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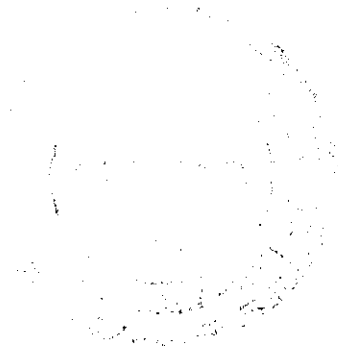
Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan

TRANSITION FROM LOCAL LEVEL MANAGEMENT TO STATE REGULATION:

Formalization of Water Allocation Rules in Pakistan



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ACKNOWLEDGMENTS

The research work for this report was initiated during the period when the International Irrigation Management Institute, Pakistan, was in a financially lean position. Despite all financial constraints, Professor Gaylord Skogerboe, the Director IIMI-Pakistan, in consultation with other colleagues, decided to initiate ground work on social organization in irrigated agriculture including this work, at Hakra 6-R Distributary command area. A special field team was set up for this purpose, and a new emphasis was given in IIMI-Pakistan's program for the institutional development research. The authors are thankful to Professor Skogerboe for his initiatives and support. The authors also appreciate the financial support provided by the Royal Netherlands Government through their project funds to IIMI for publication of this report and some additional field work that was needed.

During the intensive field work of interviewing farmers and taking discharge measurements at the outlet, IIMI's field team located at Haroonabad worked hard, traveling long distances and spending long hours. One of our team members, Mr. Muhammad Ishaque, succumbed to injuries in a road accident when the team was going to calibrate the outlet. The authors are indebted to his life sacrifice for the cause of research.

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FOREWORD

Usually, there is some romanticism attached to all indigenous norms and practices. In this sense, *Kachcha Warabandi* is often seen as a more appropriate water allocation practice than the formal rules introduced after the large canal irrigation systems were built. Some tend to even argue that *Kachcha Warabandi* should be revived on a larger scale in the context of Pakistan, alluding that it would make organized users groups essential and therefore more viable. However, the historical development of canal irrigation management suggests that the shift to formal *Pakka Warabandi* system was necessitated by an increasing incidence of water related disputes when informal water allocation methods continued to be practiced in newly established large systems.

In one of our earlier papers (Bandaragoda and Rehman, 1995), we mentioned that *Kachcha Warabandi* arrangement could have fitted well with the socio-political environment existing before the advent of large systems, at a time when the use of a few big landlords was found to be very convenient in settling occasional local disputes. As the big landlords "managed to arrange some sort of consensus", field level water distribution posed no difficulty, but the flexibility could have been used at the expense of the weaker sections of the community (Malhotra, 1982:1). Even in a more recent assessment of warabandi in Pakistan, *Kachcha Warabandi* is seen as a type that "suits the irrigation needs of large farmers" (Qureshi et al 1994). With increased political awareness and social development, the role of the big landlords was increasingly challenged, and the disputes started to undermine their authority. Increased frequency of disputes among farmers led to greater agency involvement, in an attempt to improve equity by formalizing water allocation methods into the *"Pakka Warabandi."*

In this paper, empirical evidence to this process is presented, with the additional hypothesis that the technical requirements arising from large canal systems can also encourage the formalization of water allocation rules. Interestingly, the tradition of *Kachcha Warabandi* was continued at this watercourse until it was challenged by a new generation.

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ABSTRACT

Theorists have identified various factors that promote or prohibit collective action at the local level. Various schools of thought attempt explaining collective action from various perspectives. This study addresses the basic question of why the state regulated pakka warabandi replaced irrigation water resources management at the local level. A case study approach has been followed. Farmers had already been practicing very effective water distribution at the tertiary irrigation level under a kachcha warabandi arrangement. This organization dissolved, and farmers adopted a pakka warabandi system. The community, and their organization, depicted in this study met almost all the standards laid down by earlier research. Results indicate that some users were acutely affected by unreliable water supplies, which the organization had no solution for. Cause for conflict among members pertained to sustaining the organization as a sacred symbol of tradition, as well as dealing with the unreliability as an exogenous variable. Dissatisfied members vetoed these, and invited state-regulated warabandi, which does not ensure reliability as such, but specifies the time and duration of irrigation turns for each user. Therefore, this study argues that technical factors form the root cause that triggers off social complications. These social complications challenge the potential of the organization and its aptness to mitigate the technical issue. If the organization cannot meet the challenge, the collective action is discarded. Thus, the presence, or absence, of collective action hinges upon the technical appropriateness of the organization and its ability to cope with the social constraints.

1. INTRODUCTION

Collective action for natural resource management, especially at the local level, remained in extensive focus during the second half of the twentieth century. Many researchers have studied, from several perspectives, the management of water resources for irrigation. While all such research on collective action emphasizes the importance of social organization around the resource to be managed, the conditions that promote, or prohibit, collective action for water resources management for irrigated agriculture remain debated.

The management of surface irrigation in parts of India and Pakistan provides an opportunity to study both, the emergence and the collapse of collective action; a recent phenomenon initiated in the late nineteenth century with the construction of large canal irrigation systems. People were settled in canal command areas, and management functions were partly entrusted to the farmers at the tertiary level of the irrigation system. The Irrigation Departments were responsible for allocating water up to the secondary canal outlet, leaving farmers to manage the distribution themselves.

Thus, water distribution at the tertiary canal level of the irrigation system of Pakistan was primarily the responsibility of the farmers benefiting from these watercourses. Resultantly, irrigation communities experienced social organization processes and established their own water distribution arrangements among their members. Water distribution took place through an irrigation roster, or ***warabandi,*** which is primarily determined by the amount of irrigable land owned by each member. The farmer-managed *warabandi* was called *kachcha* (flexible, informal) *warabandi*. Later, the government intervened when the day-to-day application of water distribution resulted in dispute, or when farmers requested additional water for increased cropping intensities, particularly to nurture their fruit orchards in arable land.

Reason for state intervention increased when farmers were exposed to new opportunities to acquire more water. Special allowances for orchards and other non-traditional needs were often misused. Sometimes, when a special allowance had been sanctioned, farmers exceeded the limitation several times over in order to get more water. At other times, farmers obtained special allowances without actually owning an orchard. This flexibility was often the result of an alliance between lower cadre staff of the Irrigation Department and more influential farmers. Invariably, such instances were unacceptable for the other, less privileged, water users. Disgruntled farmers either approached higher officials for some redress, or sought mitigation of these disputes through the judicial system. Successful settlement of disputes through this process encouraged more farmers to lodge complaints with the authorities.

Apart from these allocation-related disputes, farmer-managed water distribution at the watercourse level also tended to generate conflicts among farmers, which sometimes culminated in violence. The main origins of these disputes were two inter-related social factors. The first was the existence of a number of heterogeneous groups in terms of caste, *baradari*, or kinship, political affiliation, etc. along the same watercourse command. The coalition, and conflict of interest, of various sub-groups in the community easily fostered

inequity and free riding in water distribution. The second was the ***kachcha,*** or flexible, *warabandi* practice, which became prone to manipulation by the more influential water users.

Confronted with growing problems of inequity in water distribution caused by *kachcha warabandi*, some aggrieved water users expressed their preference for a fixed irrigation roster. Leading petitioners in such cases were mostly from the tail or middle reaches of the watercourses (Mirza, 1975), who were more affected by the upstream disturbances. Other affected water users usually agreed to sign the petition to formalize the irrigation roster.

In the Punjab province of Pakistan, the Irrigation Department's interventions in water distribution, by fixing formal water schedules (*pakka*[1] *warabandi*), started somewhere during the 1960s. By now, most of the watercourses in the area have switched over to *pakka warabandi*, and have discarded the flexible form of *kachcha warabandi*. This large-scale switch over, from local management to government control, provides an opportunity to study the conditions associated with organizational decay at this level. This widespread phenomenon of switching over from the *kachcha* to *pakka warabandi* reflects the limited formation of social capital among the farming communities in Pakistan. Thus, a study of this changed process can provide important information regarding the social, cultural and technical factors that influence the re-organization of water resources management.

The major objective of this paper is to trace the process of the switch over from *kachcha* to *pakka warabandi*, and to highlight the underlying factors that have contributed to the related re-organization of the irrigation management. This is undertaken by exploring the system of water distribution along one of the watercourses where farmers had formerly managed irrigation water distribution by applying their own rules, which was later dissolved in order to move towards state regulated *pakka warabandi*. Organizational rules are analyzed to test their validity for equitable water distribution. The causes of farmers' dissatisfactions, and dissolution of the organization, are isolated. Finally, the underlying factors that led to the organizational decay are discussed.

Application of *warabandi* was studied in a research program on social organization for water resources management, that was initiated by the International Irrigation Management Institute (IIMI) in 1994 at the Hakra 6-R Distributary of the Eastern Sadiqia Canal command in the Punjab Province. The farmers of one of the sample watercourses (No. 101/R) along this distributary were effecting the distribution of irrigation water through their self-managed *warabandi*. The farmers had devised their own water distribution rules by practicing *kachcha warabandi*. Transparent distribution, whereby a permanent demarcation of the water levels at the diversion point (*mogha*) with fixed nails installed at the structure, determined different water allocation patterns for the watercourse.

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[1] It can be argued that the use of the words ***pakki*** and ***kachchi*** instead of "pakka" and "kachcha" is more appropriate grammatically. Being adjectives, these have to be used keeping in view the original word that is qualified by these terms. Since *warabandi* in Urdu, Hindi and Punjabi is a feminine word, use of a feminine form of adjectives is grammatically more appropriate. However, the literature on warabandi generally uses "pakka" and "kachcha".

The users believed that when compared to *kachcha warabandi,* the official *pakka warabandi* did not offer proper equitable water distribution procedures, especially during sudden canal closures and periods of low flow. The community of water users along this watercourse had entrusted distribution of irrigation water responsibilities to one of the watercourse shareholders. The community had also authorized him to impose sanctions on free riders and violators of local water allocation rules.

While the water distribution system at this particular watercourse was radically different, and informally managed by the farmers, the majority of watercourses in this canal command were already practicing *pakka warabandi*, sanctioned by the Irrigation Department. Some flexibility in this arrangement was provided in terms of exchanging water turns. Table 1 details the distribution along the watercourses.

Table 1. Details of Pakka and Kachcha Warabandi along Different Watercourses in Hakra Branch Canal.

Level of the System	Total Number of Watercourses	Watercourses with *Pakka Warabandi*	Watercourses with *Kachcha Warabandi*
Hakra Branch Canal	1485	1277	208
Hakra 6-R Distributary	276	246	30

Source: Irrigation Department, Hakra Division, Bahawalnagar.

According to Irrigation Department records, farmers on more than 86 percent and 89 percent of the watercourses on the Hakra Branch Canal and the Hakra 6-R Distributary, respectively, have already opted for a state-regulated *pakka warabandi*. Due to various reasons, water users at most of the remaining outlets are, in practice, observing a *kachcha warabandi*.

2. THE THEORETICAL BASIS

A considerable amount of literature on collective action is available, mostly in the disciplines of economics, sociology and political science. Each of these disciplines, however, tends to explain collective action in isolation of the other disciplines. Economists (for example, Prathasarathy, 1998) would try to explain collective action through the game theory, and other theories of public goods. Sociologists (for example, Merry, 1982), on the other hand, would expose collective action to social psychology, cultural and traditional values, and social capital formation. Political scientists would always refer to the theories of Prisoners' Dilemma (Axelrod, 1981; Wagner, 1983; and Wade, 1987), Tragedy of Commons (Hardin, 1968; Dawes, 1975; Kimber, 1983 and Wade, 1987), Olson's Logic of Collective Action, and Assurance Problem (Oslon, 1971, and Wade, 1987).

Apart from these disciplines, management professionals would try to interpret successful management in the framework of appropriateness of the organizational rules, sizes and structures (Hunt, 1989; Wade, 1988). Canal managers, usually engineers by profession, would refer to the suitability of physical designs to the users' resource needs. All of these disciplines provide useful insights towards analyzing the context of our problem, and to arrive at conclusions.

Many researchers have tried to isolate the factors generally associated with appropriate social organization for irrigation management (Hunt, 1989; Wade, 1987, Merry, 1982). Wade (1987) postulated that the likelihood of successful organization would depend on the following:

a) smaller and more clearly defined physical boundaries of common pool resources;
b) higher cost of exclusion of technology for non-members;
c) greater overlap between the location of the common pool resources and users' residences;
d) greater demands (up to a limit) and more vitality of the resource for survival;
e) users' improved knowledge of sustainable yields;
f) smaller amount of users (up to a limit)
g) clearly-defined boundaries for membership;
h) comparatively less powerful free riders;
i) better arrangements to facilitate discussions for the users;
j) extent of promise kept by the users;
k) extent of applicability of rules;
l) easy detection of rule-breaking; and
m) state tolerance for the local management.

Merry (1982) documents the following characteristics of irrigation communities, in Pakistan, that cooperated to have their watercourses lined:

a) lower percentage of economically non-viable farmers;
b) less skewered land and power distribution;
c) larger percentage of influential farmers;
d) relative concentration of power at the middle and tail portions than at head reaches;
e) relatively more progressive communities;
f) history of cooperation on community projects;
g) relatively small amount of shareholders; and
h) membership of most of the shareholders in a single *baradari*.

A more recent effort (Malik et. al, 1996) shows that past history of cooperation among the community, existence of effective leadership, credibility of punishment, less tenants and effective conflict resolution were social factors that contributed to effective organization of irrigation activities. Contrarily, small group sizes, total absence of conflicts and single committees for religious affairs did not affect the effectiveness of organized behavior. In addition, the presence of one dominating agricultural caste was found to lead to well-organized common irrigation activities. Thus, the effect of intra-*baradari* set-ups and rivalries (*sharika)* has been found to be less correlated with organized behavior.

Theoretically, organizational decay could be the result of the interplay of many technical, agronomic, social, cultural and organizational factors. Some researchers who studied the switchover process, from *kachcha* to *pakka warabandi,* have confirmed that the major reasons behind farmers' interest to switch to *pakka warabandi* were inequity and an imbalance of power distribution within the community (Mirza, 1975). Another study, (Merry, 1982) saw additional reasons as main social variables, i.e., free riding and values encouraging conflict, such as *izzat* (honor, repute), that contributed to the lack of cooperation among irrigation communities in Pakistan.

The current study aims to analyze the process documentation related to the operation of *kachcha warabandi* in order to understand how the social organization works. Information pertaining to various socio-cultural aspects of the community, and its system of water distribution, was collected through eight key informants from within the community along Watercourse 101/R. A series of hydraulic measurements was undertaken to validate the water distribution rules of the organization. In depth interviews with users facilitated collating their perceptions about the effectiveness of *warabandi* operations, and were recorded before and after the switchover.

2.1 DEFINITION OF WARABANDI

The term *warabandi* is derived from two local words ***wahr*** and ***bandi***, meaning "turn" and "fixed", respectively (Bandaragoda and Rehman, 1995; and Bandaragoda, 1997). Thus, *warabandi* translates into fixation of irrigation turns for the landowners along a particular watercourse. Essentially, *warabandi* is a rotational method to equitably distribute available water in an irrigation system. Turns are fixed according to a pre-determined schedule specifying the day, time and duration of supply to each irrigator, in proportion to the size of

his landholding in the outlet command (Singh 1981, and Malhotra 1982). In consideration of "fixing" water turns, this definition seems to apply only to the officially sanctioned *pakka warabandi* schedule, which is determined and "fixed" by the Irrigation Department.

a) Pakka Warabandi

A *pakka warabandi* generally follows a cycle of one week, or ten-and-a-half days. Furthermore, the 12-hour *pakka warabandi* rotation is alternated every year, generally after the annual canal closure in December-January, so that farmers who had been irrigating at night during the previous year will irrigate during daytime hours during the next year. This *warabandi* is sanctioned by respective Irrigation Department Executive Engineers, and also serves as proof of water rights for shareholders along the watercourse (Bandaragoda and Rehman 1995).

b) Kachcha Warabandi

Converse to *pakka warabandi*, farmers distribute the water entering their watercourse by following an agreed irrigation roster without formal involvement of the governmental agency. This type of *warabandi* is generally referred to as *kachcha* (ordinary, unregulated, informal) *warabandi* (Bandaragoda and Rehman (1995). This type of *warabandi* provides turns that are generally fixed and predetermined, but the day and timing of each turn is flexible and depends on the availability of water in the watercourse.

c) *Differences between Kachcha and Pakka Warabandi*

These two *warabandi* systems contrast sharply with each other in several respects. Differences between *kachcha* and *pakka warabandi* systems range from the way the irrigation roster is devised to the way it is used in conflict resolution. A brief account of major conceptual differences is given below.

Irrigation Roster: In the case of *pakka warabandi*, the roster is formulated by the Irrigation Department's Executive Engineer on the basis of field information collected by his staff in consultation with the shareholders, such as area owned by each of the shareholders, location of the farm on the watercourse, etc.. He uses established principles to fix *khal bhrai* (time required to fill a unit length of an empty watercourse), *nikal* (flow time of water left in a watercourse at the end of a turn, or upon completion of *warabandi*), and additional allowances, like that required for orchards etc. (Nasir, 1993). Under the *kachcha warabandi*, the shareholders prepare the roster themselves, sometimes in consultation with a local water allocation expert.

Cycle of Irrigation Turns: The cycle of irrigation turns is fixed in the case of *pakka warabandi*. This may span over a period of one week, or ten-and-a-half days. For *kachcha warabandi*, however, the cycle of the turn is fixed for supplies under normal conditions, but

it may not necessarily be similar to that of *pakka warabandi*, since it depends on the variability of irrigation water supplied to the watercourse.

Continuity of the Turns during Canal Closures: The irrigation roster for *pakka warabandi* is continuous, moving even if there is no canal water. In the case of *kachcha warabandi*, the roster stops at the last farm receiving water at the time of supply disconnection, then starts from the same farm when the supply starts again.

Flexibility in Water Turn Duration: The duration of the *pakka warabandi* is the same for all flow levels of the parent distributary / minor channel, and conversely, is flexible in the case of *kachcha warabandi*. A farmer irrigating at any flow less than that of the canal's full supply is granted additional time for his irrigation turn to compensate for the loss caused by a decreased flow.

Equitable Distribution of Gains and Losses: Under *pakka warabandi*, gains and losses may not be equitably shared due to flow variability at the distributary and outlet heads. *Kachcha warabandi* accommodates adjustments in water turns, and thus, farmers can share gains and losses equitably. When the distributary is closed, the *pakka warabandi* rotation schedule still continues, but the *kachcha warabandi* stops. Thus, all the *kachcha warabandi* shareholders suffer equally. In the case of *pakka warabandi*, however, only those who were irrigating at the time of the flow disturbance will lose a particular turn, or part thereof.

Dispute Resolution: Water-related disputes among shareholders along the same watercourse are to be settled by canal officers, if reported to him. If irrigation offences (*wara shikni)* are reported to department officials, inquiries would be conducted, and sanctions imposed. Farmers spend interminable years commuting to and from irrigation courts, arbitrators and judicial courts before disputes are resolved. In contrast, *kachcha warabandi* water users resolve disputes by consensus among themselves and take punitive action against the violators. This is swifter and more efficient than the formal legal arrangements under *pakka warabandi*.

2.2 THEORETICAL PROCEDURE FOR PREPARATION AND MODIFICATION OF *WARABANDI*[2]

In theory, the state has no power to interfere in the internal distribution of water along a watercourse. The Divisional Canal Officer (DCO) may only consider a *warabandi* case upon receipt of a written petition that bears a court fee stamp from one, or more, of the shareholders, stating the nature and details of the water rights dispute.

Upon receipt of such a petition, the DCO must take up the case. His inquiry has to be confined to the matter detailed in the petition, and preparation of the new, complete *warabandi* can only be undertaken when the petition is worded in a manner that justifies itself. In order to avoid unnecessary work, the petition has, therefore, to be carefully studied before the case is taken up. If the petition is vague or unclear, it can be filed.

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2 Nasir, 1993

The DCO is not responsible for conducting the entire inquiry himself. The preliminary inquiry and preparation, or modification, of *warabandi* is to be carried out by the *Zilladar* under the supervision of the Deputy Collector, or revenue officer. Cases of *warabandi* have to be dealt with expeditiously. Irrigation and revenue survey staff have to liaise with each other when investigating cases of this nature.

Before passing the new orders, the DCO must call a meeting with all interested persons, or persons liable to be affected. This meeting should be announced at least 14 days beforehand to allow sufficient time for the shareholders to participate. The DCO has to hold an inquiry in the meeting, and should explain the proposed *warabandi* to the shareholders, as well as hear, and record, any objections raised thereto.

The DCO's decision should subsequently be issued in the form of an order under Section 68 of the Canal Act of 1873. This should be presented in the form of a judgement that states the alteration desired as requested in the petition, and objections raised. In addition, it should also state the petition's points, and the objections that were accepted and over-ruled, providing reasons in each case. A copy of the modified *warabandi* should accompany the orders. The *Zilladar* should announce the orders to the shareholders personally, and hand a copy to *Lumberdar*[3]. Any other copies required by the shareholders should be supplied upon payment of the usual copying fee. A civil court is the only authority that can set a DCO's orders aside. The DCO, however, can alter these himself for a successor, particularly when a different dispute arises and a written petition to this effect is received, when a fresh inquiry is to be instituted under Section 68 of the said act.

2.3 HISTORICAL BACKGROUND OF *WARABANDI*

At the advent of irrigated agriculture in this part of the world, big landlords owned most of the irrigated land. Not too many shareholders, along most of the watercourses, existed then (Malhotra, 1982). With few shareholders and water allocation decisions being taken by dominant farmers, the traditional *kachcha warabandi* was practiced without interruption. The *kachcha warabandi* was a very flexible method of water distribution below the outlet structure. This *warabandi* ensured water for all the shareholders along the watercourse. When the water flow was temporarily disrupted due to canal closure, or for any other reason of water shortage, the irrigation cycle would start from the last irrigated farm upon restoration of the flow. *Kachcha warabandi*, along some of the watercourses, underwent some modifications in areas where irrigation communities had decided to fix the day and time of irrigation turn for each user, regardless of the presence of water in the watercourse. However, it was possible for any two farmers to exchange irrigation turns with each other through mutual agreement. As long as the group of relevant shareholders could manage the distribution of canal water agreeably and collectively, the *kachcha warabandi* was functional.

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3 Lumberdars were appointed in each community from within the community by the British Government and have several functions. For irrigation department, they collect the revenue and deposite it with the government treasury after deducting their commission.

Resultantly, there was no need to invite the interference of government agencies (Bandaragoda and Rehman, 1995).

In erstwhile years, disputes related to water distribution were settled locally, as big landlords always managed to arrange some sort of consensus without bothering the state (Malhotra, 1982). Therefore, from the administrative point of view, the problem of water distribution within the watercourse presented little or no difficulty to the state. This, however, does not mean that the water distribution was fair, just and scientific (Malhotra, 1982).

Initially, people of similar kinship resided in nearby villages where irrigated agriculture was being practiced in the Punjab province. Mostly, irrigated agriculture was only developed near the head of the watercourse (Malhotra, 1982). After the extension of the irrigation systems during subsequent years, especially after being partitioned into Pakistani and Indian Punjab provinces in the 1940's, the two provincial Punjab governments intervened so that farmers could settle in areas with relatively more uncultivated lands. As a result, a flux of settlers and migrants invaded the un-irrigated lands near the canal commands, and the irrigation systems were expanded to watercourse levels to fulfill irrigation needs.

Due to intensified agriculture with the passage of time, the pressure on canal water resources increased. Besides, landholdings were fragmented into small plots of varying sizes because of the inheritance law[4] and land trading. As a result, the land distribution pattern has become highly skewered, adversely affecting the productivity of agriculture in the country.

Also, the socio-cultural milieu of irrigated agriculture has changed. The involvement of considerations like *baradari (*kinship group, brotherhood, bloodline), *sharika* (inter-*baradari* rivalry) and *izzat* foster irrigation-related disputes among shareholders (Mirza and Merry, 1979). With growing irrigation disputes on *wara shiknis* (irrigation offences), and violations of irrigation *haqooq* (water rights) by relatively influential shareholders, *kachcha warabandi* water distribution posed serious administrative problems. The state had gradually to intervene by replacing the *kachcha warabandi* with *pakka warabandi* when requested by affected shareholders. Thus, there had been a gradual shift from local level management to state regulation.

[4] The inheritance law in Pakistan contrasts sharply to that of many advanced countries and allows for continued distribution of ancestral land into fragments, and does not impose any boundary on further distribution.

3. DESCRIPTION OF FIELD DATA

3.1 GENERAL FEATURES

The Hakra 6-R Distributary is one of the largest secondary canal irrigation systems in the Punjab province. Off-taking from the Hakra Branch of the Eastern Sadiqia (South) Canal, which originates at Sulemanki Headworks, the Hakra 6-R Distributary is some 50 kilometers long and has 113 outlets. Apart from these outlets on its main stream channel, it also has four minor canals that supply water through 163 outlets.

The watercourse under discussion off-takes at RD 101+015 on the right side of the main distributary channel. The outlet structure is an adjustable proportionate module (APM). The watercourse is partly lined with a sanctioned culturable command area of approximately 109.5 hectares. The design discharge is 1.22 cubic feet per second (cusecs). At the time of this study, official records reflected 22 shareholders. All the shareholders were members of the same caste (Arain).

The pattern of land distribution was relatively less skew when compared with the average watercourse commands in the area. There was only one shareholder that owned less than two hectares of land (1.5% of the total area). Another 15 shareholders (around 68%) owned between 2 and 5 hectares (roughly 58% of the total area). There were 6 large landowners (27%) who owned in excess of 5 hectares, but less than 11 hectares (around 40 % of the total area). The biggest landholder along the watercourse owned slightly more than 10 ha. Therefore, the land distribution cannot be regarded as excessively skewed.

Upon further characterization of the community, indications that it had cooperated on several collective issues, such as the construction and maintenance of the mosque, village road, village electrification, and the school, were evident. Major water-related disputes in the recent past were non-existent. Community members communicated comfortably among themselves, often helping each other out of difficult situations. On most collective issues, the community acts as a single brotherhood and has no familial disputes involving *izzat* and *sharika* considerations.

3.2 *KACHCHA WARABANDI* ROSTER AT FULL SUPPLY OF WATER

At full supply of water in the distributary, the irrigation roster comprised a cycle that operated for 146 hours and forty minutes, against, generally, 168 hours (7 days) at other watercourses governed by *pakka warabandi*. The belief shareholders held was that a cycle shorter than a full week suits the soil in the command area of the watercourse best, because most of the soil is of a sandy nature. Lighter, but more frequent irrigation has had a positive effect on crop production. Thus, in order to provide an early irrigation turn to all the shareholders as a preventive measure against crop wilting, the cycle has intentionally been kept short. The *kachcha warabandi* list detailing the duration of water turns for various shareholders at normal distributary flow conditions is presented in Annex 1. The list contains the names of cultivators and their respective land holdings, their cultivation status and water

time allocations. The total water allocation is determined on the basis of 28.8 minutes per acre of the command area.

Irrigation officials originally framed this *warabandi* schedule about half a century ago. At that time, the concept of *pakka warabandi* was non-existent, and a 12-hour irrigation allocation, per 25 acres, was decided. Most land holdings were 25 acres each. Farmers did not own watches then, and estimated the start and end of water turns by observing the position of the sun during the day and that of the stars at night. Thus, this allocation was easy to apply. Land division has rendered this arrangement impossible due to shorter irrigation turns. Nowadays, as watches are common, farmers punctually reach diversion points at the exact time their turns start.

Farmers were found to be unaware of the start of their irrigation turn time at low flows, due to the disturbance to the length of the turn. They had to contact the *warabandi* **member**[5], selected by them to manage the roster for the shareholders. In the case of normal flow, most people remembered their turn timings. Some relatively simple farmers, however, needed confirmation because they assumed that they could be mistaken. Therefore, they frequently confirmed their turn timings from neighboring farmers, or from the *warabandi* **member**. The major reason for this lack of awareness was because of the length of the cycle being less than a full week.

Under normal flow, each turn repeated itself about 21 hours earlier than the preceding one. Besides, the distributary rotation system followed along the Hakra Branch Canal caused the variability in the flow within the distributary channel due to upstream disturbances, which usually also necessitates allowance for increased water turns.

3.3. CHARACTERISTICS OF THE OUTLET STRUCTURE

The outlet structure is an adjustable proportionate module. Discharge measurement experiments revealed that the structure had been tampered with. Farmers were of the view that the designed size of the outlet structure did not meet their irrigation requirements. Therefore, some farmers consulted the Irrigation Department's lower staff, and utilized their knowledge to adjust the outlet structure. During each closure period the department would repair the damaged outlet, but farmers would subsequently tamper with it again after the canal closure ended.

Farmers had created a hole underneath the metallic outlet structure by removing the brick beneath its crest. Thus, the size of the opening had been increased, simultaneously increasing the outlet's discharge correspondingly. The exact dimensions of the hole could not be measured due to its irregular shape and coarseness. An important point delineating from this situation is that though the canal water cannot be regarded as abundant at this watercourse,

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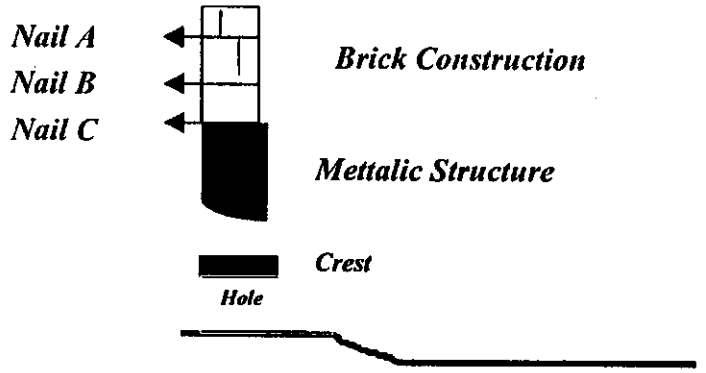
5 The English word member is commonly used for all those persons (s)elected to an honorable office by the community to represent them for a specific job. A member of the local bodies, ushar zakat council etc. is all called a *member*.

the farmers were still able to secure adequate water through their interface with the Irrigation Department.

The actual width, or "b", of the metallic structure was 0.25 feet and the height of the orifice opening, or "y", was 0.68 feet. The outlet is depicted in Figure 1.

Figure 1. Side View of Outlet 101-R / 6-R.



Outlet tampering was discovered at the time of the study; there had been a "hole" beneath the crest. Three nails had been fixed on the side brick wall. Each of these nails was fixed at equal distances of one brick-height from each other. These physical characteristics of the outlet had facilitated devising a water distribution system in which farmers used three nails fixed near the metallic outlet structure to indicate the water level in the distributary.

Original Nail Fixation Points: Initially, the top nail (Nail A, Figure 1) had been located 1.51 feet below the upper edge of the brick structure, the middle nail 0.45 ft below the top nail, and the bottom nail, 0.29 ft further down. The four pioneers of this scheme estimated these distances by trial and error using the height of a brick as a measure. Farmers mentioned that in erstwhile years, before metal outlet structures were installed and outlets used to be open weirs, the **member** used a "yard" to determine the water level in the distributary, which he had imported from experiences in the "Toba Tek Singh" District. Thus, farmers were aware, to some extent, about the gap between the critical points in the outlet structure and the corresponding flow levels. Using this qualitative judgement, farmers assessed that if the nails were placed at these points, and the agreed decision rules were applied properly, the same area could be irrigated as though at full supply of the distributary. At any flow less than the full supply level, extra time would be allocated to the shareholder for each level indicated by the nails, as discussed below.

Change in the Location of the Top Nail: The position of the top nail was shifted from 1.51 feet to 1.67 feet below the top edge of the brick wall in 1989. The logic behind this decision was related to the emergence of waterlogging in the head reach of the distributary. Shareholders along the head reach started closing their outlets due to a lower demand for water. The Irrigation Department, as a result, remodeled the channel and reduced the outlet discharges in the head reach to avoid breaches in the distributary. As this departmental action

resulted in a small reduction in the distributary discharge, the water quickly reached the top nail, and farmers had to adjust the turns more frequently. Usually, additional time had to be allocated to the irrigators. As a result, the *warabandi* **member** needed to adjust the water turns after frequent examination of the water level in the distributary. This increased his workload enormously. To reduce his workload, the top nail was moved further down to the present location.

3.4 ROLES OF THE THREE NAILS IN WATER DISTRIBUTION

The Top Nail: If the water level in the distributary was above the top nail, all the shareholders were entitled to their normal irrigation turns, i.e., 28.8 minutes per acre. When the water in the distributary touched the top nail, or when the water level was between the top and middle nails, the irrigator was entitled to half the time more than the actual time (i.e. 150% of the farmer's normal irrigation turn).

The Middle Nail: (Nail B, Figure 1.) When the water level in the distributary dropped to reach the middle nail, or was between the middle and bottom nails, the irrigator was entitled to avail twice his normal irrigation turn. Thus, an irrigator entitled to a 2-hour water turn would instead get a 4-hour turn during this period of low flow.

If the change in the flow took place at the end of a particular turn, the irrigator would be compensated for his entire turn proportionately, even though he had already availed most of his turn's time at the normal flow of the distributary. The respective irrigator, however, had to inform the *warabandi* member about this change in flow well in advance so that it could be inspected. The member had then also to inform the next irrigator about this adjustment in advance.

When the irrigator failed to report to the member in good time, he would not be entitled to avail this compensation, as the next irrigator would already have reached the diversion point (*nakka*) to start his or her water turn. If a particular irrigator neglected his responsibility to inform the member, then the member would penalize the irrigator by disallowing an additional duration of the turn. The next irrigator would never be asked to go home and return at a later time, unless he would willingly consent to the compensation.

As an alternate option, such an irrigator might avail an extra water turn at the same nail, or wait for the anticipated further decline in the water level at the middle nail, so that he could claim double his normal turn time. Generally, however, bigger farmers who were certain that the flow would reach the middle nail during their actual timings, as their turns were longer, opted for this opportunity. Small farmers, generally, opted not to wait for a further decline in the water level.

Sometimes, those who opted for a concession at the middle nail suffered. They would wait for the water level to drop further to the middle nail, but the water level would remain constant at the top nail, or start rising. In such cases, they would not be entitled to any concessions.

The Bottom Nail: (Nail C, Figure 1.) When the water level drops to the bottom nail, the duration of the turn became rather irrelevant. When the water level reached this nail, an irrigator was entitled to continue his irrigation turn until such time that he would be able to irrigate one-fourth of his entire holding. The logic forwarded by the farmers is that at normal, or full, supply level of the distributary, one irrigation turn is sufficient to irrigate one-quarter of the total land. For the purpose of the pre-soaking irrigation (called ***rauni*** in the local language) or sugarcane ratoon crop field, an irrigator was supposed to irrigate one-sixth of his total land because such fields absorb more water. At this nail, irrigators were not allowed to irrigate their fields by flooding; only basin irrigation was permissible. Due to this condition, farmers had small *bunded* fields. The farmers first irrigated one sub-plot equivalent to of one-fourth of an acre, then diverted the water into a second sub-plot, and so on.

If, upon reaching the bottom nail the watercourse dried up during, or even at the end of the turn, the whole un-irrigated sub-plot would be considered as if not irrigated from his potential area of 25 percent. He was compensated for this sub-plot, and was entitled to resume his turn when the water was released again, so that he could irrigate his remaining sub-plot free of cost. This compensation was, however, not granted happily, but rather, due to the constraint that water, when released in the distributary, takes some time to become stable. At unsteady flow it is difficult to adjust the water turn schedule due to fluctuations and a possible rise in the water level. While irrigating one sub-plot the flow could become stable, and then the roster could start from the next shareholder again. The rules regarding the distribution of irrigation water at this particular watercourse are summarized in Table 2.

Table 2. Location of Nails, and Farmers' Decision Rules for *Water Distribution at Watercourse No. 101-R/6-R.*

Nail	Water Level Range	Decision Rule
Above top nail	Full supply to above first nail	Allocation of normal irrigation time, i.e., 28.8 minutes per acre
Top	First nail to above second nail	Allocation of 50 percent more time per acre
Middle	Second nail to above third nail	Allocation of double time, i.e., 57.6 minutes per acre
Bottom	Third nail and below	Allocation of water continues until the water user completes irrigating 25% of his holding

3.5 WATER AVAILABILITY AT THE OUTLET

The Hakra 6-R Distributary was monitored at the outlet structure for a period of one year during 1994-95 in order to record flow levels during the two cropping seasons.
The rotation among different off-take channels (such as minors and the main channel) along the distributary is planned to run at full flow for one week, at second priority during the next week and at third priority during the third week. In the fourth week, it will once again run at full supply. Excluding the 4 weeks' closure during December-January, there should be 48 rotations. In principle, the distributary channel should flow at one supply level for 16 weeks.

Table 3 shows that instead of 48 different rotations for the year, there were 53, which indicate more rotations due to operational manipulation. For 15 times out of 53, all three nails remained under water during the *Kharif* and *Rabi* seasons, thus the number of water turn adjustment interventions by the **member** was not needed during these times. Compared to the *Kharif* season, the flow was more consistent during the *Rabi* season, as there were only 11, against 17, variations (October 15 to March 15). There are two reasons why the distributary was not disturbed during the *Rabi* season. Firstly, the prevalence of waterlogging in the head reach of the distributary resulted in the farmers keeping most of the adjoining watercourses closed, which caused high flow in the downstream of the distributary. Secondly, the distributary remained closed during the month of January for the annual closure.

The proportion of rotations during which the member had to adjust the farmers' water turns to distribute water is quite high. The total number of rotations like these were 30, double than those where the member's role is relatively passive. Again, compared to the *Rabi* season, variations during the *Kharif* season had been more.

Table 3. Flow Situation at the Hakra 6-R Distributary during Kharif and Rabi, 1994-95.

S.No.	Water Level	*Kharif* 1994	*Rabi*, 1994-95*
1	All three nails under water	12	3
2	Two nails under water	16	3
3	One nail under water	8	3
4	All three nails above water	6	2
5	Total	42	11

* *Includes closure period at the start and end, where there are generally more fluctuations.*

The above information reveals that when water was available in the distributary during one year, almost three-quarters of that period was highly variable. The organization had also to work in consideration of its water distribution rules. While this reflects that the organization had to be

involved in water distribution continuously, a high degree of unreliability in the water supply is also reflected. An important implication of this situation is that the users had to be in touch with the *warabandi* **member** to obtain information about the start and duration of their water turns.

3.6 THE SOCIAL ORGANIZATION

History of this Farmer-managed Water Distribution System

Origin of Water Distribution System: Four persons who had migrated to this watercourse command from Toba Tek Singh District in 1947 pioneered the described practice of *kachcha warabandi* water distribution at this watercourse. They arranged easy visual measurements during the first installation of the outlet, a method they had learned from their elders in Toba Tek Singh and Rahim Yar Khan Districts. The stated purpose of the method was to maintain equity in water distribution.

Initially, the outlet head was unpaved, rendering it a mere pipe outlet. The **member** at the time used a metallic rod or equivalent to one yard to measure the depth of the water from the bottom (crest) of the pipe to adjust the shareholders' water turns. Since 1967, when the Irrigation Department constructed the brick walls around the outlet structure, the three nails were fixed at different levels in the wall to demarcate different flow levels replacing the measuring rod.

Selection of the Warabandi Member: The first *warabandi* member worked at this post for almost 25 years. He managed the practice honestly, to the satisfaction of the shareholders. In 1972, old age took its toll, and he was unable to continue. Shareholders asked him to suggest a suitable replacement. He suggested another person who was also honest and wise. His farmhouse was located suitably close to the center of the watercourse command, from where he could easily inspect the head and the tail reaches of the watercourse. Besides, he was also always available for the shareholders. People used to consult him to estimate expenditures for marriages and other unrelated matters, because they trusted his wisdom.

The shareholders were by then already divided into two groups due to a familial clash that involved *izzat* and *sharika*. One of the groups opposed the selection of the proposed member because they suspected that he would discriminate in favor of the other group with water distribution. Therefore, it was decided to select two members who would work together. The new member would assist the old retiring member, who owned land in the head reach of the watercourse, and the former, as mentioned earlier, was located somewhere in the middle of the watercourse command. This arrangement continued for two years, by which time the disputes had been resolved among the shareholders.

Once again a single unit, farmers agreed to appoint the proposed new member, who decided to have his brother assist him. They now share the special irrigation turn allowance of one hour, for jointly discharging responsibilities as members, between them equally.

Responsibilities of the Warabandi Member: The role and responsibilities of the *warabandi* member are:

a) to operate the *warabandi*, particularly at low flow, and also to inform every water user whether his water turn is scheduled for during the day or night;

b) to inspect water users' irrigation practices to monitor misuse, especially for when the water level reaches the bottom nail, as each water user is supposed to conduct basin-type irrigation when this happens;

c) to impose sanctions on those violating the rules (for instance, a few years ago an irrigator cheated the member by mis-reporting that the distributary was running at the top nail instead of at the full supply level. The member believed him and allotted him extra water, which is prescribed at this nail. Later, others informed the member that the distributary had not run at the top nail, but at full supply level. The member did not penalize the cheating irrigator for mis-reporting, but waited for his next turn. The same irrigator tried to do the same in his next turn, but this time he was caught red-handed. The cheating irrigator apologized, assuring the member that he would abstain from this dishonesty in the future. The member deducted the extra, cheated water from his turn);

d) to allow a one-hour water turn to a person with an extensive demand for water, only valid at the low flow (the next irrigator should be informed well in advance about the arrangement); and

e) to keep track of the distributary's opening and closure, and to record the name of the last irrigator at the time of distributary closure so as to avoid disturbances that could affect the adjustment of the irrigation turns.

Resolution of Disputes: There had been only one reported water-related dispute at the watercourse. An irrigator opened his *nakka* and started availing his water turn without informing the previous irrigating farmer, which was a total mis-understanding and not willful violation of rules. He thought that his turn had started. In fact, the low flow had started but the member had not informed him. The previous irrigator asked him to close his *nakka,* as his turn was still effective. He refused, as no one had informed him about the low flow. The case was referred to the member, who admitted that it was his mistake. The member requested the person to close his *nakka* and promised to compensate the water from his own turn.

Benefits of Extra Water Received as Member: The member believes that the extra turn of canal water given to him for his services does not have any impact on yield. The cropping intensity has increased, as it enables him to cultivate an acre of additional land that would be kept fallow otherwise.

Farmers' Perceptions about the Suitability of Kachcha Warabandi: Out of the eight key informants, only one regarded this pattern of water distribution as cumbersome and complicated, while the remaining key informants regarded it as equitable and useful. There are twenty-two water users in total, of which only four had some negative opinions about the system of water distribution.

In general, the older people expressed their satisfaction with this form of *kachcha warabandi,* but some of the educated younger ones had negative opinions. To them, uncertainty attached to their irrigation starting times has some economic costs as they have to wait for the information from the member and forego some other important tasks they could have performed during the time in which they needed to wait. Three of the four were part-time farmers and had other, more regular businesses, such as a shop or a job. Besides, they did not consider being "respectful" necessary by having to consult the member merely to know the time of their irrigation turns, and consider this as being "dishonored". Nevertheless, they could not disregard the decision of the majority, who was satisfied with the *kachcha warabandi* arrangement. However, they favored *pakka warabandi* whereby every irrigator would know the time and day, and the duration of the irrigation turn, in advance. Farmers can go to their *nakkas* and open these at the specified times. There is no need to "salute" the member every time. Up until 1997, the following reasons prevented them from applying for a *pakka warabandi*:

* All the shareholders belonged to the same Arain *baradari*, so they had to respect and take care of each other's feelings;

* They had to obey their elders. The elders were in favor of the *kachcha warabandi* in practice, because to them, the gains and losses were equitably distributed in *kachcha warabandi*;

* The relatively small water user community precluded the possibility of a high incidence of water-related disputes and conflicts. There had been almost no conflicts, as no one's rights were jeopardized with this equitable distribution of water;

* The majority of the water users were owner-cultivators who were more interested in their lands than the tenants, and preferred to take precautions to avoid over-irrigating their lands; and

* The opposition group comprised only four persons, thus carried less weight than the majority.

***Kachcha Warabandi* Systems at Two Watercourses, 101/R and 132/L**

(a) The *kachcha warabandi* at 132/L runs in a fixed cycle of 168 hours, but at 101/R it generally runs in a cycle of 146 hours;

(b) The *warabandi* at 132/L is not interrupted by flow changes or stoppages, but at 101/R , the cycle stops working with the closure of the distributary;

(c) At 132/L, an irrigator gets fixed time regardless of the distributary's water level, while at 101/R, an irrigator does not receive proportionate increases in the fixed duration of time at the low flow of the distributary;

(d) At Watercourse 132/L, the water allocation is inequitable. For ordinary farmers, the time allocation is 38 minutes per acre, but the *Lumberdar* gets 55 minutes per acre. The other farmers do not demur, as the *Lumberdar* is an influential person. In fact, the *Lumberdar* is considered to be a big obstacle in converting to *pakka warabandi*. Conversely, at 101/R, the water is allocated and distributed more equitably;

(e) At 132/L, only those who have an irrigation turn during the closure of the distributary miss the water, while at 101/R, all of them suffer equally; and

(f) There is no allocation of water for orchards on Watercourse 132/L.

4. DISCUSSION: SOCIO-TECHNICAL LINKAGES

One of the objectives of this paper is to verify the decision rules set by the farmers for water distribution empirically, including their practice of determining the duration of water turns according to the water level in the distributary. This objective can be met in several ways. The water level in the parent channel is simply an indicator of the amount of water discharged into the watercourse, as the amount of water in the watercourse is a function of the upstream water level, the area of the outlet structure and the outlet characteristics. Therefore, a relationship between the allocated time and the discharge in the watercourse can be analyzed for empirical verification. The correlation between the allocation of time and the discharge in the watercourse can provide a statistical method to verify the first three decision rules. The fourth decision rule is based on farmers' experience that allows them to irrigate one-fourth of their area during each irrigation turn at full supply. The product of the discharge and the duration of the irrigation turn will yield the volume of water. For the purpose of this study, we use the estimated volume of irrigation water at the head of the watercourse for validation of the decision rules.

4.1 CALIBRATION OF OUTLET STRUCTURE

For actual measurement of the discharge at various water levels, a benchmark approach was followed (During, 1997). Benchmarks were installed both upstream and downstream of the outlet and the respective water levels were recorded above the crest of the outlet at the time of the measurements. The actual discharge in the watercourse was measured by using a pygmy current meter that records the velocity of water flowing in the watercourse. The watercourse was divided into three sections and the velocity and the area of each of the cross sections were measured. The discharges were then computed by the velocity-area method using the following formula:

$$Q = A*V \qquad (1)$$

Where:

Q is the discharge in cubic feet per second;
A is the area of the cross section (width of the section multiplied by the depth of water in the cross section in square feet; and
V is the velocity of water in feet per second.

A total of eight measurements were conducted at various flow levels for calibration of the outlet structure. The calibrated formula is used to calculate the estimated discharge for different levels of water in the distributary.

For an adjustable proportionate module outlet structure discharging modularly, the relationship between the actual discharge and the water level in the distributary is described by Equation 2, which is generally referred to as design formula.

$$Q = Cd * B * Y * (Hu-Y)^{0.5} \quad (2)$$

Where:

Q is the discharge in cusecs;
B is the inner width of the outlet structure in feet;
Y is the inner height of the structure in feet;
Hu is the water level above the crest in the parent channel in feet; and
Cd is the discharge coefficient[6].

The outlet has been calibrated using this formula, and assuming that the hole underneath the outlet has to be added to the "y" of the outlet and has the same width as that of the metallic structure itself. The implication of this assumption is that the reference level for the structure for calculation of the upstream water depth is not the crest, but the bottom of the hole, 0.45 feet lower than the crest. The calibration of the formula is presented in Table 4.

Table 4. Calibration, Watercourse 101-R.

Ha	Hb	Hu	Q	C	Qc	Q-Qc	% of Q	Q Theory	% of Qc
0.59	0.56	2.81	2.69	7.35	2.81	-0.12	-4.37	2.67	-4.8
0.61	0.37	2.79	2.96	8.13	2.79	0.17	5.72	2.66	-4.8
0.66	0.42	2.74	2.83	7.90	2.75	0.08	2.88	2.62	-4.8
0.73	0.36	2.67	2.68	7.64	2.69	-0.01	-0.30	2.56	-4.8
1.11	0.56	2.29	2.54	8.35	2.33	0.21	8.15	2.22	-4.8
1.3	0.44	2.1	2.05	7.37	2.13	-0.08	-4.06	2.03	-4.8
1.33	0.21	2.07	1.86	6.79	2.10	-0.24	-12.91	2.00	-4.8
1.33	0.42	2.07	2.14	7.81	2.10	0.04	1.87	2.00	-4.8
			Avg. c=	**7.67**					

b = 0.25 *WMup = 2.946*
y (including hole) = 1.13 *WMdown = 0.932*

These assumptions yielded acceptable results, as the average calibrated c-value is 7.67, roughly 5 per cent higher than the theoretical value. For a tampered outlet, this margin of error seems quite acceptable. The curve of the calibrated equation also runs comfortably in between the measured points. The curve resulting from a logarithmic regression on the measured points has a largely similar form as that of the calibrated curve, which reinforces the idea that this curve remains usable. Besides, the curves for the orifice and for the flume range fit into each other comfortably. See Figure 2 for a comparison of the calibrated curve, the logarithmic curve and the measured points for this tampered outlet. Note that the R-

[6] Under the laboratory conditions, the theoretical value of this coefficient is 7.3 as given by Iqbal Ali in his book "Irrigation and Hydraulic Structures" 1993

Figure 2. Comparison between Calibrated and Logarithmic Curves, Watercourse 101-R, Hakra 6-R Distributary.

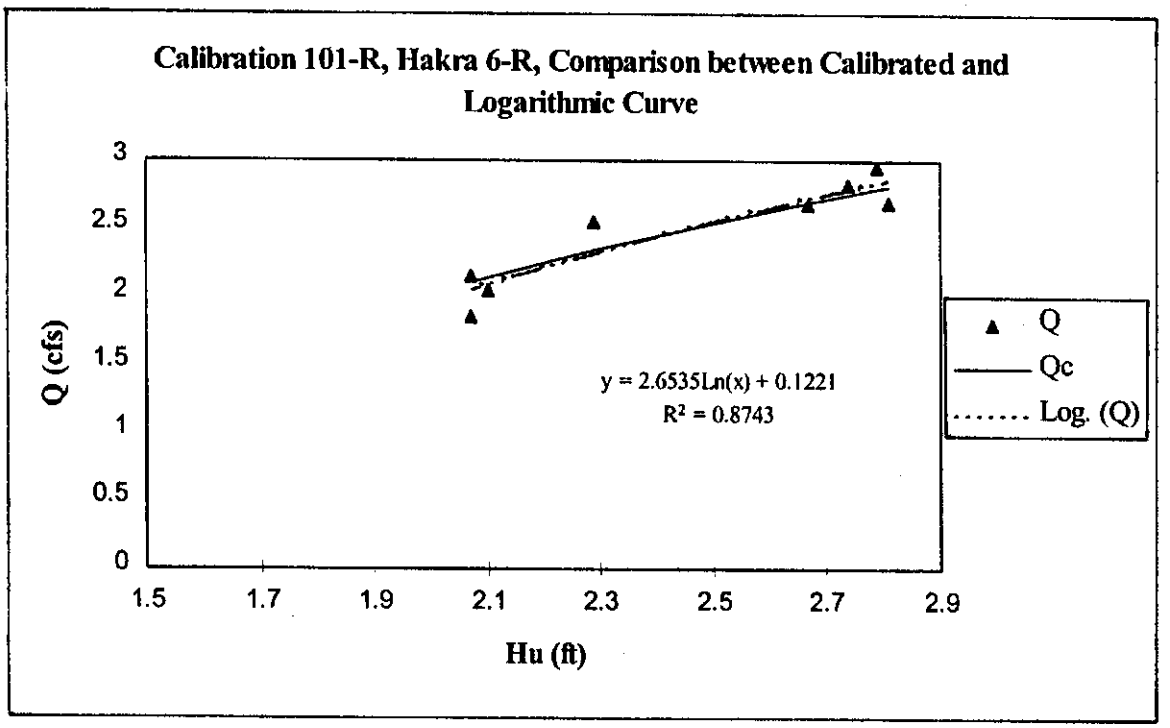
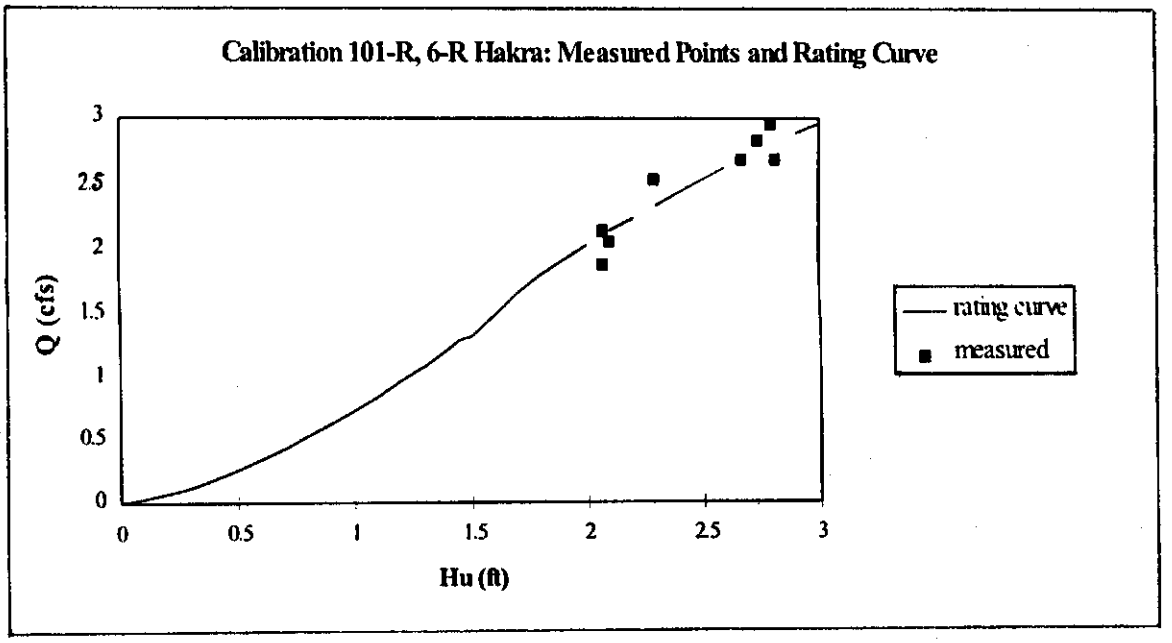


Figure 3: Measured Points and Rating Curve, Watercourse 101-R, Hakra 6-R Distributary.



square for this curve is quite high (0.87). The logarithmic function yielded the following relationship between the upstream water level and the discharge:

$$Y = 0.1221 + 2.6535 \ln (Hu) \quad (3)$$

Where:

Y is the estimated discharge in cusecs
ln (Hu) is the natural logarithmic value of the upstream water level above the bottom hole of the outlet

Figure 3 presents an overview of the calibrated curve. For this calibration, all eight measurements listed in Table 2 have been used. Because of the form of the roof block, the AOSM/APM functions as a free flowing flume (FF) for a considerable range where the water is still touching the roof block. This range can be estimated by looking at the way the curves for orifice flow and flume flow fit together. In the current case, for all the discharge calculations for the Hu smaller than 1.45 feet (with reference to the bottom of the hole), a free flume formula has to be employed as both the curves fit nicely into each other at this point (During, 1997). This calibrated formula has been employed for all the calculations presented in the next sections.

4.2 FARMERS' PERCEPTIONS ABOUT EQUITY IMPLICATIONS OF THE ORGANIZATIONAL RULES

Before discussing the results obtained, it is important to understand the farmers' way of looking at their water availability. The yardsticks and indicators of the farmers are generally different from those of the engineers. Their indicators are based on ranges and central points defined by upper and lower limits, rather than on precise point locations. The reference point for farmers to ascertain a performance indicator would be the central point. At the central point, a relatively higher water level in the distributary and a relatively lower water level would be balanced for the three regimes defined by them. Thus, all the central points between the three nails would be regarded as reference points for decisions to be based on.

The farmers do not regard the volume of water as an indicator. They assess the performance of the outlet by looking at the area irrigated in one turn, or the time required irrigating one acre. In this sense, they can very easily assess the performance and equity without much technical support of equipment and engineers. Thus, the farmers' emphasis is on the ultimate result and their techniques are relatively easier to learn.

At the full supply of the distributary they reported that one irrigation turn of the allocated time per acre allows them to irrigate one quarter of the cropped acre. This means that at any flow level, they will fix the irrigation turn in such a manner that the farmer receiving water is able to irrigate one quarter of his land holding. The explicit purpose behind all of the laid down rules is that they should be able to irrigate the same size of area through application

of the rules. Thus, the volume of water received at the head of the outlet can be regarded as an indicator for validation of the rules.

4.3 VALIDATION OF FARMERS' DECISION RULES

The above discussion implies that if the total volume of water is worked out for a unit of irrigation time by applying different rules, the resulting volume of water should be the same. For validation of the rules, the total volume of water is estimated for an irrigation turn for one acre. The results from the use of the calibrated formula to calculate discharges for important water levels are presented in Table 5.

The results reveal that at the central point of the full supply, the watercourse receives a total of 4554 cubic feet of water per irrigation turn of an acre. This can be regarded as the **reference volume of water.** At the central point between the top and middle nails, where 50 percent more time for the water turn starts, the volume of water falls to approximately 2 cusecs, or roughly one quarter less than the full supply. Slightly above the last point that demarcates the allowance for double time, the estimated discharge is around 1.7 cusecs. Thus, the discharge variation between the two extreme points here (top and the middle nails) is around 0.35 cusecs.

Table 5. Evaluation of Farmer's Decision Rules by Estimated Discharges.

Farmers Reference Point	Time Allocation in the Decision Rules (minutes)	Water Level Above the Hole (ft)	Actual Volume of Water (Eq. 2) (cubic feet)	% Variation from Full Supply Volume
Central point between full supply and top nail	28.8	2.665	4554	0
Central point between top and middle nails	43.2	1.885	4795	+5
Central point between middle and bottom nails	56.6	1.595	4924	+8
Central point between bottom nail and the bottom of the hole	Unlimited	0.950	-	-

The discharge at the central point between these two nails is estimated at 1.88 cusecs, which is 70 percent of the reference discharge at full supply, which by farmers' definition, should be 67 percent.

Similarly, the discharge at the middle nail, where the irrigation turns starts to double, could be estimated around 1.7 cusecs. At the bottom nail, the discharge falls to around 1.3 cusecs, or 0.4 cusecs less than the highest discharge in this range. In the center of these two points, the discharge is estimated around 1.5 cusecs, or 55 percent of the reference discharge, and can be regarded as almost half of the reference discharge at full supply.

Logically, the rule for allocation of the water turn should be doubled when the discharge falls to half. Between the middle and the bottom nails, the discharge is more or less half of the discharge at the full supply. **Thus, the rule to allocate double the time of a normal water turn when the water level in the distributary is between the middle and the bottom nails is justified and technically sound.**

The average discharge between the top and middle nails is almost 70 percent of the discharge at full supply. This also implies that the rule to allow 50 percent more time for irrigation is justified, as the drop in discharge is almost half that of the half discharge at full supply. Thus, by allocating 50 percent more time for irrigation turns enable the farmers, in general, to irrigate an equal extent of area to that of a normal irrigation turn at full supply.

The case with the discharge at the bottom nail, and below, is almost the same. If the hole under the outlet is ignored simply because water will not discharge into the watercourse unless above the minimum head (which has to be higher than the crest), then the central point between the bottom nail and the crest is 0.5 feet above the crest, or 0.95 feet above the bottom of the hole. The estimated discharge at this point is 0.68 cusecs, which is just one quarter of the reference discharge at full supply level. The farmers' rule in this regime is to continue the water turn, unless he is able to irrigate one quarter of his area. But, the condition that he will not use this turn to pre-soak, or ***rauni*** irrigation, has to be observed, and the fields that are to be irrigated have to be with furrows so that consumption of water is less and irrigation efficiency is more.

Under normal full supply, they have reported that one turn irrigates one quarter of the area of the farmer. Therefore, the amount of area irrigated per irrigation turn is again more or less the same. The decision not to fix time in this regime seems justified as the discharge here is variable; the water level will only fall to this point at the time of closure, or opening, of the distributary. Thus, the water depth in the upstream channel will be consistently fall or rise, making it more unpredictable. The farmers' rule for water allocation in this regime also appears to be justified.

An important point to mention is that the location of the third nail is where the outlet stops acting as an orifice. Rather, it starts behaving like a free flume; thus a different discharge formula has to be applied to calculate the discharge at this point. The reason is that the

relationship between the upstream water depth and the discharge in the watercourse changes as the AOSM/APM structure starts acting as a free flow flume.

The conclusion is that all their rules are based on long years of experience, and are now found to be technically sound for the equitable distribution of water.

4.4 ADEQUACY AND RELIABILITY IMPLICATIONS OF THE ORGANIZATIONAL RULES

One of the most fundamental concerns of water delivery systems is to deliver the amount of water required to irrigate crops adequately. The adequacy of irrigation water delivery is dependant on water supply, specified delivery schedules, the capacity of hydraulic structures to deliver water according to the schedules and the operation and maintenance of the hydraulic structures. Since the water delivery to various farms in the command area of the watercourse depends on the water delivery from upstream, it can be concluded that the (in) adequacy of water is more dependent on the water availability in the distributary, and upstream. Had there been enough water, there would have been no need for farmers to frame rules to distribute water equitably as the water would have sufficed for all the shareholders and all the crops they grow. Thus, for the present research, the adequacy of water can be regarded as an exogenous variable. However, the organizational rules were framed in such a manner that the users would get as much water as possible while giving prime importance to equity.

The organizational rules for the reliability of water appear to be focused more on equity than on reliability. If water in the *pakka warabandi* is available in the watercourse, each user knows when he is entitled to irrigate his crops. Under the *kachcha warabandi* system, especially in variable flow conditions, the users are never sure when their irrigation turn would start. Thus, the reliability of water is severely undermined.

Given that the daily distributary flow varied at least 53 times during the year, and that users' irrigation turns had to be adjusted by the member around 70 percent of times, water users were bound to wander around in the village in order to ascertain exactly when their turns would start, and end. Thus, the water distribution system posed serious challenges for those farmers who had irrigable land elsewhere on any other watercourse. Likewise, for users who had other part-time occupation outside of cultivating land on the watercourse under discussion, a tradeoff between irrigation and other preoccupations would become a compulsion. Thus, the unreliability regarding the irrigation induced unreliability in other tasks.

The unreliability of water delivery within the *pakka warabandi* system contrasts sharply to the unreliability of irrigation water under *kachcha warabandi*. Under the *pakka warabandi*, the user is unsure about the water supply in the distributary / watercourse channel. If there is water in the channel, he is sure that he can avail his turn and irrigate (part of) his land at the specified day and time of the week. The flow variability of course forces him to under- or over-irrigate, but there is an element of certainty about the time required for the labor input needed for the irrigation event.

4.5 THE PROCESS OF REORGANIZATION

Efforts to get the *warabandi* converted from *kachcha* to *pakka* were initiated during late 1993. However, the majority of farmers, especially the elderly ones, soon discouraged such efforts, as they wanted to continue with *kachcha warabandi* as a symbol of unity established by their ancestors.

Four of the farmers at Watercourse 101/R started an active campaign to convert *kachcha warabandi* to *pakka warabandi.* One of these farmers played the leading role, while the rest merely followed along and supported his efforts in one way or the other. All four were of the opinion that the water supply with *kachcha warabandi* was unreliable. They were unable to manage because they had land on other watercourses as well. Due to *kachcha warabandi* at the watercourse under discussion, their water turns at both watercourses sometimes overlapped. Consequently, they were unable to irrigate effectively.

During 1993, some tenants also moved against *kachcha warabandi.* The tenants argued that the *kachcha warabandi* was unsuitable under present circumstances, as they had to wait for the water turn at the cost of foregoing other tasks. Some landowners also endorsed the tenants' views. Nevertheless, the majority of farmers opposed the idea of moving towards *pakka warabandi.* One elderly farmer even started crying as people were trying to uproot their ancestors' symbol of unity. This display of emotion helped the farmers to reach a decision to abstain from applying for a *pakka warabandi* then. Consequently, the move was stopped.

Again, during late 1995, one of the four persons favoring *pakka warabandi* restarted the move, but it was soon squashed because some Irrigation Department staff demanded an informal payment to establish a *pakka warabandi* schedule. He could not afford to pay the amount demanded single-handedly.

In the last quarter of 1996, another of the four favoring *pakka warabandi* restarted the campaign. On behalf of the shareholders along the watercourse, he forwarded a written application to the Irrigation Department to convert their *warabandi* to *pakka* on September 29, 1996 (Annex-2). This time, efforts were successful. The farmers stated that the person had a manpower problem as he was employed as a full-time civil servant and his younger brother could not manage irrigation at two plots of land situated along two different watercourses. This difficulty was accentuated at the time of watercourse cleaning as one person from this person's family had to participate in the cleaning of both of these watercourses.

At Watercourse 101/R, the person used to irrigate through a private branch of the main watercourse that belonged to one of his relatives. The watercourse was approximately 800 feet from his sanctioned diversion point, and had been abandoned by his relative. Therefore, this branch had to be cleaned by his family and the main watercourse had to be cleaned by his downstream farmer-neighbor, who was taking full *nikal.* The person requested his downstream farmer-neighbor to give him half of his the *nikal* time, as it was his legitimate

right, so that he would use the main watercourse from the sanctioned *nakka* and participate in its excavation. The downstream neighbor refused to share the *nikal* with this person, who threatened the neighbor that he would get the *nikal* by getting the *pakka warabandi* established. The downstream neighbor, who was also interested in *pakka warabandi*, told him to proceed with the *pakka warabandi* application immediately. The person submitted an application in the name of his father as the land was still in his fathers' name, and signed the application on his father's behalf without informing him.

The canal *patwari* investigated, simultaneously meeting the landowners. The majority of the farmers expressed that they were unaware of the application, clearly indicating that they were not interested in getting their *warabandi* converted to *pakka*. They requested the applicant to withdraw the application, requesting the *patwari* not to ever to return with this application. Although the young person was admonished for his improper conduct, he argued that *pakka warabandi* was being practiced everywhere, and advocated the benefits of a *pakka warabandi*. He also said that he could not wait for the *warabandi* member for guidance as he had other things to do. At the request of the other farmers, he agreed not to proceed with the *pakka warabandi* if the neighbor would give him *nikal* time. The farmers then pressurized his neighbor-farmer to share his *nikal*, who simply refused.

Since nobody withdrew the application and the *patwari* expected some ***bakshish***[7], the *patwari* pursued the case with the *Zilladar,* who asked the *patwari* to gather the shareholders and record their statements. The *patwari* again visited the shareholders with the same application and showed them the orders of the *Zilladar*. Seven shareholders confirmed that they had been informed about the meeting (Annex 3).

Meanwhile, the person who originally moved the application secured the support of three other persons and met the *patwari* while he was preparing the command map of the watercourse (Annex 4). The applicant's statement was prepared (Annex 5). The farmers called a meeting in the village, which was held at the home of an ardent advocate of *kachcha warabandi*. In the meeting they requested the original mover to withdraw the application, but he and his three supporters refused to do so as any person could move a petition for his irrigation turn to be fixed by the department. The decision reached was that the four persons interested in *pakka warabandi* should be set free to have their irrigation turns become *pakka* and other farmers would operate the *kachcha warabandi*. After discussion, it was decided that all of them were bound to follow a *pakka warabandi* because of the impracticability of operating *kachcha* and *pakka warabandi* simultaneously.

The *patwari* visited the village and solicited signatures from 11 farmers, stating that they wanted a *pakka warabandi* (Annex 6). After a few days, the *patwari* visited them again, with the *Zilladar's* assistant. They were to verify and sanction the illegal *nakkas* for which ownership deeds from all the shareholders, and statements from 8 farmers, were collected

7 The term Bakhshish has been used for tip. No one is boun to pay bakhshish by law but pays to please a person who performs a service for the payert to his entire satisfaction. However, now the government functionnairies of the lower cadre expect this as a reward and are displeased if not payed.

(Annex 7a through 7e). There were only four legal *nakkas* and the remaining 13 *nakkas* were unauthorized. Others had not contributed towards the application of the *pakka warabandi* because the original mover and his supporters had done it confidentially and were hesitant to request others for financial contributions. They thought that others might withdraw getting the *warabandi* sanctioned if they had financial implications for it.

The *Zilladar* forwarded the case to the Deputy Collector for fixation of the *warabandi*, and the approval of *nakkas*, which was received on October 26, 1996 (Annex 8). The Deputy Collector served the farmers with a notice of meeting informing farmers that he wanted to conduct an inquiry, particularly regarding their application about the *pakka warabandi* (Annex 9). The *patwari* asked all the farmers to attend the meeting on November 23, 1996 at 0800 hours, at the irrigation rest house close in the area. All the shareholders, or their relatives, were informed, and their signatures were obtained (Annex 10). Eleven out of twenty-two farmers attended the meeting (Annex 11), and the case was favorably decided on the same day (Annex 12). The farmers decided to implement the *pakka warabandi* from January 01, 1997 (after the annual canal closure). Between November and December, the *kachcha warabandi* remained in operation. The sanctioned (*pakka*) *warabandi* is presented in Annex 13.

4.6 THE TECHNICAL IMPERATIVE FOR INSTITUTIONAL CHANGE

The conflict regarding distribution of the *nikal* time, which finally led to the organizational decay, basically stemmed from the issue of water rights. The real motive behind moving towards state control was to reduce the unreliability of water supply caused by the constrained organizational rules. The reliability is a subjective term. On one hand, the water supplies under the *kachcha warabandi* could be regarded as reliable, as each member was sure that he would be able to irrigate at least one-fourth of his land in a given irrigation turn. On the other hand, it can be regarded as unreliable, as they were unsure about the exact time when they would get water. This unreliability led to the conflict between the two sets of users, who later joined hands as both groups wanted a state-regulated *warabandi*. Thus, the technical factors, more specifically unreliability, triggered off the apparently conflicting situation among some members. The organizational platform did not really provide an opportunity to discuss and solve the root cause for the conflict, because members had only been discussing it in meetings as a "**sacred tradition**" and advocating the virtues of the *kachcha warabandi* system. There were two groups with conflicting viewpoints; one for sustaining the distribution system, and the other for mitigating unreliability accentuated by the organizational rules. Since the conflict could not even be traced, the capacity of the organization to resolve the problem remained unutilized and the situation precipitated to organizational decay.

The fact that all the shareholders, who were manageable in number, were related and belonged to the same caste and had no familial conflicts among them, indicates that there was no involvement of *izzat* considerations as most consider themselves as a part of a larger family. Thus, the community was not suffering from an ***upper-lower syndrome***. Besides, they had been cooperating with each other for almost 50 years for the local management of

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irrigation resources and many social issues. The land distribution is not very skewed either. There had, in fact, been no free riders at all. All these social variables were theoretically supportive, but could not sustain the organization.

Likewise, the social organization around the resource was very strong having clear membership, applicable rules, effective conflict resolution and apparently, the state had no intentions to intervene unless invited by the members. The organizational decay, therefore, can only be attributed to the organizational capacity to cater to the technical constraints.

Among the technical factors, the farmers, as a group, were able to interface with the Irrigation Department to obtain more water for all the members by tampering with their outlets each season. Therefore, it was beneficial for the farmers to stay together to acquire adequate water through outlet enlargement as they could have mobilized money much easier. The adequacy of water, therefore, does not appear to be associated with organizational decay either. The framework for water distribution was perfect for an equitable distribution as the farmers' indicators and methods were very appropriate. As under the local management, most times the users were uncertain about their next irrigation turn, the only reason for the switchover appears to be the unreliable water supply. To improve reliability, the organization had neither, a mechanism nor realization of the real problem. The organization, therefore, disappeared due to an unreliable provision of water and limited technical capacity for mitigation of the problem.

5. CONCLUSIONS

The evidence provided in this paper, shows that the farmers had managed their irrigation resources at the local level quite successfully. The major socio-cultural and organizational pre-conditions, which are ardently advocated in literature to sustain an organization for shared resource management at the local level existed in the community, but were inadequate to meet the technical implications of the organizational task. The major variables behind this organizational decay are clearly more technical than social and cultural in nature.

The social organization around water ensured that the rules were equal, and transparent, for all the shareholders. The organization installed nails in the outlet structure to indicate various water levels upstream. They were aware of the fact that the discharge to their outlet was dependent on the level of water in the parent channel. The farmers based their organizational rules on their own performance indicators for equitable water distribution. The rules proved to be quite logical and practical, and the volume of water available in the watercourse remained in the regime of 5-8 percent error when compared to the intended volume. Therefore, the organizational rules appear to be appropriate for equitable water distribution. The equitable distribution of water, by the farmers, implies that if the farmers get a chance, they can manage their resources without the supervision of a central irrigation bureaucracy.

Farmers ensured the adequacy of canal water by effectively interfacing with the Irrigation Department, and arranging to adjust the outlet and even to obtain double than the so-called design discharge. Although this appears to be unethical, it reflects that as an organized group, farmers took care of their common needs for a necessary resource. Had the Irrigation Department not agreed to let farmers tamper with their outlet, the users would have sought some alternative measures to assure adequate water, or moved to more economic use of water through improving maintenance of their watercourse and by adopting water-saving agronomic techniques.

The organization could not solve the dilemma of obtaining reliable water supplies, as unreliability of the canal irrigation water is a serious constraint in the area. The Irrigation Department operates the canals following a rotational program, whereby each distributary has to be at less than full supply level for at least two consecutive weeks out of every three. During these two weeks, there are frequent variations due to regulation activities upstream to manage the rotation program. This unreliability travels to the farmers' fields as well.

The farmers' decision to move from the self-managed *kachcha warabandi* system of water distribution to state-regulated *pakka warabandi* was triggered off by certain practical reasons. The main actors behind the move faced difficulties because they remained uncertain about the start of their irrigation turns, especially during the low flows. The upstream fluctuations, coupled with the unreliability induced due to the organizational rules, accentuated the unreliability at the local level, which led to farmers' dissatisfaction. The dissatisfaction was translated into a conflict between two sets of users, both of whom covertly wanted a reliable water supply. This may be regarded as a conflict arising from

inter-group rivalry, or *izzat*, by some. In fact, neither group perceives it as such. They were aware that with the official sanctioning of the *warabandi* schedule, the Irrigation Department, following the laid down principles, would invariably adjust the time turns according to conveyance time along the watercourse routes. This technical improvement was beyond the farmers' capacity, and the final decision was to follow what the majority of watercourse commands have already done: to opt in for *pakka warabandi.*

In sum, the successful local management of irrigation water resources no doubt depends on social, economic, cultural, and political variables, but the more fundamental determinant of a sustainable organization is related to the technology of the tasks to be managed and the technical nature of the task environment. In the context of a weak organizational capacity, as is the case in many developing country rural settings, the technical variables can easily lead to organizational decay when the "artificial" social factors, such as the influence of a few families, cease to play an effective role.

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Annex-1. Kachcha Warabandi List of Watercourse 101-R/6-R.

Name of the Water User	Size of Holding (acres)	Cultivation Status	Total Irrigation Turn (Hours)	Comments
1-Ali Ahmad	40	OC&SC	19.5	
2-Muhammad Ali	12	SC	5.88	
3-Mustafa	18	OC	8.88	
4-Abdul Razaq	8.25	OC	4	
5-Rahmet Ali	8.25	OC	6.5	Orchard water for 2.25 acres as well as membership water (0.5 hrs) is included.
6-Khushi Muhammad	8.25	OC	6.5	Same as above
7-Abdul Sttar	13	OC	10.08	Orchard water for 4 acres is included.
8-Roshen Din	8.5	SC	4.08	
9-Ali Mohd.	11.5	OC	5.75	
10-Mohd Ali	12	OC	6	
11-Pir Mohd.	4	C	1.92	
12-Dr. Sarwar	6.25	OC	5.33	Orchard water for 2.5 acres is included.
13-Sultan	6.25	OC	5.5	Orchard water for 2.5 acres as well as 15 minutes *Khal Brahi* time is included.
14-Bashir	12.5	SC	6	
15-Ahmad	12.5	OC	6	
16-Mohd. Azhar	12.5	OC	6	
17-Ramzan	12.5	OC	7.5	Orchard water for 1.5 arce is included.
18-Sardar	12.5	OC	7.5	Same
19-Ismail	25	SC	12	
20-Bashir	12.5	OC	6	
21-Rafiq	4.2	OC	2	
22-Yaqoob	8.3	OC	4	

OC = Owner Cultivator, SC = Sharecropper, C = Contractor/ Lessee

- The Person at serial 5 is the brother of *warabandi* member, so he assists him from time to time in operating the *warabandi*, that's why the *warabandi* member, i.e., serial no.6, has given a half an hour water to him.

- Water allocation for orchards is twice that of the normal field. For instance, in the list, orchard is occupied on 16.5 acres of land and these are getting the water equal to 49.5 (2 times more) acres of normal fields. A very long time ago, the department sanctioned this length of the irrigation time in turns. Afterwards, nothing was sanctioned due to filling the quota for this watercourse. The next sanction will only take place with the enlargement of the outlet. This was the major reason that some people who were unable to get water for orchard

Annex 2: The petition submitted by one of the shareholders

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بخدمت جناب ڈپٹی کلکٹر صاحب بہاولنگر ڈویژن بہاولنگر

PAKISTAN COURT FEE
محمد شریف
29-9-96

1 108/55C/6R

عنوان: درخواست بابت منظور کرانے تقرری وارہ بندی موگہ نمبر 55.C/6.R چک نمبر 108/6.R ملکداری نیتیم والہ

جناب عالی!

گزارش ہے کہ سائل کا رقبہ موگہ نمبر 55.C/6.R چک نمبر 108/6.R
کی چیندی میں واقع ہے۔ موگہ مذکوری کی وارہ بندی زمیندار سے
وارہ پانی لگانے کے وقت لڑائی جھگڑے کا اندیشہ رہتا ہے۔ لہذا
استدعا ہے کہ موگہ مذکوری وارہ بندی تقرری منظور فرمائی جائے
پرچہ ملکیت سالم موگہ کا رقبہ پیش کر دیں گے۔ اور جاری شدہ
کھال بندی جات منظور فرمائے جائیں۔

آپکی نوازش ہوگی

جملہ حصہ داران موگہ نمبر 55.C/6.R چک نمبر 108/6.R ملکداری نیتیم والہ

ڈویژن بہاولنگر

بذریعہ محمد شریف ولد غلام محمد

محمد شریف

29/9/96 [illegible] 20R [illegible] 29/9/96

Annex 3: The Zilladar asks Patwari to call shareholders for recording statements and collecting needed documents

(3)

از ضلعدار سیکشن تیمم والہ

بنام منشی محمد اصغر پٹواری حلقہ

عنوان :- درخواست بابت منظور کرنے تقسیم پری وارہ بندی موگہ نمبر 55.c/L.R
چک نمبر 108/L.R ضلعداری تیمم والہ

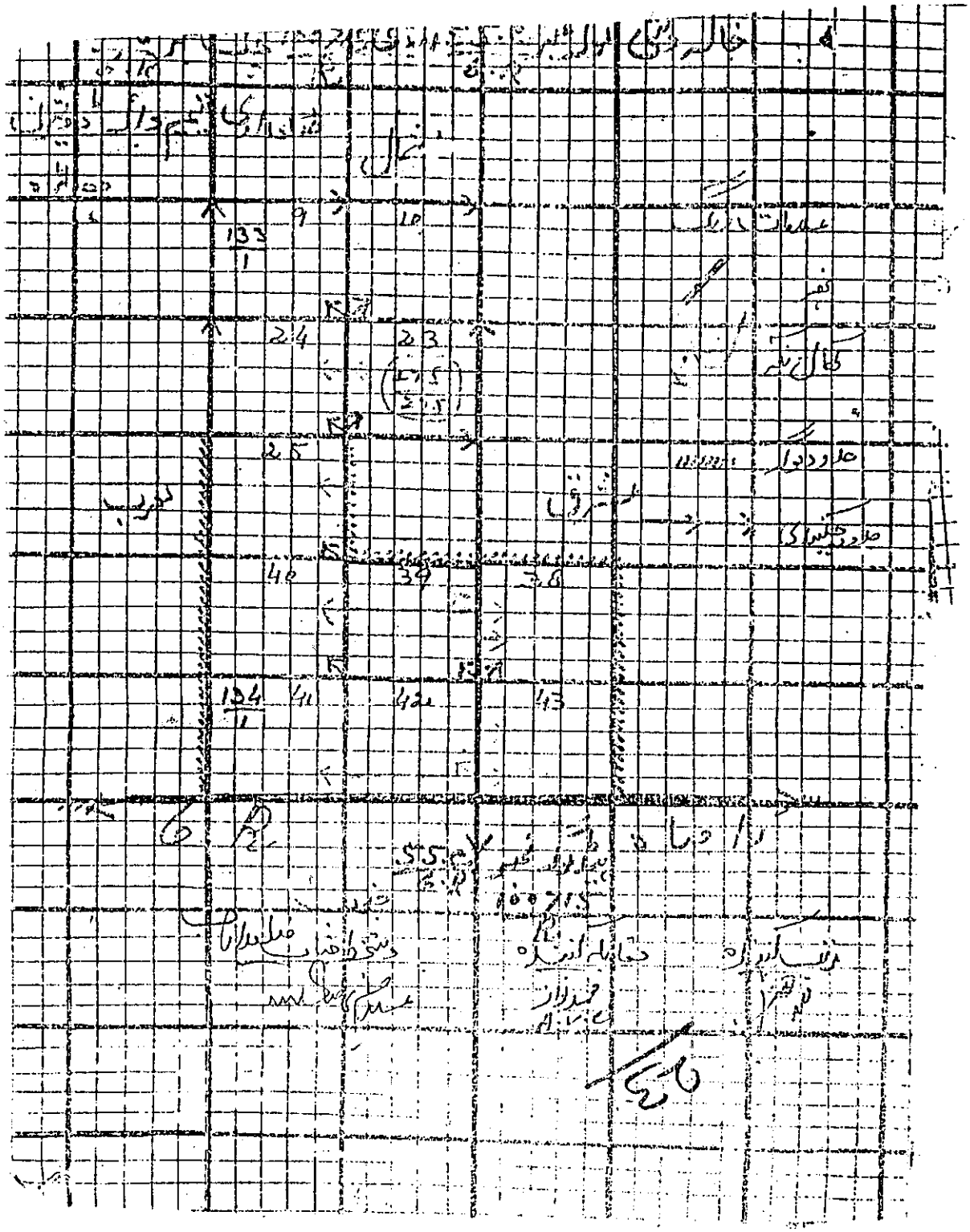
بذریعہ پروانہ ہذا تحریر ہے کہ سائل محمد شریف ولد غلام محمد نے متذکرہ بالا
درخواست گذاری ہے ۔ لہٰذا سائل کے متعلقہ حصہ داران کو بغرض قلمبندی
بیانات موقعہ پر کو موقعہ پا بند کرے ۔ نیز سائل سے متعلقہ کاغذات
شامل کرائے جائیں ۔ تاکہ کیس کی کارروائی ہو سکے ۔ بعد ازاں ہذا الحد عیالی
واپس کریں ۔

محمد شریف

غلام مصطفیٰ — بشیر احمد — محمد شریف

محمد اسحاق — محمد اکبر — عبدالرشید

Annex 4: Watercourse Command Map of 101-R/ 6-R prepared by the Patwari



Annex 5: **Statement of the applicant stating that warabandi needs to be sanctioned**

محمد شریف ولد عیسیٰ محمد حویلدار موگہ نمبر 55.c 6.A ملک نمبر 108 6.A

نے بتلائیں بیان کیا۔ کہ خسرہ کا رقبہ مرلہ نمبر 23 فرد کا موگہ نمبر 55.c 6.A ملک نمبر 108 6.A کی چندی میں واقع ہے۔ موگہ کی وارہ بندی زمیندار کرتے ہے۔ وارہ پانی لگانے کے وقت لڑائی جھگڑے کا اندیشہ رہتا ہے۔ لہٰذا موگہ کی وارہ بندی تحریری منظور فرمائی جائے۔

بیان سنکر دستخط کیا

محمد شریف

محمد شریف

شناخت کنندہ

Ahmad

Annex 6: Statement of other shareholders

بشیر احمد ولد فضل محمد حصہ دار موگہ نمبر 55.C/6.R چک نمبر 108/6.R مالک خسرہ 9 جزوی

محمد یعقوب ولد محمد اسماعیل ہمشیرہ زاد ,, ,, ,, ,, 9 جزوی

محمد شریف ولد غلام محمد برادر محمد اظہر حقیقی ,, ,, ,, ,, 23 جزوی

محمد رمضان ولد غلام محمد برادر محمد اظہر چچا حقیقی ,, ,, ,, 21 سالم

محمد الیاس ولد محمد شریف ,, ,, ,, ,, 38 جزوی

عبدالستار ولد عبداللہ ,, ,, ,, ,, 38-39 جزوی

محمد صدیق ولد مولا بخش ,, ,, ,, ,, 38 جزوی

احمد علی ولد غلام محمد ,, ,, ,, ,, 40 جزوی

محمد آصف ولد فضل محمد ,, ,, ,, ,, 41 جزوی

غلام مصطفیٰ ولد محمد اسماعیل ,, ,, ,, ,, 38-43 جزوی

نذیر حسین ولد محمد بوٹا ,, ,, ,, ,, 52 جزوی

نے حسب ذیل بیان کیا۔ کہ ہم موگہ نمبر 55.C/6.R چک نمبر 108/6.R کے حصہ دار زمیندار ہیں۔ موگہ مذکور کی وارہ بندی زمیندار خود کرتے ہیں۔ وارہ پانی لگانے کے وقت لڑائی جھگڑے کا اندیشہ رہتا ہے۔ لہٰذا استدعا ہے۔ کہ ہمارے موگہ کی وارہ بندی تعزیری منظور فرمائی جائے۔

بیان سن کر درست تسلیم کیا

بشیر احمد — محمد یعقوب برادر غلام سرور — محمد شریف برادر محمد اظہر

بشیر احمد — غلام سرور — محمد اظہر

محمد رمضان برادر محمد اظہر — محمد الیاس — عبدالستار — محمد صدیق

محمد الیاس — عبدالستار

احمد علی — محمد آصف — غلام مصطفیٰ — نذیر حسین

احمد علی — غلام مصطفیٰ — نذیر حسین

[illegible] [illegible]

Annex 7a: Statements of two shareholders for approval of Nakkas

محمد الیاس ولد محمد شریف حصہ دار موگہ نمبر 55.e/6.R چک نمبر 108/6.R

نے حلفیہ بیان کیا۔ کہ [illegible] موگہ نمبر 38 میں شیئر ہولڈر ہوں۔ جو کہ موگہ نمبر 55.e/6.R چک نمبر 108/6.R کی چیئرمین میں واقع ہے۔ بند [illegible] نمبر 38 [illegible] نمبر 11/26 درمیان نکہ جاری کیا جا سکتا ہے۔ لہٰذا استدعا ہے کہ جاری شدہ نکہ منظور فرمایا جائے۔

بیان سن کر درست تسلیم کیا

محمد الیاس ولد محمد شریف

محمد الیاس

شناخت کنندہ

سردار محمد ولد نور محمد حصہ دار موگہ نمبر 55.e/6.R چک نمبر 108/6.R

نے حلفیہ بیان کیا۔ کہ [illegible] موگہ نمبر [illegible] شیئر ہولڈر [illegible] 500 [illegible] کی چیئرمین میں واقع ہے۔ بند [illegible] جاری کیا جا سکتا ہے۔ لہٰذا استدعا ہے کہ جاری شدہ نکہ منظور فرمایا جائے [illegible] پیر وارہ تعین فرمایا جائے

بیان سن کر درست تسلیم کیا

سردار محمد ولد نور محمد

سردار محمد

شناخت کنندہ

Annex 7b: Statement of one shareholder for approval of Nakka

Annex 7c: Statements of two shareholders for approval of Nakkas

مسمی سردار محمد ولد غلام محمد قوم ... بذریعہ علی احمد پسر حقیقی حصہ دار ڈوگر نمبر $\frac{55.c}{6.R}$ چک نمبر $\frac{8}{R}$

نے بتلا کر بیان کیا ۔ کہ منظور کا رقبہ مربعہ جات 1-2-3 کے ڈوگر نمبر $\frac{55.c}{6.R}$ چک
کی چیکبندی میں واقع ہے ۔ ڈوگر مذکور کی وارہ بندی زمیندار نے کی ہے ۔ اب منظور
ہو رہی ہے ۔ لیکن کھال ۔ نکہ جات مذکور کافی نہیں ہیں ۔ لہذا استدعا ہے
کہ مربع نمبر 43 کے کیلہ نمبر $\frac{10}{11}$ درمیان اضافی نکہ ۔ مربع نمبر 42 کیلہ نمبر $\frac{16}{25}$ درمیان اضافی
۔ مربع نمبر 42 کیلہ جات 16 تا 20 کے نمبر کی جانب کھال ۔ مربع نمبر 42 کیلہ نمبر $\frac{16}{25}$ درمیان
جاری شدہ اضافی نکہ منظور فرمایا جائے ۔ تاکہ وارہ پانی لگانے میں آسانی ہو سکے ۔

بیان سنکر درست تسلیم کیا

نشان انگوٹھا

سردار محمد بذریعہ علی احمد پسر حقیقی

مسمی اسماعیل ولد ... بذریعہ غلام مصطفیٰ حصہ دار ڈوگر نمبر $\frac{55.c}{6.R}$ چک نمبر $\frac{108}{6.R}$

نے بتلا کر بیان کیا ۔ کہ منظور کا رقبہ مربع نمبر 43 میں [illegible] 18 ایکڑ میں واقع ہے
میرے مربع نمبر 43 کا نکہ مذکور نہیں ہے ۔ بندہ نے مربع نمبر 43 کے کیلہ نمبر $\frac{20}{21}$ درمیان
نکہ جاری کیا ہوا ہے ۔ لہذا مربع نمبر 43 کے لئے نکہ کیلہ نمبر $\frac{20}{21}$ درمیان منظور
فرمایا جائے ۔

بیان سنکر درست تسلیم کیا

نشان انگوٹھا

اسماعیل بذریعہ غلام مصطفیٰ

غلام مصطفیٰ

Annex 7d: Statements of two shareholders for approval of Nakkas

نذیر حسین ولد محمد بوٹا حصہ دار گوگیرہ نمبر 55.C/6.R بلاک نمبر 108/6.R

نے بتصدیق بیان کیا۔ کہ مظہر کا رقبہ ہر دو نمبر کے کھیدار 12 ایکڑ میں واقع ہے
نیز میرے ہر دو نمبر کے بلاک نمبر 6/15 درمیان نکہ جاری کیا گیا ہوا ہے۔ لہذا استدعا ہے
کہ جاری شدہ نکہ بلاک نمبر 6/15 منظور فرما کر اسی نکہ بیرواری تصدیق فرمایا جائے۔

بیان سنکر درست تسلیم کیا

نذیر حسین

شناخت کنندہ

احمد علی۔ مہر علی وغیرہ پسران امام دین بذریعہ احمد علی برادر حقیقی حصہ دار گوگیرہ نمبر 55.C/6.R بلاک 108/6.R

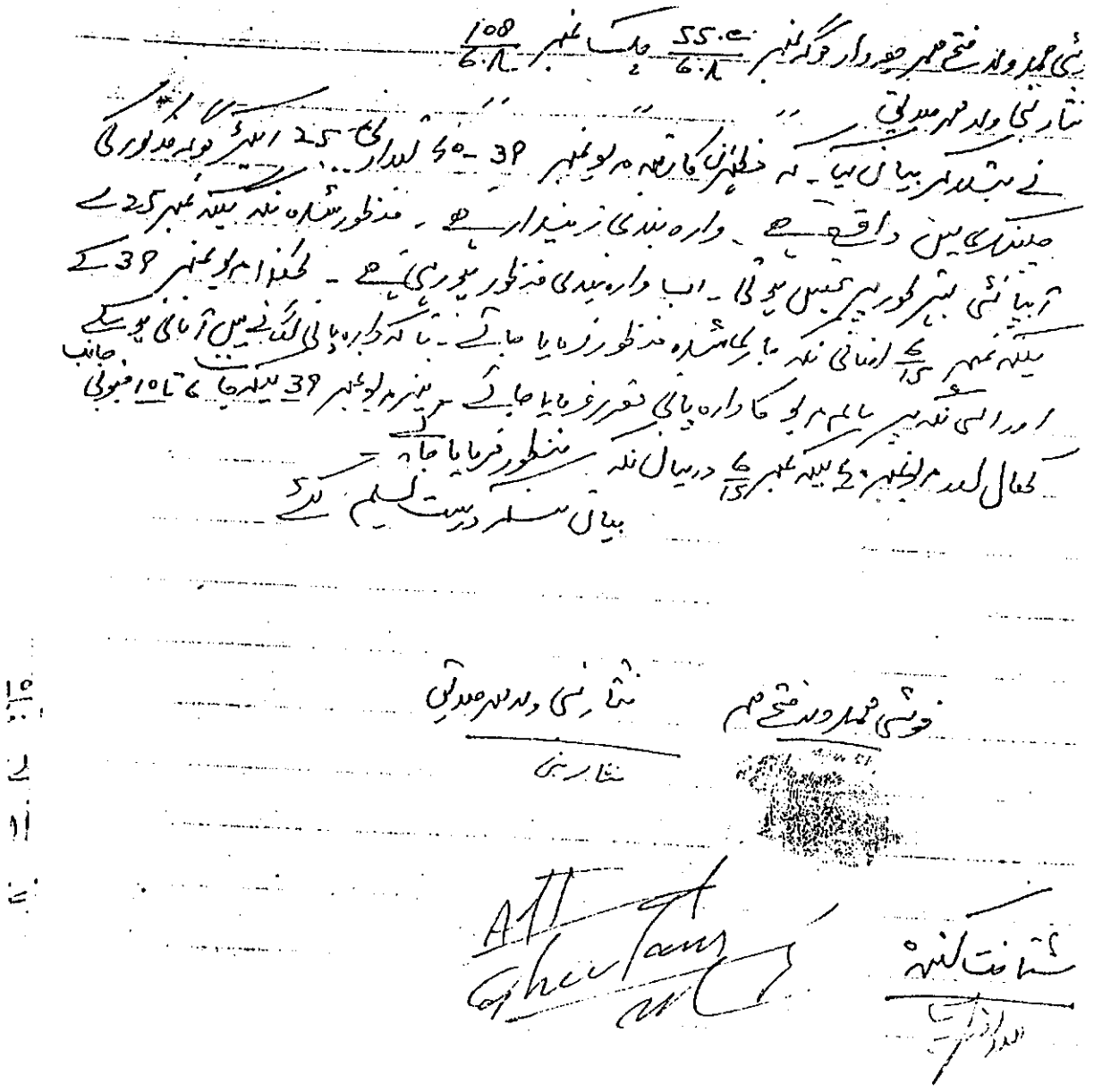
نے بتصدیق بیان کیا۔ کہ مظہر کا رقبہ گوگیرہ نمبر 55.C/6.R بلاک نمبر 108/6.R کا حصہ داران میں واقع
ہے۔ نیز میرے ہر دو نمبر 23 بلاک 20/11 درمیان جو کہ میری ملکیت ہے۔ نکہ جاری کیا ہوا ہے
لہذا جاری شدہ نکہ بلاک نمبر 20/11 درمیان منظور فرما کر اسی نکہ کو درست فرمایا جائے۔

بیان سنکر درست تسلیم کیا

احمد علی

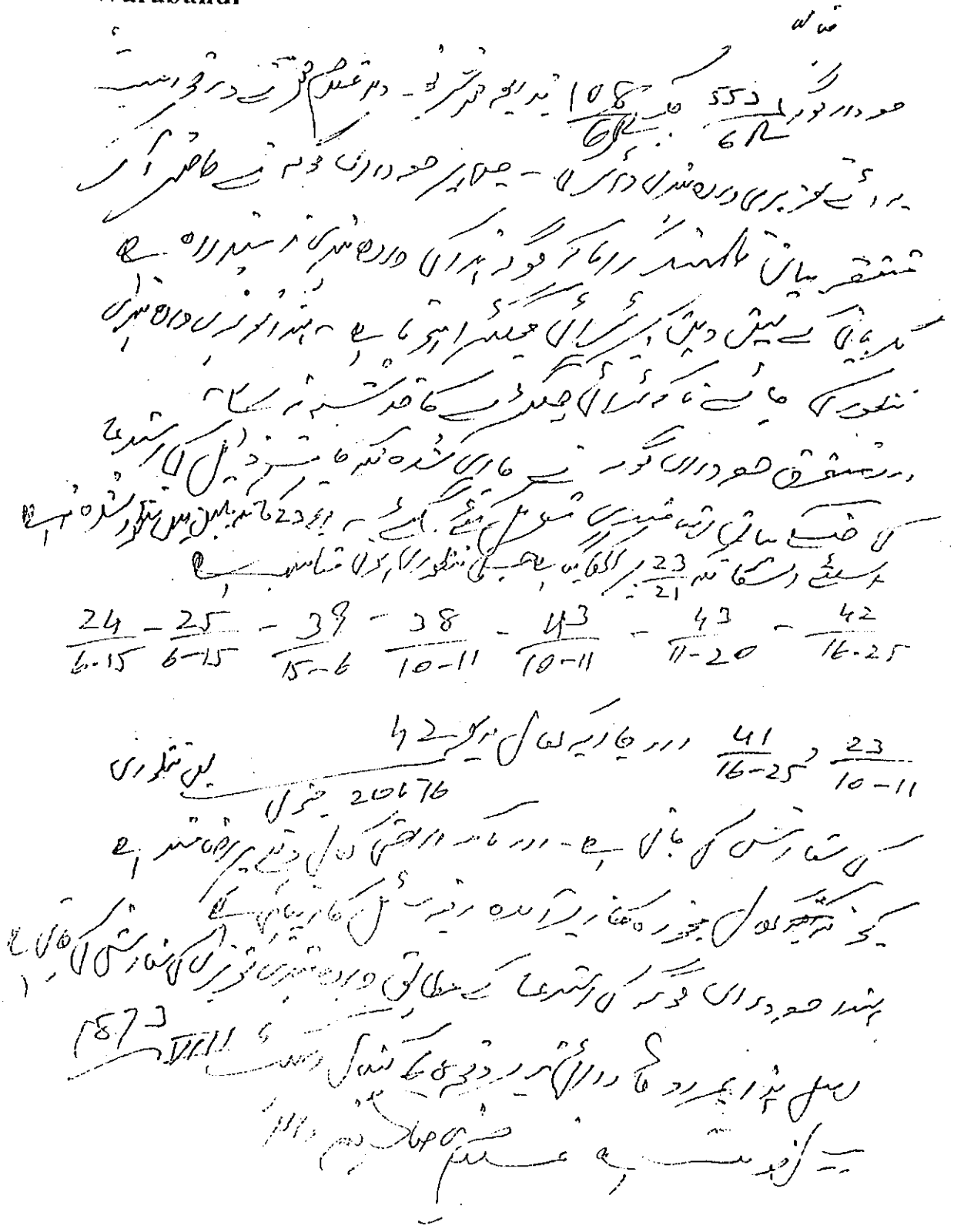
شناخت کنندہ

Annex 7e **Statements of two shareholders for approval of Nakkas**



49

Annex 8: **Zilladars' report to Deputy Collector recommending sanctioned Warabandi**



DCR [illegible]

26/10/90

[illegible] 68 [illegible]

10/96

Deputy Collector,
Hakra Division,
Bahawal Nagar

Annex 9: Notice of Meeting to Shareholders by the Deputy Collector

ی۔ او نمبر ۲۰

اطلاع نامہ بنام حصہ دار کسی بموجب دفعہ ۹۸ ایکٹ ۸ - ۱۸۷۳ء

یہ اجلاس ~~ڈویژنل کنال افسر صاحب~~ محمد عبدالغفور DCC ڈویژن حاکم

بنام مسمیٰ محمد عمر و دیگران 5SC/6R ولد قوم سکنہ 108/6R حصہ دار کسی موسومہ مخرجہ نالہ

جو کہ مسمی محمد شریف ولد غلام محمد قوم سکنہ 108/6R حصہ دار آبپاشی کنندہ از کسی موسومہ

مخرجہ نالہ 5SC/6R نے تحریری درخواست گزارنی ہے۔ اور جو کہ بتاریخ 23/11/96 ۱۹ء

بوقت 8/- بجے بمقام ریسٹ ہاؤس تحقیقات اس مقدمہ کی شروع ہوگی۔ اس واسطے

یہ اطلاعنامہ بمنشاء دفعہ ۹۸ - ایکٹ ۸-۱۸۷۳ء بنام حصہ داران مندرجہ بالا جاری ہوکر لکھا

جاتا ہے۔ کہ اگر کسی حصہ دار کو مذکورہ بالا کو نسبت درخواست سائل کچھ عذر ہووے۔ تو

تاریخ و مقام مقررہ پر اصالتاً یا وکالتاً حاضر ہوکر عذر اپنا پیش کرے۔ بصورت غیر حاضری یک

طرفہ کارروائی ہوگی۔ آج یہ نوٹس بدستخط ہمارے اور مہر سر رشتہ جاری ہوا۔

Deputy Collector,
Hakra Division,
Bahawal Nagar

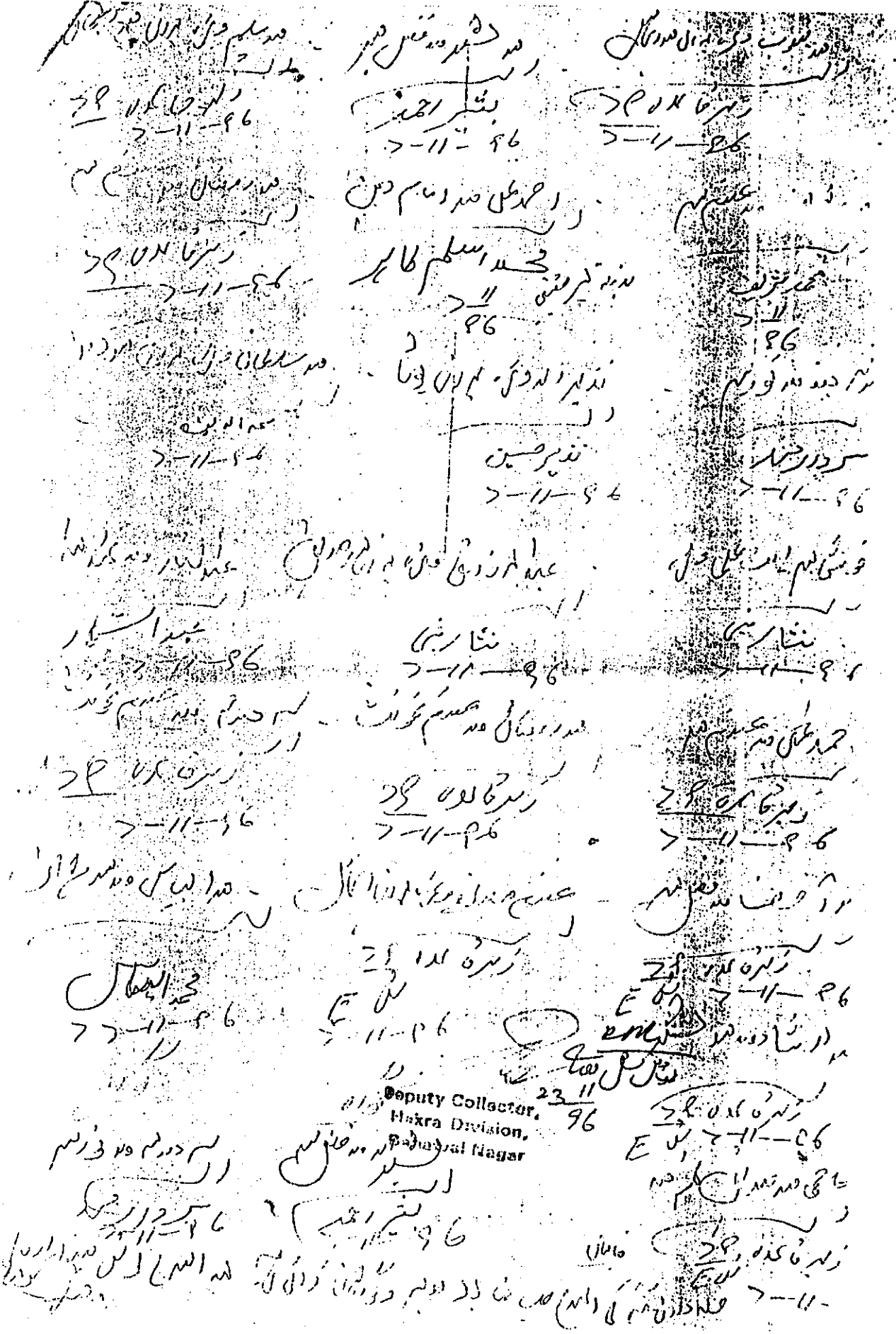
بتاریخ ماہ

نوٹ :- نوٹس ہذا کی تعمیل موجب قاعدہ ۹۷ ایکٹ انہار و نالی ہائے نکاس اضلاع شمالی ہند
نمبر ۸ مجریہ ۱۸۷۳ء ہونی چاہیئے۔ ضلعدار صاحب کو اس کے ہمراہ ایک فہرست شامل کرنی
چاہیے۔ جس میں تمام حصہ داران موگہ کے نام درج ہوں۔ تعمیل نوٹس تاریخ سماعت سے پیشتر
ہو جانی ضروری ہے۔ ضلعدار صاحب کو اس امر کی رپورٹ بھی کرنی چاہیئے کہ ہر ایک حصہ دار
کی اطلاع کس طرح سے کرائی گئی ہے۔

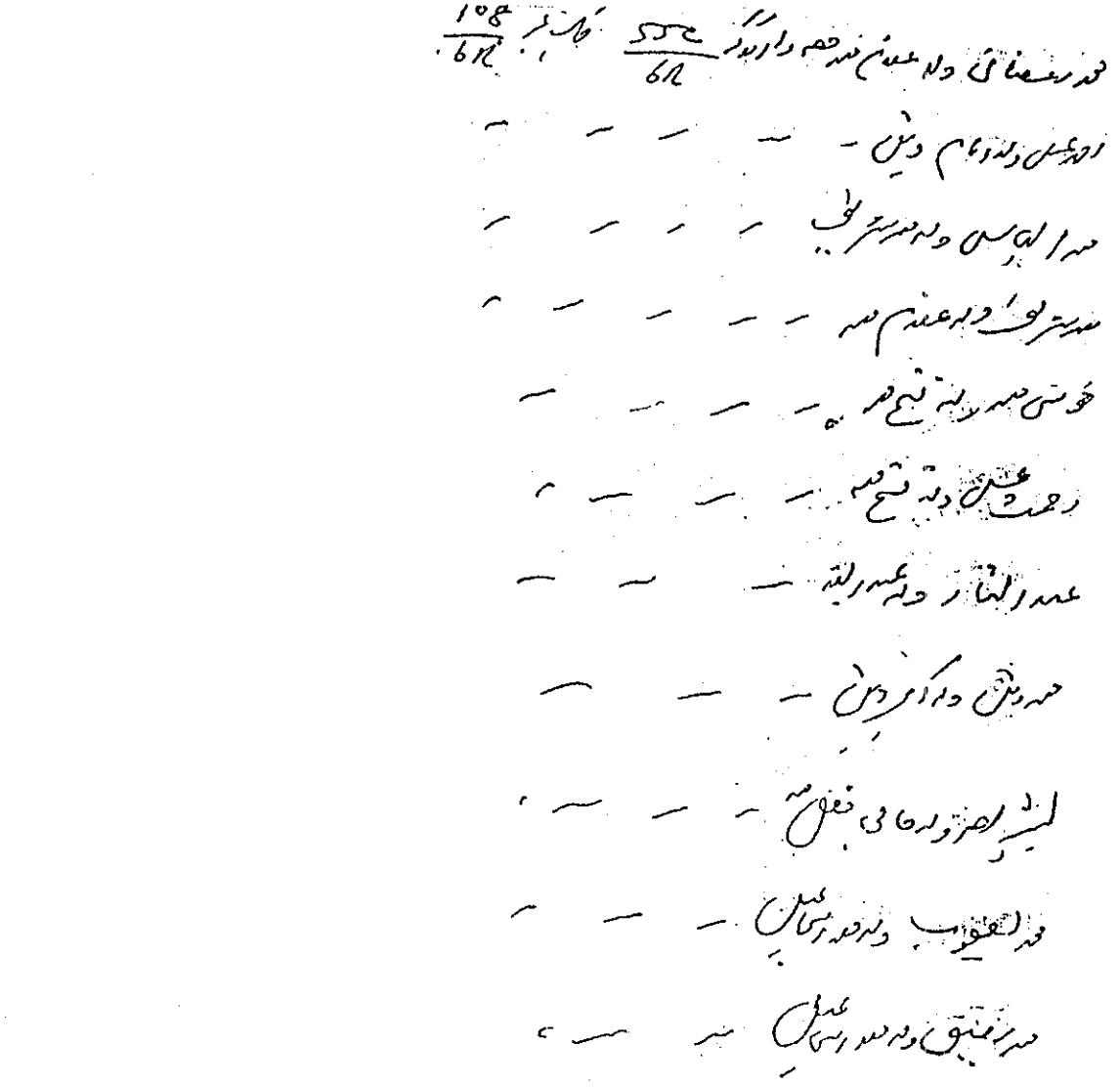
Deputy Collector,
Hakra Division,
Bahawal Nagar

G.C.P.-(Exp.) 47 L.P. 30,000 P.—1-93.

Annex 10: Patwari reporting that all the shareholders have been informed abou the meeting



Annex 11: Minutes of the Meeting between the Deputy Collector's Representative and the Shareholders



Accepted

23.11.76
Deputy Collector,
Bulandshahr

Annex 12: Deputy Collector's Orders for Approval of the Petition regarding the Approval of the Sanctioned Warabandi

10/556/6R

ہے۔ جسے منسوخ کرتے ہیں۔ صاحب ایڈیشنل کمشنر [illegible] اور ناگر

جو ارو منڈی بزیر دفعہ 68 کینال ایکٹ منسوخ کی جاتی ہے اور

مربعہ نمبر 39 کے عوض بقیہ 60 تا 70 ٹیوب ویل مربعہ نمبر 42 کسرجات

نمبر 16 تا [illegible] ٹیوب ویل کھال جاری شدہ۔ اور [illegible] مربعہ جات

نمبر 43/20/21 ۔ 43/10/11 ۔ 42/16/25 ۔ 41/16/25 38/11/20 ۔ 38/10/11 ۔ 39/6/15

40/6/15 - 45/6/15 ۔ 23/10/11 ۔ 24/6/15 اور 23/21 منسوخ کیئے

جاتے ہیں۔ جو ارو منڈی بزیر دفعہ 68 کینال ایکٹ 8 - 1873

ترمیم شدہ اپریل 1977 منسوخ کی جاتی ہے۔ فیصلہ سنا دیا گیا

احکام جاری ہوں [illegible] فیصلہ [illegible] داخل دفتر ہو

[signature] 23/11/96

Deputy Collector, … Division, Bahawal Nagar

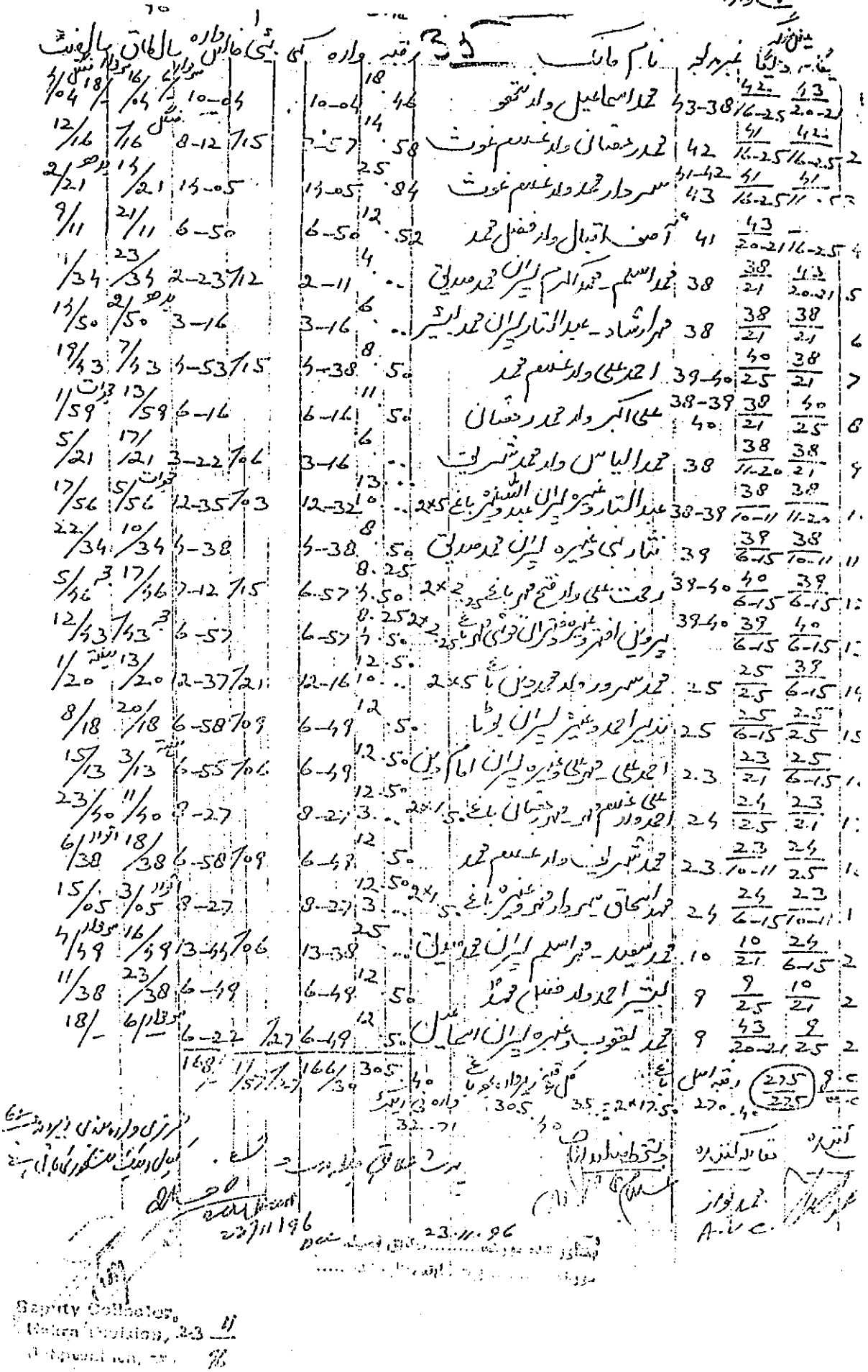
یہ فیصلہ قلم بند کر کے لکھوایا گیا

[signature] 23/11/96

Deputy Collector, Bahra Division, Bahawal Nagar

10/36

[signature] 28/2/97



Annex-14. Official Warabandi List of Sample Watercourse 47/R, Hakra 6-R Distributary.

Name	Holding Size	Day	Start Time	End Time	Total Time (hour)	Comments
1-Boota	13.5	MON	0600	1539	9.65	Orchard water is also included.
2-Faqir	25	MON	1539	0541	14.3	15 minutes' *Khal Brahi.*
3-Ismail	25	TUE	0541	1943	14.3	Same
4-Muhd. Ali	25	TUE	1943	0945	14.3	Same
5-Muhd. Hussain	25	WED	0945	2402	14.28	30 minutes' *Khal Brahi.*
6-Fathe Khan	25	THU	2402	1349	13.78	
7-Fazal	25	THU	1349	0351	14.3	15 minutes' *Khal Brahi.*
8-Ali Muhd	20	FRI	0351	1718	13.45	Orchard water& 6 minutes' *Khal Brahi.*
9-Muhd. Ali	5	FRI	1718	2004	2.77	
10-Aziz	20	FRI	2004	0720	11.27	15 minutes' *Khal Brahi.*
11-Muhd. Ali	5	SAT	0720	1005	2.77	
12-Ali	20	SAT	1005	0122	15.27	6 minutes' *Khal Brahi* & orchard water.
13-Aziz	5	SUN	0122	0408	2.77	
14-Jhon	21	SUN	0408	1553	11.75	9 minutes' *Khal Brahi.*
Hamlet	-	SUN	1553	1908	3.25	
School	6	SUN	1908	2225	3.30	
15-Boota	2.5	SUN	2225	2349	1.38	
16-Jhon	0.5	SUN	2349	2407	0.5	
17-Aziz	8	MON	2407	0432	4.42	
18-Ali	4	MON	0432	0600	1.47	One hour *nikal* water is deducted.

Annex-15. Agreed Warabandi List of Sample Watercourse 47/R, Hakra 6-R Distributary.

Name	Holding Size	Cultivator 's Status	Day	Start Time	End Time	Total Time (Hrs)	Comments
1-Ali	2.75	OC	MON	1800	1955	1.92	Orchard water is included.
2-Munir	2.75	OC	MON	1955	2150	1.92	Same
3-Anwar	2.7	OC	MON	2150	2345	1.83	Same
4-Wali	2.7	OC	MON	2345	0140	1.92	Same
5-Taj	2.7	OC	TUE	0140	0338	1.97	Same
6-Yaqoob	8.35	SC	TUE	0338	0818	4.67	
7-Anwar	8.35	OC	TUE	0818	1300	4.7	
8-Sardar	8.35	OC	TUE	1300	1740	4.67	
9-Asghar	6.25	OC	TUE	1740	2134	3.9	30 minutes' *Khal Brahi.*
10-Ashraf	6.25	OC	TUE	2134	0100	3.43	
11-Asghar	6.25	CON	WED	0100	0422	3.37	
12-Akram	6.25	OC	WED	0422	0743	3.35	
13-Riaz	5	OC	WED	0743	1033	2.83	
14-Bashir	11.5	SC	WED	1033	1613	5.67	
15-Arshad	8.5	SC	WED	1613	2145	5.53	30 minutes' *Khal Brahi.*
16-Hussain	25	SC&OC	WED	2145	1202	14.28	
17-Fathe	25	OC	THU	1202	0149	13.78	45 minutes *nikal* time
18-Maqbool	5	SC	FRI	0149	0439	2.83	
19-Noor	5	OC	FRI	0439	0729	2.83	
20-Nisar	10	CON	FRI	0729	1309	5.67	
21-Mansha	5	CON	FRI	1309	1551	2.7	
22-Rafiq	5	SC	FRI	1551	1841	2.83	
23-Niamet	10	OC	FRI	1841	2421	5.67	
24-Hakeem	10	SC	SAT	2421	0518	4.95	Orchard water is included.
25-Rafiq	5	SC	SAT	0518	0808	2.83	
26-Nazir	22	SC&CON	SAT	0808	2208	14.0	30 minutes' *Khal Brahi.*
27-Niaz	2.5	OC	SAT	2208	2333	1.42	

Name	Holding Size	Cultivator 's Status	Day	Start Time	End Time	Total Time (Hrs)	Comments
28-Munawwar	10.5	OC	SAT	2333	0735	8.03	Orchard water is included.
29-Said	10	OC	SUN	0735	1608	8.55	Same
30-Sharif	21	OC	SUN	1608	0353	11.75	
Village	-	-	MON	0353	0708	3.25	
31-Sharif	21	OC	MON	0708	0924	2.27	
School	6	-	MON	0924	1242	3.3	
32-Hashmet	11.75	CON	MON	1242	1800	5.3	99 minutes *nikal* time.

Foot notes

-OC for owner cultivator, SC for sharecropper, CON for contractor

The per acre allocation is not fixed. Rather, it varies from 29 minutes to 37 minutes per acre, despite the time fixed in the official list as 33 minutes per acre. This shows that people are not following the official list at all.

IIMI-PAKISTAN PUBLICATIONS

RESEARCH REPORTS

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