of tail end farmers is remunerated in the form of compensation in workload in each cycle. A arrangement could be whether this should be considered as an inequity. In general, it is known that the tail end farmers are 'more enthusiastic' to clean the watercourse. The benefit they gain from it is higher than the benefit that a head end farmer gains from a clean watercourse. Therefore, the authors would argue that a higher workload for tail end farmers does not automatically imply an inequity.

Figure 6. Head-tail differences in labor input for watercourse cleaning.

Labor investment for desilting of sample watercourses in Hakra 6-R Distributary



2.4.2 Mobilization of funds

In none of the sample watercourses did farmers maintain a contingency fund for routine maintenance. In the case of emergency maintenance, such as a breach in the watercourse, the person having their *warabandi* turn is responsible for repairing the watercourse. Often, the one who is affected by the breach will help him. If they do not succeed in repairing the breach and if more damage is expected, the one whose turn it is can make an announcement on the mosque loudspeaker, and all who have a turn after him will go there and repair it (this was mentioned in H61-L watercourse).¹⁴

In watercourses where the shareholders have introduced a fine (or where there used to be a fine system), the penalty money is oftentimes used to buy tea and sweets for the participants in the desilting activity. In other cases, the money is spent on hiring a laborer to do the work for the absentee. In a few cases, fine money, or money from selling part of the village water turn, is said to be used for activities in the watercourse (such as maintenance), but in practice, nothing like this was found.

None of the watercourses receive contributions from outside for specific activities.

2.4.3 Mobilization of kind

Mobilization of kind is not required and does not take place. Farmers bring along their own *kassi* (spade), *daranti* (sickle) and a few of them, an axe. On many desilting occasions, farmers carry along their *hukkah* (local water pipe) to make the breaks in between the work more pleasant.

2.5 Communication

The initiative-taker is responsible for spreading the message. He may inform the village 'chowkidar,' who, in turn, will communicate the date and time to the concerned shareholders. In case the *chowkidar* is called, he will be further responsible for informing all of the concerned shareholders. Another way is to make an announcement through the loudspeakers of the village mosque, or of any private person. In the smaller watercourses (or branches), the shareholders usually communicate the program personally. In watercourses where a relatively high number of absentees can be expected, both methods are used. The announcement through the loudspeakers is made one day before the desilting activity is going to take place. In this announcement, all of the shareholders of a specific outlet (the name or number of the outlet is mentioned) are requested to come for desilting the next day at a specific time

In those cases where the initiative-taker is also carrying the responsibility for noting and motivating the absentees, he is more keen to have everyone informed, and even visits the shareholders personally in their *deras* or fields.

¹⁴ In a few watercourses, a leading person collects funds for other activities, like changing the size of the outlet. In those cases, farmers contribute on the basis of landholding size. The money is controlled by the same person, and can be released only for the purpose for which it was collected.

2.6 Rule enforcement

2.6.1 *Legal basis*

Some of the maintenance works are considered a 'community' responsibility and are, therefore, performed collectively. Other maintenance activities are seen as the responsibility of the individual farmer. Cleaning of the watercourse is considered routine maintenance in which legally, the irrigators, having a right to water from the channel, have to participate (see Canal and Drainage Act 1873, Section 3, Clause 5). Only in a few cases is the Divisional Canal Officer of the Irrigation Department allowed to stop the water supply; one such case is 'Whenever and so long as any watercourse is not maintained in such proper customary repair as to prevent the wasteful escape of water therefrom (Canal and Drainage Act, Section 32, Clause 32). He can stop the water supply through '[s]atisfying himself through personal inspection or through a subordinate officer not lower in rank than the Sub-divisional Canal Officer that the watercourse in question is not well maintained and that non-maintenance thereof causes wastage of supply besides inconvenience to the shareholders by way of frequent breaches in the adjacent lands, footpath or roads, etc., etc. (Section 32, Rule 32(2)).

According to the shareholders, water supply in our sample watercourses has never been stopped because of deferred maintenance. Every farmer (water user) is aware of his duty to participate in keeping the watercourse clean. The right of farmers to make a complaint to the Irrigation Department, in case one of the shareholders does not fulfill his duty, has never been used, as far as this study could determine.

2.6.2 *Absenteeism*

Participants, in cleaning the watercourse, are the cultivators of the land. These might be owner-cultivators, tenants (cultivating the land on a sharecrop basis), or lessees (cultivators on contract basis). Landowners who do not cultivate (part of) their land themselves, do not participate in the routine cleaning of the watercourse.¹⁵ The size of the group of participants is, in principle, as big as the number of shareholders of the watercourse, or branch, to be cleaned. Usually, a shareholder comes with (or sends) more than one person. This is especially the case if the length he has to clean is long.

In each desilting activity there are absentees. The participants will accept it if a farmer has a genuine reason for not being present. In all the watercourses, shareholders have reached an agreement on what are good reasons for being absent. The main accepted reasons are death in the family, marriage of a family member, or illness.¹⁶ In all other cases, a person is expected to participate, or send at least a family member, or laborer, instead. Farmers who now have their

¹⁵ In H117-R, it was mentioned that in desilting activities during the year, a cultivator could send his servant or a laborer, but that for the desilting in the annual canal closure he himself had to be present. In this watercourse, however, hardly any work needs to be done and there has not been a collective cleaning activity during the research period.

¹⁶ There are watercourses in which persons with waterlogged land are not even considered 'absentees' during the cleaning activity; they are not expected to participate, because they are no longer beneficiaries.

watercourse lined, recall that in former times, cleaning of the watercourse was such a laborious job, that there were always a lot of absentees, as a result of which other people also started staying away. On the other hand, in some lined watercourses, farmers complain that since the lining of the watercourse there are more absentees, because they assume that a few others can easily do the work.

Sometimes a desilting activity is postponed because not enough persons show up. This is not the case in those watercourses where the stretches that need to be cleaned are fixed, because everyone can do the work at his own pace. In those watercourses, the stretch of the absentee will be left for him to clean at a later point in time. Two watercourses, in which the desilting activity is often postponed due to this reason, are H45-L and [FD84-L left branch]. In H45-L three main reasons were found:

- 1) 'Zid'. Unwillingness of some persons to participate in a collective activity, especially since conflicts have recently occurred. The consequence is that the other group (the participants) will also be absent the next time. Here, it concerned a conflict between two sub-castes of Jat, namely Gill and Kalloo. Their relation worsened after a murder case that took place in the initial stage of this research.
- 2) All the shareholders belong to the same caste, so if there is a death, or marriage, no one will be able to attend the planned desilting.
- 3) There is only one person who takes the initiative, without whom desilting will never take place. If this person has some other things to do, the program will be postponed.

In the case of FD84-L left branch, different reasons (as given by the farmers) for the lack of collective action to desilt the water-course are:

- 1) Most of the farmers have off-farm employment to earn a decent living since land holding sizes are very small. Therefore, farmers do not have enough time for this activity.
- 2) Because of the lack of interest in watercourse desilting by big landowners (8-10 acres) small landowners also do not desilt the water course.
- 3) There is not much water in the watercourse, hence no need to clean it.

If a person is hindered to participate on the set date and time, he is expected to clean his share before the water will again be in the watercourse, or branch. Whatever work he was supposed to do will be left by the others. If he had a genuine reason for his absence, or if he will not be able to desilt his share before the water comes into again the channel, the others will clean his share. In case someone stays away without notification and without sending a replacement, and if it is likely that he will not clean his share before the water comes, he is considered an 'absentee'¹⁷. Since the benefit from cleaning the watercourse is the highest when it is cleaned completely, absence of one of the shareholders is at the cost of all the concerned shareholders. The only way to mitigate this loss is for the shareholders that are present to also clean the share of the absentee.

¹⁷ In H45-L, a person is considered an absentee when he does not show up within 30 minutes after the announced starting time.

2.6.3 Sanctions

A sanction could be a means to diminish the absence of shareholders. A sanction can be 'positive' in the form of rewards, or negative by means of punishment. Although it is recognized by all of the shareholders that a sanction could enforce the social norm to participate in the cleaning activity, in most of the watercourses there is no sanction. There could be several reasons:

- Lack of authority. The group, or an individual, does not have the power to enforce the sanction.
- Kinship relations. If all the shareholders belong to the same caste, it might improper to openly give a punishment to someone. The fear, however, of finding oneself in an embarrassing situation in front of others, could be considered an effective informal sanction.¹⁸
- Financial position of shareholders. In one watercourse, the fine system was abolished, because nowadays, most of the cultivators are not the owners of the land (which is largely waterlogged and saline) and they are poor. They cannot, or do not want to, enforce the fine on each other.

In most of the watercourses it was tried, once, or several times, to introduce a formal sanction, but without success. Only one watercourse was found where a formal sanction, in the form of a penalty (Rs 100), can be imposed successfully. Here, it is even mentioned in the announcement on the loudspeaker that absentees will be fined. In the same watercourse, there used to be a different, informal, sanction before the watercourse was lined. They went to the absentees to tell them that next time they had to come (this is called '*gilla shikwa*'). Another way, was to call the absentees in front of them in a group meeting, and asked why they did not come, and warned that next time they had to be there (this is called '*sharminda*'). In one of the watercourses, where open punishment is not feasible because they all belong to the same caste, 'hidden punishment' (as one farmer called it) is given. An example of a hidden punishment is to put a brick in the outlet structure when it is the absentee's water turn.

A farmer with land in the head reach of H10-R Watercourse said that if others do not listen to his request to desilt the watercourse (his lands will be affected if the watercourse overflows), he closes the outlet. This is what he had done one year before. In this watercourse, there used to be a sanction, namely that during a next desilting, the absentee had to clean 11 times his share. One of the main persons who introduced this rule said that once he was absent on purpose. Next time, he had to clean more and happily did so, in order to show others that rules should be obeyed. But even this strategy did not lead to an institutionalization of rule enforcement.

In another (not a sample) watercourse along the Hakra 6-R Distributary, the shareholders established a Desilting Committee, after the watercourse had not been desilted for one year due to conflicts. As a consequence, farmers could not cultivate their *kharif* crop. This watercourse is prone to sedimentation (Bandaragoda and uz Zaman, 1996: Annex 2).

¹⁸ An incident was found of a person who no longer makes use of his water turn because his land is waterlogged, but still participates in the desilting activity. Although all of the other shareholders know that this person does not cultivate his land anymore, fear for social or moral pressure forces him to continue taking part.

3 Conclusions and Recommendations

This chapter discusses the main conclusions of the study (Section 3.1) and reflects on recommendations with regard to interventions in the existing institutional arrangements at the watercourse level (Section 3.2).

3.1 Conclusions

The actual occurrence of collective action for watercourse maintenance depends on various factors. Collective action here is defined as an organized activity among a number of people in order to reach a common goal, and in which all participants share an understanding of, and follow, the rules. Collective action is required for watercourse maintenance. One person cannot do the job. Even in watercourses where not all of the shareholders clean at the same time, the ultimate goal remains the same, and (maybe even more) rules need to be developed and followed by the shareholders. Therefore, 'need for maintenance' and 'need for collective action for maintenance' is practically one and the same thing.

In this section, the sample watercourses will be grouped as 'being organized, or not' (Section 3.1.1) and the main circumstances found to have an influence on this are discussed (Section 3.1.2).

3.1.1 The occurrence of collective action

Field results about the requirement for watercourse maintenance, and the capacity of the irrigators to organize the maintenance, show that a number of different situations may appear. A simplification of the possible situations is given in the matrix in Figure 7.

Figure 7: Occurrence of collective action for watercourse maintenance

	Necessity ¹⁾	No necessity
Collective action	H7-L (33) ²⁾ H117-R (<i>katcha</i>) H10-R (29+33) (0) H61-L (43) FD38-L (22) H101-R (0) FD84-L (RB) (0) FD96R (17) (Situation 1)	(Situation 2)
No collective action	H45-L (88) FD84-L (LB) (25) ³⁾ MD1-R (56) MD11-TC (67) (Situation 3)	H117-R (main) (33) FD67-L (0) (Situation 4)

¹⁾ Need is based on the farmers' perspectives. In all cases, the farmers' opinions could be supported by that of the researchers.

- 2) The numbers in brackets give the percentage of deferred maintenance (see also fig. 8). These numbers were given after the watercourses had been written in the cells.
- 3) Watercourse cleaning does take place, but the shareholders are not satisfied with the procedure, since no one works at the same time and cleaning is done very irregularly.

From the point of view of the performance of the system, two situations can be considered desirable:

- Situation 1: there is a need for watercourse cleaning and the farmers undertake collective action for it. This situation was found in most of the watercourses.
- Situation 4: there is no need for watercourse cleaning and there is also no collective action for it. 'No collective action' follows logically from the fact that there is no need to get organized. This situation was found in two watercourses.

An exceptional situation is situation 2, where there is no need for watercourse cleaning, but still farmers get organized to perform this task. This situation was not found in the field.

One situation will, sooner or later, harm the functioning of the system:

- Situation 3: There is a need to perform watercourse cleaning, but the farmers do not undertake collective action to do it. This situation was found in four watercourses, which will be briefly discussed below.

H45-L

Due to conflicts among the different sub-castes of the watercourse, it is extremely difficult to organize a desilting activity. All the shareholders belong to one caste (Jat). Much of the watercourse command area is waterlogged.

FD84-L (LB)

The left branch of the watercourse is not cleaned collectively. Though only one sub-caste (Lobana, which is a sub-caste of Gujar) is residing along this branch, every farmer cleans his part on a day and time that is convenient to himself. The land in this watercourse is scattered. Many shareholders also have land on other watercourses and have income from off-farm employment. Many of the cultivators are tenants or lessees.

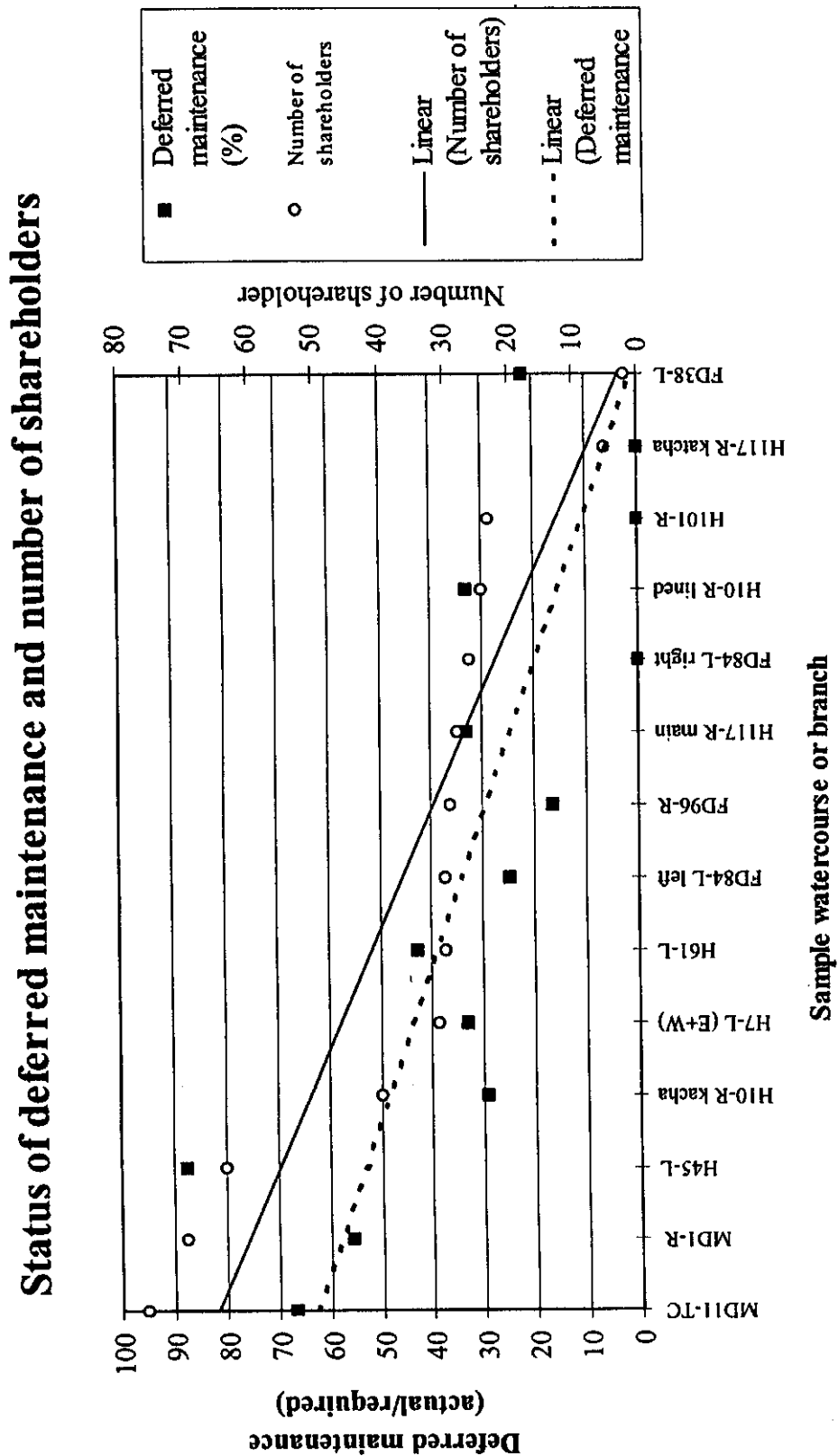
MD1-R and MD11-TC

These two watercourses have ample water available for irrigation. Moreover, their actual cultivated area is much less than their design cultivated area (design CCA). Therefore, the number of times they actually desilt the watercourse is less than the number of times it should be desilted, looking at the condition of the watercourse.

3.1.2 Required conditions for collective action

Each situation is influenced by a number of encouraging and discouraging factors. Looking at the outcome (collective action for maintenance or not), encouraging factors seem to play a more prominent role in Situations 1 and 2, where collective action does take place. In Situations 3 and 4, where no collective action was found, it can be expected that discouraging factors prevail. The required conditions as encountered in the 12 sample watercourses, are discussed below.

Figure 8: Lack of maintenance and number of shareholders.



Demand for water

By the far most important factor that encourages farmers to maintain their watercourse, is the need for water. Farmers recognize that a better maintained watercourse improves the water supply to their fields. A high water demand leads to a higher need for watercourse maintenance. Although crop water requirements were not calculated, the water allowances indicate that the water supply in the sample watercourses is relatively scarce. In many cases, the farmers managed to reduce this scarcity by increasing their outlet size, which can be seen from the (higher) actual allowances. Watercourses MD1-R and MD11-TC are not maintained properly because the farmers have enough water. Although they expect some benefit from desilting (see Section 2.2.4), the costs (the effort) does not outweigh the benefits.

The need for water is not the same throughout the year. Farmers will organize themselves only for watercourse cleaning if the growing stage of the crop demands. When the cropping pattern does not differ much within the watercourse command area (which is likely to be the case in such a local system), the demand for water, and thus the interest in watercourse cleaning, will be similar for all of the shareholders.

Next to the (growing stage of) the cropping pattern, the need for water is defined by some other factors. In the few watercourses where timely maintenance is not executed (situation 3), income from off-farm activities, or from land outside the sample watercourse, is higher than in the other watercourses. Sixty percent of the H45-L Watercourse command area is affected by waterlogging and salinity. The owners of the land complain that due to this, they can no longer tenants to cultivate their land. For only 44% of the cultivators, income from crops in this watercourse command area is the main source of income.

Condition of the watercourse

The layout of the watercourse has a direct effect on the need for watercourse cleaning. The slope of the bed, the length of the watercourse, whether the watercourse is lined or not, are factors that separately, or in combination influence siltation and weed growth. If an unlined watercourse is elevated compared to the field level, rat holes may endanger the condition of the banks. Watercourses H117-R (main branch) and FD67-L are clear examples of watercourses where no collective action for maintenance takes place, because of the condition of the watercourse. All of the shareholders state that the slope is good, due to which the water, which flows with high velocity, can easily carry the silt to the fields. These watercourses are entirely lined. H117-R is a short watercourse, with conveyance losses that are negligible. In both watercourses, farmers expect hardly any, or no, effect from watercourse cleaning. Both watercourses have not been cleaned since the lining¹⁹, which occurred a few years ago.

In general, it was found that farmers are well aware of the physical condition and constraints of the watercourse and the maintenance required for each. Especially in the improved watercourses, farmers have a good knowledge of the slope of the watercourse, the quality of the materials used (sand-cement ratio), the condition of the banks and bed, etc.

¹⁹ Due to specific circumstances (see section 2.2.6) the head reach of FD67-L Watercourse was cleaned during the research period.

Social capital

Awareness of the need for watercourse maintenance does not necessarily lead to collective action. A whole set of conditions must be favorable to make it work. Although, in most of the watercourses, less maintenance is done than required and desired by the shareholders, overall, the farmers manage to organize themselves for this. The sample of watercourses is too small to show any unconditional correlation between separate social variables and the potential of collective action. On the other hand, the sample is diverse enough to show that different settings can lead to similar outcomes, and that, more or less, similar conditions can lead to different patterns of organization. One of the main conclusions is that no single social factor (be it cultural, institutional, economic or political) can determine the outcome. Realizing the shortcomings of considering each variable in isolation of the rest, an attempt will be made to mention some of the main conditions that are assumed to be of importance for the organization of watercourse maintenance.

Clear set of rules

Legally, it has been determined that each shareholder is jointly responsible for maintaining the watercourse. This rule is internalized to such an extent that farmers feel accountable to their fellow farmers, more than towards the Irrigation Department.

The rules for division of the work are clear to all of the shareholders of all the watercourses. The farmers themselves make these rules, as the Canal and Drainage Act does not at all indicate how the implementation of watercourse maintenance should be done. In all of the watercourses, the rules in use are the same as those introduced by their forefathers. In a single case, where, since the improvement of the watercourse, no desilting is required anymore, the rules are no longer in use (though still remembered). In another watercourse, farmers think about changing the rules, because since improvement of the watercourse, there are many absentees. In a branch of this watercourse, no division of work is made (so actually there are no rules for it) and now they are considering making a division of the work, so that each individual can be held responsible. In conclusion, it can be said that a 'sense of ownership' of the rules, as well as respect for traditions, makes, rules acceptable to all shareholders.

The basic rules are simple:

1. Each farmer cleans a stretch of the watercourse that is in correspondence with his land holding size;²⁰
2. Each farmer cleans up to his last *nakka*; and
3. The sequence of stretches to be cleaned follows the *warabandi* schedule.

Because the number of shareholders and the area of a watercourse is limited, everyone knows more or less, how much land everyone has, where that land is located, and the *warabandi* sequence. The person who allocates the shares (on the basis of these rules) is expected to be even more knowledgeable about land holding sizes and the *warabandi* schedule.

In conclusion, it can be said that the set of rules is simple and clear to all of the persons concerned.

²⁰ The same rule is applied in other cases. For example, if contributions for the village mosque need to be made, for the payment of village servants (carpenter, blacksmith, etc.), or when money is to be collected to bribe the Sub-engineer of the Irrigation Department to have the outlet enlarged.

Leadership and authority

Most shareholders say that there should be a leader to organize the desilting activity, but that there isn't one.²¹ A good leader is someone who is respected by the other shareholders and 'who can ask others to do something'. Such a statement also indicates that oftentimes, persons who do not expect to gain an immediate benefit, are expected to participate. In many cases, the leading person has inherited this 'position' from his father. Someone who takes the initiative for watercourse cleaning is not necessarily considered a leader. Most often he is just a shareholder who faces problems during his irrigation turn. Only if that person also takes the decision to actually plan the desilting activity, makes the announcement and motivates the others, then he is considered a leader. The person who divides the work, allocates the shares, and supervises the activity is normally selected by all of the shareholders before the start of the activity. This person is considered a leader (at least for that moment). To ensure that the basic rules of division of work are clearly followed, only 'honest persons' will be selected.

In all of the watercourses, farmers can tell about the rules in use to deal with absentees in desilting activities, like the type of punishment, or under what conditions these sanctions are to be applied. Sometimes, it is even told exactly when these rules were discussed and decided upon, and who took the initiative. But, if asked about the actual situation, they cannot clearly indicate which steps are taken against absentees. Sanctions for absentees are very difficult to enforce. In some cases, this is said to be due to the absence of a leader. It seems to be difficult to have a leader, because no one accepts someone else above him ('everyone wants to be a *Chaudry*'). In other cases, leading figures do not have the authority to enforce sanctions. Social, or moral, pressure from the group is one of the main mechanisms that make people participate. This is found especially if all shareholders belong to the same caste.

With regard to leadership, there is diversity. This can be illustrated by looking at the sample watercourses in Hakra 6-R Distributary. In H61-L, for example, there is one big landowner who is also *numberdar* of the village and an influential person with good political contacts. He is considered by all of the shareholders as the leader of the watercourse. He took over this position from his father, who did a lot for the village. When an announcement is made in the village for cleaning of that specific watercourse (the village has several watercourses), the watercourse is referred to as being the watercourse of that person. This is also the only watercourse, where, in the announcement, people are warned about the imposition of punishment (a fine) in case of absence. In H101-R Watercourse, shareholders say that there is no leader and that they do not need one. Here, all of the shareholders belong to one caste. The tense situation at the time of (recent) change from *katcha* to *pakka warabandi*, gives the impression that the shareholders fear the emergence of factions within the watercourse, something they wish to prevent since they feel closely related to one another. H10-R Watercourse has several factions and persons leading each faction. Here, being a leader is something with which respect can be gained. Now, the watercourse command area is split into two (during this research), each of the new watercourses can have its own leader. Watercourse H45-L, in which all of the shareholders are *jats*, has one main person with regard to the organization of water management. Most of the shareholders considered him a leader, but not those who belong to a certain sub-caste. This person does not want to be considered a leader ('leaders are persons who do silly things'). In the *katcha* branch of H117-R, there are five shareholders. Since four of them are brothers who do not have good internal relations, the fifth person, an 'outsider', is considered the leader of the desilting activities. In the main branch of this watercourse, two landowners, who are not cultivators themselves, used to be the initiative-takers.

²¹ Sometimes it was also mentioned that there should be one person to take the lead for all activities in the watercourse.

In this watercourse, where all of the tenants work on a 1/8-share basis (compared to 1/2-share, which is normal), it would be unacceptable if a tenant would take a leading role.

The conclusion is that only in rare cases will there be leaders that are accepted by all shareholders and given the authority to enforce rules. In general, farmers feel a need for a leader who can organize the entire desilting activity and maybe other activities in the watercourse command area.

Decision-making

Watercourse maintenance in the sample watercourses could not be observed long enough to see how different decision-making processes have emerged and which impact the different decision-making processes have on the performance of the system. Normally, if a person wants the watercourse to be cleaned, he will contact any of the leading persons of that watercourse to consider this and to make an announcement. In most of the cases, before making an announcement, the person who has to arrange the announcement will consult with a few others whether they also find it necessary and what would be the best day to undertake the work. In watercourses where cleaning of the watercourse is a laborious job, and with a relatively high number of absentees, it may take a long time before the decision is taken, since the willingness of more people needs to be checked.

For the allocation of shares to be cleaned, a person is selected at the spot. Even if this is, more or less, the same person every time, farmers are still of the opinion that they have a say in this. They demand an honest and knowledgeable person and would never accept someone who has a bad reputation. No one forces himself on others as being the right person for this. In some watercourses (e.g. H10-R), the process of how the work will be divided is discussed and an agreement is reached before the actual division starts. Everyone will see to it that the actual allocation is fair. In case of disagreement (which happens only rarely), farmers will refer to the basic rules.

Cost and benefit

Farmers in the tail end invest more time in cleaning than farmers who have their land in the head reach of the watercourse command area. Not a single time was this complained about. This 'inequity' seems to be accepted for two reasons: 1) In most watercourses, tail enders benefit more from cleaning the watercourse than head enders. This does not count in those watercourses with a bad slope, where the head reach easily overflows when the water turn is in the tail (e.g. H10-R); and 2) Because it has always been like that (tradition). Therefore, the authors would argue that a difference in workload is not an inequity (contrary to the lower amount of water tail enders get due to conveyance losses, even after a desilting operation).

Costs and benefits of desilting have also been discussed earlier in this chapter. In two of the four watercourses, in which farmers do not organize (properly) for watercourse maintenance, there is no need for more water, and thus, benefits (more water) of desilting will not outweigh the cost (the effort). In two other watercourses, dependency on income from sources other than cultivation, may be the reason that farmers are less concerned with maintaining their watercourse.

Izzat and Zid

These concepts seem to be inherent in rural Punjabi culture, which also affects watercourse maintenance. *Izzat* may be glossed as 'honor', 'esteem', 'reputation', 'status' or 'face' (see

Merrey, 1979). Farmers were asked about the meaning of *izzat* and they mostly exclaim it as 'respect'. As Merrey already indicated, one can distinguish between positive and negative *izzat*. A person who manages to create fear among others, can have negative *izzat*. People will still show respect, but only do that because they fear that person and are afraid that, if they don't show respect, he might turn his bad deeds towards them. So, it is false *Izzat*. This is not sincere respect, but just a manner to 'remain on the safe side'. 'Doing *zid*' can be defined as 'being stubborn', 'being destined', or 'being insistent upon doing something'. Doing *zid* means that a person is so persistent in acting upon one's words, so that he does not care about the consequences, even if he will harm others, or himself. Like *izzat*, there is positive and negative *zid*, though none of them is false. *Zid* is negative if its aim is to obstruct others. Positive *zid* may be displayed by those who try to do something good for the community, but are obstructed by others. To counteract the negative *zid* of the other party, they themselves will also become very persistent in reaching their goal, and are also prepared to pay a higher price for it.

Zid and *Izzat* are two concepts that cannot be understood in isolation from each other. *Zid* includes both, goal (objective), and a way to reach it. The goal is to bring down someone's *izzat* and the manner to do it is to obstruct him. The word *zid* is used mainly to refer to the manner, or way, the objective has to be reached. Once it failed, or succeeded, the objective disappears and it is no longer a matter of *zid* (*zid* also disappears). The objective of doing *zid* (in a negative sense) is to bring someone else down, to give him a bad name, or at least make sure that he does not get a better name. So, *zid* is used in the game for *izzat*.

In Watercourse H45-L, farmers blame the deferred maintenance on *zid*. Some persons are not willing to participate in a collective activity. This is mainly because of a conflict in the village; that they do not want to collaborate with others and they do not accept the initiative-taker as a leader. In short, they are 'doing *zid*'. To their convenience, is that their land is in the head reach and that they do not feel much need for watercourse cleaning (their land in the tail is already waterlogged and out of use). Their absence during a desilting activity made others decide not to clean the first part of the watercourse, in which the absentees were supposed to participate. The persons present knew the intention of the absentees and certainly did not want to be the 'sucker' by doing the work for them. As a consequence, there was only a marginal benefit from the cleaning effort, since the head reach was not cleaned, causing danger for overflowing and a backwater effect. In the end, the outlet had to be closed, unless someone was willing to repair the watercourse before using his turn. In May (eight months later) the watercourse was cleaned again. At this time of the year, both the cotton crop and the *kharif* fodder need a lot of water. This dire need for water and the understanding of all shareholders that they will be at a loss if they don't desilt their watercourse, influences their decision to clean the watercourse. The part of the absentees in the head reach was cleaned as well. This example indicates that *zid* can have a huge effect on the potential of farmers to get organized, but that in itself, it cannot explain everything.

Some cases were also found where the game for *izzat* led to a better organization, since people realize that they can gain respect by mobilizing others.

Small group of shareholders

The data indicate a relationship between the number of shareholders of the (branch of the) watercourse and the status of deferred maintenance. In Figure 8 the size of the group of shareholders and the lack of maintenance is given. The number of shareholders is given in actual numbers. In order to plot and make comparable the status of deferred maintenance, the actual number of desilting activities is divided by the required number of desilting activities, and this is

deducted from the number of required desiltings; given in percentages. For example, in MD11-TC, farmers say that the watercourse should be cleaned nine times, but it is done only three times (see Figure 3). The researchers consider this a maintenance gap (deferred maintenance) of 67%. The linear trend lines in Figure 8 are almost parallel. This shows that maintenance is performed better (according to the farmers' perspective) in watercourses, or branches, where the number of shareholders is relatively small. The watercourses where there is no maintenance gap, have less than 30 shareholders. To be noted is that FD67-L is not included in this graph, because it had a negative deferred maintenance (i.e. according to the farmers, it does not need to be cleaned, but during the research period it was cleaned).

3.2 Recommendations

The focus of this study was the organization of watercourse maintenance in twelve watercourse command areas in Pakistan's Punjab. Different methods of data collection and analysis were used to understand and to integrate the technical and social aspects of one of the main water management activities at the tertiary level. Based on their findings, the authors would like to make some recommendations.

Organizing farmers at the watercourse level

1. There is no need for external intervention to motivate farmers for watercourse maintenance. In general, shareholders of a watercourse perform this task whenever benefits outweigh the costs. Farmers are knowledgeable about these benefits and costs.
2. A clear set of simple rules is needed to facilitate collective activities. Farmers usually build upon existing rules, such as those coming forth from the *warabandi*. Rules are best understood and acted upon if developed by the farmers themselves.
3. Leading persons are needed to motivate group members to perform certain tasks collectively. These 'leaders' can perform their tasks best if the group members trust and respect them, so that they have sufficient authority. In general, farmers are well aware of who the leading persons in the watercourse command area are and whether or not they need a leader, or will accept someone as a leader. However, insiders do not easily reveal information about leadership to outsiders. This is mainly because current group thinking about leadership and authority cannot be isolated from past experiences, which are often both, complex and sensitive. A good understanding of leadership patterns is indispensable if one wants to mobilize farmers for a collective activity, but also difficult to gain. Watercourse maintenance is one activity that could be taken as an entrance point to come to know the leading persons in a watercourse and to get a first hand understanding of decision-making processes in the group.
4. 'Izzat' and 'zid' are inextricably woven into Punjabi culture. An awareness, as well as an understanding of the functioning of these concepts, will be helpful in grasping people's enthusiasm, or reluctance, to participate in any collective activity.

Organizing farmers at the distributary level

1. At the distributary level, farmers do not (yet) have a set of rules they can fall back on. Rules, however, are indispensable to facilitate any collective action. Very likely, is that vested interests will have an influence on the process of defining new rules. This in comparison with a more egalitarian situation, in which earlier rules are expected to have been introduced at the time of introduction of the canal irrigation system in this region. In formulating new rules, it should be taken into consideration that: 1) farmers themselves set rules with regard to domains for which they are held responsible; 2) these rules should be supported (or legally backed) by the government; 3) from the very beginning, mechanisms for rule enforcement should be developed and implemented; and 4) rules should be simple and clear to all persons concerned.
2. Farmers cannot be expected to be as knowledgeable about the command area of the distributary, as they are about their own watercourse command areas. This may complicate decisions-making processes and/or may make people dependent on other, more knowledgeable persons, to take important decisions. In case of absence of (accepted) leadership, this may lead to mistrust and - in the end - no collective activities at all. Either way, access to information will benefit decision-making processes and a sense of participation.
3. Social and moral pressure, having the power to motivate farmers at the watercourse level to participate in group activities, may be less at the distributary level, where people do not know each other that well (and thus feel less obliged).
4. Patterns of decision-making, communication, resource mobilization and task division, that were found to exist in most of the watercourses for maintenance, can serve as a basis for routine maintenance at the distributary level.

Recommendations for further research

Research have shown that although general trends can be discerned, in each watercourse, outcomes of collective action for maintenance are different. This is because many factors (physical, technical, social, cultural, etc.) play a role. The main factors should be known if one wants to base organizational interventions on existing organized behavior. A further analysis of the field data may be required, as well as comparison of field experiences in other sites. A good beginning of this was made in a comparative study between the Water Management Department of NWFP Agricultural University, Peshawar (WAMA) and IIMI-Pakistan. Testing of these factors in other areas could be helpful in validating them and making them more useful for others, as a guideline for:

- assessing the potential for collective action in general;
- knowing the main constraining factors that might be necessary to overcome; and
- knowing the main encouraging factors that might be useful to further build upon.

More research on the expected effects of watercourse maintenance (such as reduction in conveyance losses after a desilting activity) is needed if one wants to assess whether or not farmers maintain their watercourse sufficiently well, or not. This should also entail a better insight into the actual effects of maintenance on sustainable agricultural productivity.

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Annex 1: Questionnaires

IIMI-Field Station Faqirwali

INTERVIEW ON W/C MAINTENANCE IN WATERCOURSE...¹⁾

Respondent :
ID :
Date :
Time :
Duration :
Subject : Maintenance activities in ... watercourse during canal closure
Location :
Interviewer :
Note-taker :
Processor :

- 1 You know about annual canal closure. Do you know for which reasons the canals are closed?
A:
- 2 Which maintenance activities will be done in this watercourse during annual closure? (and where)
A:
- 3 Can you mention some more maintenance activities?
A:
- 4 What is, for each of these activities, the expected effect? (Why should they be carried out?)
A:
- 5 If you look at the expected effect of these maintenance activities, why are some of these activities are not going to be done during annual closure?
A:
- 6 What do you consider the main branch of the watercourse?
A:

¹⁾ Some of the questions were taken from questionnaires (e.g. for a reconnaissance survey) of Baluchistan Community Irrigation and Agriculture Project (BCIAP), Quetta, Pakistan.

- 7 Can you indicate this on the map?
A:
- 8 Why do you call this the main branch?
A:
- 9 To which branch / reach do you belong?
A:
- 10 What are the other branches, or reaches, and how would you characterize them (physically, socially)?
A:
- 11 (a) Whenever the watercourse is desilted, is it desilted completely, from *mogha* to tail, including all branches, *pakka* and *katcha* reaches?
A:
- (b) Are there groups of farmers who desilt their own part of the watercourse, separate from the main branch?
A:
- 12 Does the timing of desilting of the different branches or reaches depend upon desilting of main watercourse, or other branches?
A:
- 13 Can you mention, or indicate, the cultivators of each branch?
A:
- 14 Is it possible that farmers (at least two) do cleaning or desilting work somewhere in the watercourse that you don't know about?
A:
- 15 If you think about cleaning/desilting of the watercourse, what comes into your mind? What are the things that you associate with desilting/cleaning?
A:
- 16 If you would have to evaluate the last desilting activity in your own watercourse / branch / reach, (When was it?) About which of these ingredients mentioned on the cards you are satisfied, or happy about, which unhappy, and about which equal?
A:
- 17a Why did you give 'unhappy' to some of the cards?
A:

- 17b Why did you give 'happy' to some of the cards?
A:
- 18 Do these 'desilting groups' (see above) have a person who most of the time takes initiatives?
A:
- 18 What are his tasks?
A:
- 19 Could he be considered a leader?
A:
- 20 Why you consider him a leader?
A:
- 21 Why would others consider him a leader?
A:
- 22 What is in it for him?
A:
- 23 Since when has he been a leader?
A:
- 24 Why do you not consider him a leader?
A:
- 25 Why do others not?
A:
- 26 Do you think there should be a leader?
A:
- 27 In some watercourses there is a 'desilting committee'. Do you have something like that?
A:
- 28a Do 'leaders' consult with others?
A:
- 28b Who?
A:

- 29 Who are the persons that took the initiative for desilting during the last year?
A:
- 30 Is someone responsible for allocating the work to shareholders?
A:
- 31 Who?
A:
- 32 Who selected him?
A:
- 33 What are the criteria?
A:
- 34 How does he know what to do?
A:
- 35 What is expected from him?
A:
- 35a Is this person compensated for his services?
A:
- 35b How much?
A:
- 36 Is the work supervised?
A:
- 37 Is the work checked?
A:
- 38a Can you tell us the procedure for allocating the work?
A:
- 38b Do farmers per square divide the work among themselves? How?
A:
- 39 Since when is the procedure like this?

A:

40 What happens to a person that didn't come?

A:

41a Is a record of participants and absentees kept?

A:

41b By whom?

A:

42 How is this person (who keeps the record) being informed?

A:

43 Is there a sanction against absentees?

A:

44a Who made this sanction?

A:

44b When?

A:

45 In what cases are these sanctions imposed?

A:

46 What is done with the penalty money?

A:

47 Who are the shareholders that are notorious for not taking part, although they benefit from desilting/cleaning?

A:

48 Can you tell us about the history of sanctions?

A:

48a Is there a contingency fund for **routine maintenance**? (yes/no)

A:

48b If yes, on the basis of which criteria does each individual farmer have to contribute his share?

A:

- 48c How much money is deposited?
A:
- 48d Who collects and accounts it?
A:
- 48e For which purposes can money not be released?
A:
- 49a Does/did it ever happen that **emergency maintenance** needs to be done? (yes/no)
A:
- 49b Is someone responsible for the organization and coordination of emergency maintenance works? (yes/no)
A:
- 49c If yes, who?
A:
- 49d Is he paid for his services? (yes/no)
A:
- 49e If yes, how much?
- 50 Is there any outside contribution for the maintenance of the irrigation system? (outlet + watercourse)
A:

51 Statements (give scores 1 to 5: 1 for non-participation, and 5 for well-organized).

1 Some important maintenance activities are pending for a long time

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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2 Desilting and cleaning is organized so well in our watercourse, that it could serve as an example for the other watercourses.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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3 Often, desilting activities are postponed because many farmers don't show up.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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4 Shareholders don't take any responsibility for the maintenance of the watercourse.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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5 Tailenders face more difficulties in getting headenders organized for desilting than the other way around.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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6 Desiltation of the watercourse never leads to conflicts.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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7 There are some opposing groups in the watercourse, and this affects the maintenance of the watercourse.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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8 Even shareholders who have no direct benefit from desilting (at a specific point in time), will participate when an announcement for desilting of their branch is made.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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- 9 It never happens that people do not participate in a desiltation activity because they have enmities with the initiative taker.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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- 10 All the shareholders would admit that desilting of the watercourse should be done more often.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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- 52 How many people and how many days, are required to maintain the watercourse annually?
A:

- 53 Are there any other activities that are concerned with the watercourse / tertiary unit, that might be done during closure period?
A:

- 54 Would you be able, and prepared, to make an attendance sheet of all farmers who participate in desilting, how many 'takkis' and their lengths have to be cleaned by each shareholder, and how much time each shareholder spent on desilting?
A:

- 55a When do you expect desilting activity to take place?
A:

- 55b When do you expect other maintenance activities to take place?
A:

**MONITORING OF DESILTING ACTIVITIES:
QUESTIONS AND OBSERVATIONS**

Date of notes:

Time of interview / observation:

Observer(s):

Watercourse:

Branch(es) that is/are being desilted:

Distributary:

Village:

ASK THE FOLLOWING QUESTIONS FROM AT LEAST:

4 shareholders in 7-L East

6 in 7-L West

6 in 10-R old

8 in 10-R new

8 in 45-L

6 in 61-L main branch

4 in 61-L small branch

6 in 101-R

6 in 117-R main branch

2 in 117-R *katcha* branch

Select these shareholders from head, middle and tail. Ensure that you have included one of the real headenders and the last farmer of the watercourse / branch.

MAKE NOTES ON OBSERVATIONS IN THE RESPECTIVE FIELD NOTEBOOKS
(what is happening?)

WRITE THE ANSWERS TO QUESTIONS 1 - 8 IN THE NOTEBOOK OF THE RESPECTIVE OUTLET

- 1a Name
- 1b CID (see *warabandi* list)

- 2a What are you doing?
- 2b Why are you doing this?

- 3a Who took the initiative to desilt the watercourse?
- 3b Why?

- 4a How were you informed?
- 4b Who was supposed to be informed (target group)?

- 5a Who of the shareholders of this branch did/did not participate?
- 5b Why not?

- 6a At what time did you come here?
- 6b At what time did you start working?
- 6c If difference between 9a and 9b, why?

- 7 How do you know which stretches of the watercourse you have to clean?

- 8a What happens if you would not clean your share at all?
- 8b If there is any sanction, then how is this enforced?

Name respondent:

CID:

Watercourse:

ANSWER THE FOLLOWING QUESTIONS AND FILL OUT THE TABLE FOR EACH RESPONDENT

9 Where is your last *nakka*?

10 In which branch(es) do you have to clean? (in case the desilting you observe is being done in only 1 branch, this question is not applicable).

Question	Branch / Reach			Total
	
<i>Pakka</i> or <i>katcha</i> ?				
How many acres do you cultivate?				
Total length to clean (<i>karam</i> , <i>kanal</i> , acre, etc.)?				
How much time do/did you spend (hours)?				
Time more / less / same? ¹⁾				

1) Is the total time you spend on this desilting more/less/the same as desilting activities in the same branch(es) during the year?

Annex 2: History of allocation of work

IIMI-Field Station Hasilpur

WATERCOURSE MAINTENANCE STUDY IN FORDWAH AND MAHMOOD DISTRIBUTARIES

This is a very short survey pertaining to “Where farmers have learned to distribute the work of desilting the watercourse according to the land holding size from”?

In total, 28 people were interviewed, including 27 farmers of the sample watercourses and one *Patwari* (who is a farmer himself). Five farmers from each sample watercourse were included in the sample except from the Watercourse FD 38-L, in which there are only two cultivators. The respondents also included the person responsible for the watercourse maintenance activities in each watercourse. The responses of the farmers are given below:

- Farmers allocate the workload according to the land holding size within a watercourse command area, this practice has been followed for ages.
- Nobody has even ever told us to clean their watercourse, so there is no question of anyone teaching us how to distribute the work load. The Irrigation Department is not concerned with the watercourse desilting.
- We have learned it from our elders
- Before partition, we lived in India, where we used to irrigate from the wells and used to clean small channels made for the well irrigation. After partition, when we came and settled down in this area, we started cleaning watercourses in the same manner. No one ever told us how to do it.
- Farmers themselves have created this method of cleaning the watercourse (including the distribution of workload) and no government has ever told us how to divide the workload. Though, if a farmer does not clean his share of the watercourse, other farmers can go and complain against him to the government. The government then can take action against that particular farmer, for example, by imposing a fine. In the past, we used to divide the workload according to the area, but now we do it according to the *wara* turn (same thing).

(Response of the *Patwari* who is not from a sample watercourse.) A very old man used to live (more than 100 years old) in our village, who used to tell us stories about his childhood. He has passed away now. Once he told us that there used to be two canals, dug out from the river, one Mahmoodwah and the other Daulatwah. Whenever there was water in the river, the big landlords would get all of the farmers together and clean these canals. Each big landowner would clean his part of the canal. Therefore, even then, the canals were cleaned according to the land holding size (though then it was according to the land holding size of the big landlords).