IMPROVING EQUITY OF WATER DISTRIBUTION: THE CHALLENGE FOR FARMER ORGANIZATIONS IN SINDH, PAKISTAN.

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ABSTRACT

A major objective of the Pilot Project for Farmer-Managed Irrigation in Sindh has been to help Farmer Organizations (FOs) achieve greater equity of water distribution. By giving full responsibility to water users for both operations and maintenance it is hoped that they will be able to develop water sharing mechanisms that reflect their views of equity rather than have a standardized view of equity imposed upon them by outside authorities.

Two elements of equity are considered on the basis of the results collected in the pre-transfer period. External equity issues look at water allocation and delivery between different distributaries. The three sample canals show wide variations in water deliveries, ranging from just under 100% of design to almost 200%.

Internal equity issues look at how water is shared between watercourses along a canal. In the two canals with favorable water deliveries at the head there is no noticeable head-tail difference, and all farmers get at least design discharge during the peak of the summer season. The third canal which gets close to design discharge shows a marked disparity between head and tail, with tail enders more or less deprived of reliable water.

To help farmers improve internal equity canals have been divided into three reaches more or less equivalent to head, middle and tail sections. Gauges established at each boundary provide farmers with a simple tool to determine whether each reach is taking more or less of its fair share of water. An accompanying table provides water level targets that the Farmer Organization can use as operational guidelines to allocate water between the different sections of the canal.

The farmer organizations in the three canals have become constrained because they still do not have legal powers to allocate and distribute water between watercourses, nor to determine the size of outlet structures to watercourses. If the

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enabling legislation is further delayed then it is likely the organizations will wither and become ineffective.

BACKGROUND

The decision of the Government of Pakistan to establish the Provincial Irrigation and Drainage Authorities carried with the policy of transfer of operation and maintenance responsibility from government to water users at secondary level. Traditionally water users have always had Operation and Maintenance (O&M) responsibility at watercourse (tertiary) level, although tertiary level operations are often guided by the time-sharing system known as warabandi that allows little or no flexibility in determining whose turn it is to receive water.

The increased responsibility for water users does not represent a simple increase in the amount of day to day management they already undertake. It involves a range of activities normally the preserve of government, it gets water users involved in making water allocation decisions at secondary level, in hiring staff and equipment to assist in operation and maintenance procedures, in collection of water fees and decisions about how to spend their share of money to meet the objectives of the association, and it involves direct interaction with officials of the newly established Area Water Boards which cover several secondary canals.

This paper focuses on only one aspect of the challenges facing the newly established secondary level organizations, namely the establishment of improved equity. It is based on experiences gained in assisting the process of organization of farmers on three secondary canals in Sindh which includes a detailed monitoring program that can assess the overall performance of organizations after they have been given full legal rights to manage their canals independently of government.

Concepts of Equity and Equality

The original design of irrigation canals in Sindh was based firmly on the concept of water rationing, sometimes referred to as protective irrigation. Water was allocated on a per-acre basis at a level insufficient for a farmer to irrigate all of his land holding so that cropping intensities could not reach 200%. In the canals selected for organization in the Pilot Project the design annual cropping intensity is approximately 100%, so that at any given time roughly half the land is expected to remain fallow.

To accomplish these design objectives the water delivery program was designed to meet strict discharge targets at all levels of the system. Starting at the watercourse level the design discharge can be determined using the concept of duty (traditionally expressed in cusecs per 1000 acres). The control structure at the head of each watercourse is then constructed so that the orifice or flume in the structure will deliver the precise discharge as long as the secondary canal water level is at designed elevation. There are no operable components in the outlet structure.

The watercourse discharges are then cumulated to determine the discharge at the head of the secondary canal plus an allowance for estimated losses within the secondary canal. Typically a value of 20% losses at secondary level is assumed. The same process is repeated in main canals, where secondary canal discharges are cumulated and an additional 10% added to allow for discharge. Under normal operating conditions, therefore, the intended discharge at each location in the system should be known. If, the intended plan is properly implemented then there will be close to perfect equality in water distribution. From the perspective of a secondary canal level farmer organization there are two different types of equity that they must try to deal with:

External Equity refers to the relative share of water the secondary canal receives compared with the discharges delivered to other secondary canals along the same main canal, while

Internal Equity refers to the sharing of water between different watercourses along the secondary.

DATA COLLECTION

The data collection was made from 1996 to 1998 which covered three secondary canals, however the project area was extended for other ten secondary canals. The results are discussed on only three secondary canals. Basic information on each canal is given in Table 1.

Table 1. Basic Information on the sample secondary canals in the Pilot Project

Heran Distributary, including Khadwari Minor	
Design Discharge	58.0 cusecs (1.643 m^3/sec)
Number of Watercourses	30
Culturable Command Area	15,323 acres (6,204 ha)
Bareji Distributary	
Design Discharge	41.5 cusecs (1.176 m^3/sec)
Number of Watercourses	24
Culturable Command Area	13,563 acres (5,491 ha)
Dhoro Naro Minor	
Design Discharge	51.60 cusecs (1.462 m^3/sec)
Number of Watercourses	25
Culturable Command Area	13,382 acres (5,418 ha)

RESULTS AND DISCUSSION

The discussion of results is divided into three parts.

Part 1: External Equity or Water Allocation to Secondary Canals

Heran Distributary is the most favored of the three sample canals. Because it offtakes directly from the Nara Canal and it is able to receive reliable water supplies throughout the year at a level well in excess of the original design. Figure 2 shows actual and design discharges in both 1997 and 1999.

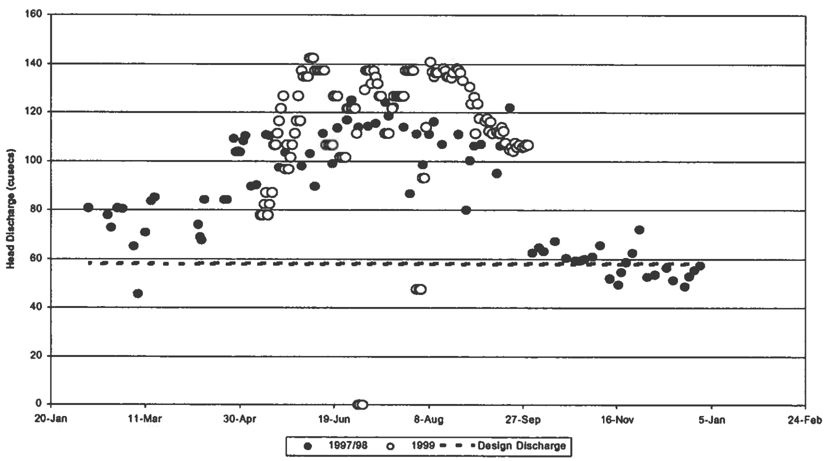

Figure 1. Heran Distributary Discharges

It is clear from Figure 1 that the Heran Distributary consistently receives far in excess of design discharge. There are three typical discharge levels: 100-140 cusecs in the peak of the summer (kharif) season equivalent to 0.57-0.80 l/sec/ha, 80 cusecs in the late winter season (0.45 l/sec/ha) when wheat is growing fast, and 60 cusecs (0.34 l/sec/ha) in early winter when cotton has been harvested and wheat is in the establishment phase. During the peak season the discharge is typically 200% of design, dropping to design discharges when demand is at its lowest level. One important element shown by these data is that there is no significant difference between the 1997/98 and 1999 data. In 1999 there is actually slightly more water delivered to the canal than in 1997.

Bareji Distributary shows a somewhat different pattern (Figure 2). In 1999, although overall discharges are higher than 1997, there is a rotation imposed upon the canal which closes it for approximately one week every four weeks. This means that the effective discharge is less than the daily discharge levels.

In 1997 kharif season the average daily discharge was 65.0 cusecs for the 13,592 acres (5502 ha) of irrigable land, or a daily discharge rate of 0.33 l/sec/ha. In 1999 the average discharge when the canal was open was 81.5 cusecs (0.41 l/sec/ha), a delivery rate 98% higher than design, but when the closure days are included the average delivery rate drops to 56.7 cusecs (0.29 l/sec/ha), only 37% above design. There is no data immediately available to determine if rotations occurred during the 1997 kharif season.

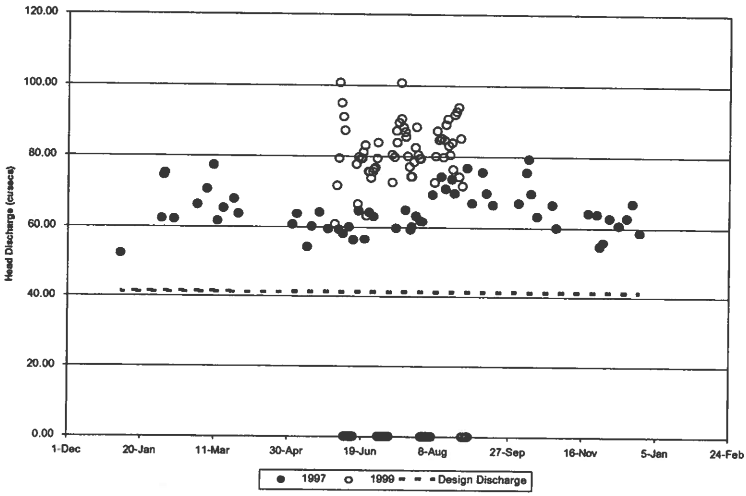

Figure 2. Head Discharges, Bareji Distributary

Dhoro Naro Minor shows a completely different pattern of water distribution and provides considerable more insight into management issues (Figure 3). In 1997 discharges were generally above design levels. The average discharge during kharif season was 59.7 cusecs for the 13,382 acres (5,418 ha) of irrigable land, equivalent to an average delivery rate of 0.31 l/sec/ha, and some 16% above design discharge. During this period the coefficient of variation of discharges was 16.5% which is considered acceptable under normal operating conditions.

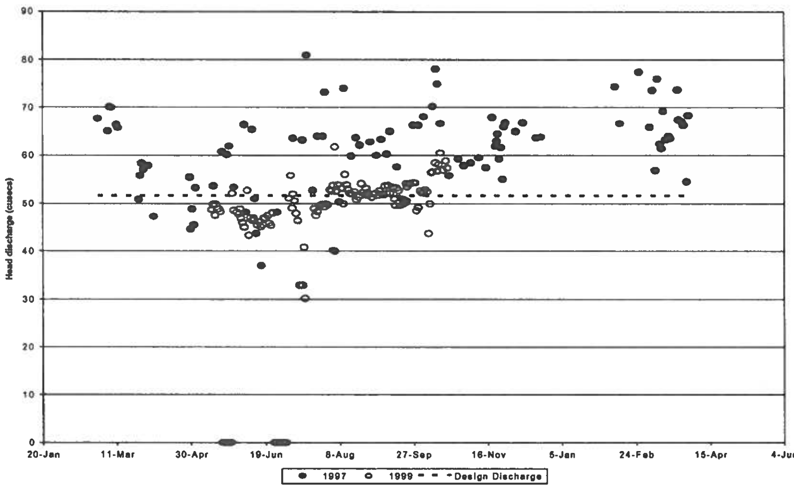

Figure 3. Head discharges, Dhoro Naro Minor

During the same period in 1999, however, discharges were significantly lower. On days when water was flowing, the average discharge was 50.4 cusecs, equivalent to an average delivery rate of 0.26 l/sec/ha and 98% of design discharge. If the rotation periods are included in these calculations, the average discharge drops to 44.87 cusecs, which is a delivery rate of only 0.23 l/sec/ha. This is only 87% of designed water delivery. At the same time, however, discharges were extremely stable: the coefficient of variation of discharge when water was flowing was only 9.6% which is considered very good.

Part 2: Issues of Internal Equity facing Farmer Organizations

Heran Distributary shows the importance of considering both absolute and relative equity (Example given in Figure 4). In terms of relative equity the data for 1997 show that the tail end-reach (the last five watercourses on the Distributary) get a lower proportion of available water than the other four upstream reaches. The head reach (Reach 1, or the first five watercourses) does not always get the highest share of water, this generally being experienced in the second reach (watercourses 6-9). However these differences hardly matter. With the exception of a few days during the entire season (7 occasions out of 48, and most of these were in April when wheat is being harvested so demand is less), the tail watercourses get more than their design share. It may be true that some farmers get twice as much as others, but this is comparatively equitable by typical standards in Pakistan.

An even more equitable pattern emerged in 1999 when discharges were more than twice design. While the tail end reach still received less water than the other reaches, and the head end reach received more than anyone else, all reaches received at least 50% more than design on every day of measurement. Under these conditions it is not worth the Farmers Organization spending much effort to reduce head-tail differences.

Their management concerns are likely to be rather different: protection of their land against waterlogging, and ensuring they do not get less water in the future. However, the latter issue is one that might emerge when the Area Water Boards become effective.

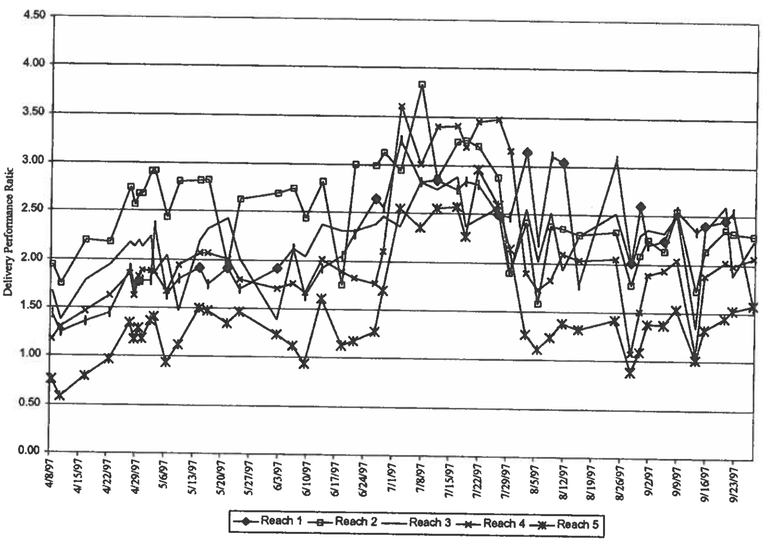

Figure 4. Water distribution equity, Heran Distributary, 1997

Bareji Distributary shows a similar pattern. Data for Kharif (Summer season)1997 show that there is no head-tail difference, and that all watercourses receive well over the design discharge. This is consistent with the data from the head gate which also show long periods when the total discharge available to the distributary are well in excess of design.

Dhoro Naro Minor shows a classic case where there is both absolute inequity and relative equity. Almost independent of the discharge at the head of the distributary, watercourses in the first reach (top 20% of all watercourses) receive more or less twice their design discharge. This is true whether the canal is running at design or at 140% of design. In contrast, the tail end two reaches hardly receive any water when the canal is running at design discharge, and only reach design discharge at the tail when the canal is running substantially above design.

How Farmer Organizations can be Helped in Improving Internal Equity. In efforts to provide a simple but practical alternative, gauges were established in each of the three distributaries that can be used to give a quick indication of whether the head and middle reaches are receiving more than their fair share and whether water is in excess at the tail and the head gate opening needs to be reduced in order to prevent over-irrigation or waterlogging.

An example of correlation analysis between gauges along the distributary canal is developed and is presented in Table 3. In the case of Heran Distributary design discharge of 58.0 cusecs is achieved if the head gauge reads 1.85 feet. If the equity objective of farmers is to distribute this water equally between each reach then the middle gauge should read 1.70 feet (35.2 cusecs) and the tail gauge should read 1.64 feet (20.2 cusecs). If the middle gauge reading is less than 1.70 then the head reach is taking more than its fair share and some remedial action may be required to reduce discharges into one or more watercourses in the head reach.

Table 3: Management Table to Help in Determining Target Levels of Different Gauges: Heran Distributary

Head of Distributary			**Top of Tail Reach**			
Head Gauge (ft)	***Percent Design Discharge***	***Head Discharge (cusecs)***	***Target Discharge (cusecs)***	***Middle Gauge (ft)***	***Target Discharge (cusecs)***	***Tail Gauge (ft)***
1.42	70	40.60	24.64	1.21	14.14	1.26
1.57	80	46.40	28.16	1.38	16.16	1.39
1.71	90	52.20	31.68	1.54	18.18	1.52
1.85	100	58.00	35.20	1.70	20.20	1.64
1.99	110	63.80	38.72	1.86	22.22	1.76
2.12	120	69.60	42.24	2.02	24.24	1.88
2.25	130	75.40	45.76	2.18	26.26	1.99
2.37	140	81.20	49.28	2.34	28.28	2.10
2.50	150	87.00	52.80	2.50	30.30	2.21
2.62	160	92.80	56.32	2.66	32.32	2.32
2.74	170	98.60	59.84	2.82	34.34	2.42
2.86	180	104.40	63.36	2.97	36.36	2.53
2.97	190	110.20	66.88	3.13	38.38	2.63
3.09	200	116.00	70.40	3.28	40.40	2.73

Part 3: Overall Conclusions and Recommendations

Farmer Organizations have two specific and separate functions. The first function is to safeguard their overall right to a specific volume of water at the head of the canal, and the second function is to distribute that water among members in equitable manner as they see fit.

Water Allocations between Canals. Safeguarding a specific volume of water at the head of the canal assumes that there is some form of hydraulic contract between the Farmer Organization (FO) and the Area Water Board which has overall responsibility for management of water resources at the level of major canal commands. This contract can take one of several forms: the simplest form is design discharge, but it could be considerably more complex so as to accommodate changes in demand and supply during the year. Whatever the details of the agreement, the basic and non-negotiable condition is that the pattern of water deliveries is known in advance with respect to both volume and timing, and that both parties are able to mutually verify that these conditions are being met.

The present situation in the three distributaries shows that there is a long way to go before both sides can feel comfortable that they have an agreed set of hydraulic conditions. In Heran and Bareji Distributaries actual discharges far exceed design, but the Irrigation and Power Department (IPD) has indicated that as a special concession these above average discharges will be maintained. However, this indication cannot have legal status at present because officially IPD is only authorized to give design discharge. This dilemma for IPD needs to be resolved.

Similarly, Dhoro Naro Minor complains bitterly that it gets less water than before, and that it gets proportionally less than other neighboring canals. It is not easy to prove these complaints because most canal gauges are no longer accurate and information on discharges is not part of the public domain. Nevertheless, whatever the specific complaints at Dhoro Naro, Area Water Boards are going to have to get used to the reality of Farmer Organizations being able to measure discharges in their canals and to make this information public

Information about Deviations from Agreed Water Allocations. Reliability of irrigation water is not merely sticking to an agreed set of allocations. It also requires an effective communication framework that can substitute information for water when there is a need to make changes.

The classic case of this is information about rotations. If, for perfectly legitimate technical reasons, suppliers of water have to implement rotations then it is incumbent upon them to ensure that the starting and ending times of each rotation are known to everyone in advance, and that actual operations of gates and other structures are timed so that the pre-announced timetable is correctly followed.

If water users do not know when their water will be cut off, or when it will be restored, then this will lead to confusion and frustration and they will have some legitimate complaint to make concerning the management of the Area Water Board.

Mechanisms for Resolution of Disputes. Disputes that arise at present, and there are many, are solved in an ad-hoc manner, normally on the basis of a personal intervention rather than in any systematic manner that will form the basis for future resolutions. This type of approach to dispute resolution favors the supplier of water over the user of water.

If water users are more certain that the supplier of water is doing the best possible, and that there is some degree of mutual trust and tolerance established on both sides, then it is possible to create the conditions whereby improvements in water service delivery to FOs can be matched by improvements in the internal management of water by FOs internal to their distributary or minor.

Achieving Greater Internal Equity of Water Distribution. To date it is impossible to say with conviction that Farmer Organizations have made genuine and lasting improvements. There appear to be three primary reasons for this: differences in absolutely equity in the three pilot canals, weak internal mechanisms to identify what is considered fair, and the lack of an overall enabling framework.

Identifying what is seen as fair. The easy way out from the problem of identifying what is fair is to equate equity and equality. The old design concepts of the British followed this path, so that water was allocated almost entirely on the basis of land holding irrespective of physical, social or other factors.

Over time, for whatever reasons, be they head-tail differences, reflections of political or social differences, or reflections of who is a better farmer, some farmers get more water than others. The more favored ones are unlikely to willingly give up all of their extra benefits, but that does not mean they might not be willing to give up some part of their advantage.

If FOs are organized solely on the basis of equality, then they will probably fail in their efforts to achieve greater equity. Instead, they need to try to identify some rules of what might be considered fair, and the mechanisms by which these rules could be implemented by members of the FO.