Report No. R-39.2

PILOT PROJECT FOR FARMER-MANAGED IRRIGATED AGRICULTURE UNDER THE LEFT BANK OUTFALL DRAIN (LBOD), STAGE-I PROJECT

MONITORING AND EVALUATION OF IRRIGATION AND DRAINAGE FACILITIES FOR PILOT DISTRIBUTARIES IN SINDH PROVINCE, PAKISTAN

Volume Two
Bareji Distributary, Mirpurkhas District

Interim Report

by
Bakhshal Lashari
Waryam Balouch
Ghulam Mustafa Talpur
Muhammad Nadeem
Asghar Ali Memon
Badrul Hassan Memon
M. Akhtar Bhatti
M. S. Shafique
Gaylord V. Skogerboe

December 1997
Hyderabad Office
PAKISTAN NATIONAL PROGRAM
INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The authors of this report express their profound thanks to the Project Leader, Mr. D. Tissa Bandaragoda, Senior Management Specialist, for his guidance and encouragement in undertaking most of the activities reported here. We also convey our gratitude to Dr. Yameen Memon, Team Leader and Sociologist, for his support in conducting these activities. Thanks are due to Mr. Abdul Hakeem Khan, Senior Field Engineer, Mr. Nisar Hussain Bukhari and Miss Rubina Siddiqui who helped in calibrating the outlet structures, measuring the discharges, and evaluating seepage rates.

Special thanks are due to Mr. Mohammad Wasi Shaikh, Mr. Ahsan Ali Kazi, Mr. Ayaz Anwar Solangi and Mr. Faisal Memon for assisting in several ways during report preparation in the Hyderabad Office of IIMI.

Also, we are very grateful to Mr. Tabrez Ahmad, Secretary, IIMI-Pakistan Headquarters, for his efforts in formatting and compiling this report.

1. INTRODUCTION

1.1. PILOT PROJECTS

The International Irrigation Management Institute (IIMI) is implementing three pilot projects on Farmer-Managed Irrigated Agriculture since July 1995, in collaboration with the Agricultural Engineering and Water Management Directorate of the Department of Agriculture, Government of Sindh. The broad purpose of these pilot projects is twofold:

(i) to test the viability of farmers' managing parts of irrigation systems, more specifically distributary/minor canals, so that more efficient and equitable distribution of water can be achieved; and
(ii) to make recommendations related to future extensions on the basis of results from the pilot projects.

The three pilot projects selected from the LBOD project area, one from each of the three districts of Nawabshah, Sanghar and Mirpurkhas, are to assist farmers in undertaking Operation and Maintenance (O&M) of the combined irrigation and drainage facilities. This would be achieved through assisting farmers to organize themselves into Water Users Associations (WUAs) at the watercourse level and into a Water Users Federation (WUF) at the distributary/minor canal level. The experience gained from these pilot command areas would also help in identifying and developing an appropriate institutional process, along with legal requirements, for effective implementation on a broader scale for all of the distributaries in a canal command area.

1.2. THE CONCEPT

The broad concept underlying these pilot projects is that the WUAs and WUFs would eventually be accountable for the water received at the head of the distributary/minor canal, responsible for water distribution among the members, collection of water charges, along with operation and maintenance (O&M) of the combined irrigation and drainage facilities in their distributary/minor command area.

They may also adapt revised procedures on water allocation, distribution and water charges collection with the agreement of their members. WUFs would be expected to enter into agreements with their own members and the Sindh Irrigation and Drainage Authority (SIDA) for implementation of the concept.

1.3. KEY ACCOMPLISHMENTS IN BAREJI PILOT PROJECT

The Bareji pilot project has achieved remarkable progress in the implementation of project activities. The project has helped farmers to organize themselves into 24 Water Users Associations (WUAs) in the Bareji Distributary command area. Using these WUAs as basic organizations, a Water Users Federation (WUF) has been formed at the distributary level. The

A Joint Management Agreement (JMA) is being negotiated between the Sindh Irrigation & Drainage Authority (SIDA) and the Bareji WUF. Under the agreement, the Bareji WUF would undertake operation of the irrigation and drainage system, collection of water charges, improve water management and drainage practices, and carry out other related activities, including the maintenance of irrigation and drainage facilities in the pilot area.

1.4. MONITORING & EVALUATION ACTIVITIES

The basic concept behind the pilot project as outlined above is to involve farmers in operation & maintenance of the irrigation and drainage facilities. This has never been successfully accomplished in the country. Therefore, there is a strong need and justification for monitoring and evaluating the process employed and its impact, so that changes can be made to make the process more useful for all concerned and to the country. The expectations are that M&E would help in at least two major ways:

(i) allow the SIDA and WUF to adjust their activities to the needs and constrains of the irrigation and drainage management turnover projects; and
(ii) provide policy-makers and planners with up-to-date information about the consequences of appropriate management changes for planning new projects that could be extended to other distributary command areas.

The Monitoring & Evaluation (M&E) activities were initiated in December 1996. The main objective was to document the on-going situation before the management turnover of the distributary canal to WUFs. As a first step, a detailed methodology was developed for data collection to monitor irrigation delivery and drainage disposal systems. Following this methodology, actual field data collection started in April 1997 (kharif season). This is an interm report that summarizes the results and findings of the M&E activities, until September 1997

2. DESCRIPTION OF BAREJI DISTRIBUTARY

2.1. LOCATION

The Bareji Distributary is situated at about 15 km southeast of Mirpurkhas City, which is situated between 23° and 32° North Latitude and at 69° East Longitude. The elevation of Mirpurkhas District is about 50 feet above mean sea level. The distributary offtakes at RD 408 from the East Jamrao Canal near Moree bridge. A location map of the project area is shown in Figure 2.1.

2.2. SALIENT FEATURES

The total length of the distributary is 12 km. The gross command area (GCA) of the distributary is lying between Jamrao Canal and the Spinal Drain from West to East, respectively. Areas adjacent to about 2 kms of the middle reach of the distributary are comparatively at a higher elevation. A command map of the distributary is presented in Figure 2.2. The salient features of the distributary are given below in Table 2.1.

Table 2.1. Salient features of the Bareji Distributary.

Description	Detail
Design discharge	41.5 cfs
Total watercourses	24
Unlined watercourses	17
Lined watercourse	7
Length of the distributary	12 km
Culturable command area (CCA)	13,952 acres
Gross command area (GCA)	14,842 acres

2.3. CLIMATE

The climate is suitable for all major crops such as cotton, sugarcane, wheat, chilies, oil seeds and bananas. The region is hot in the summer with the maximum temperature ranging between 38°C and 43°C, while the mean minimum temperature during winter ranges between 12°C and 20°C. The monthly rainfall during summer is about 40-50 mm, while the winter season is practically dry. The average annual precipitation ranges from 200 to 250 mm.

2.4. IRRIGATION SYSTEM

The irrigation system in the command area of the distributary is canal irrigation, which is called a gravitational system. The head reach command area of the distributary is being cultivated by this system, but the middle reach command area is higher than the bed elevation of the distributary channel; thus, the command of this reach is cultivated by canal irrigation through using lift machines. Also, some watercourses in the tail reach have the same problem. The details of the lift machines are given in Table 2.2.

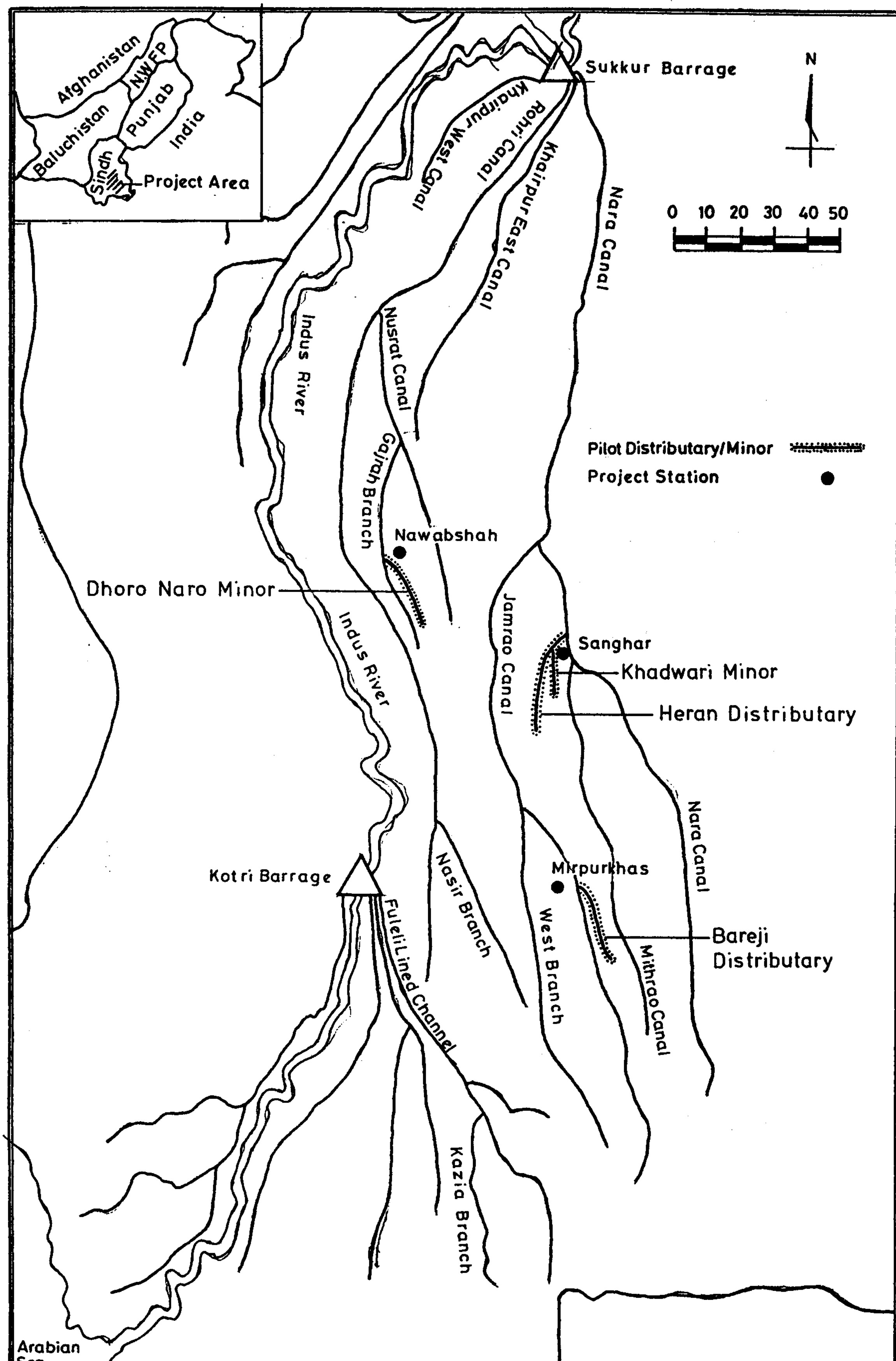


Figure 2.1. Location map of the three pilot distributaries in Sindh Province.

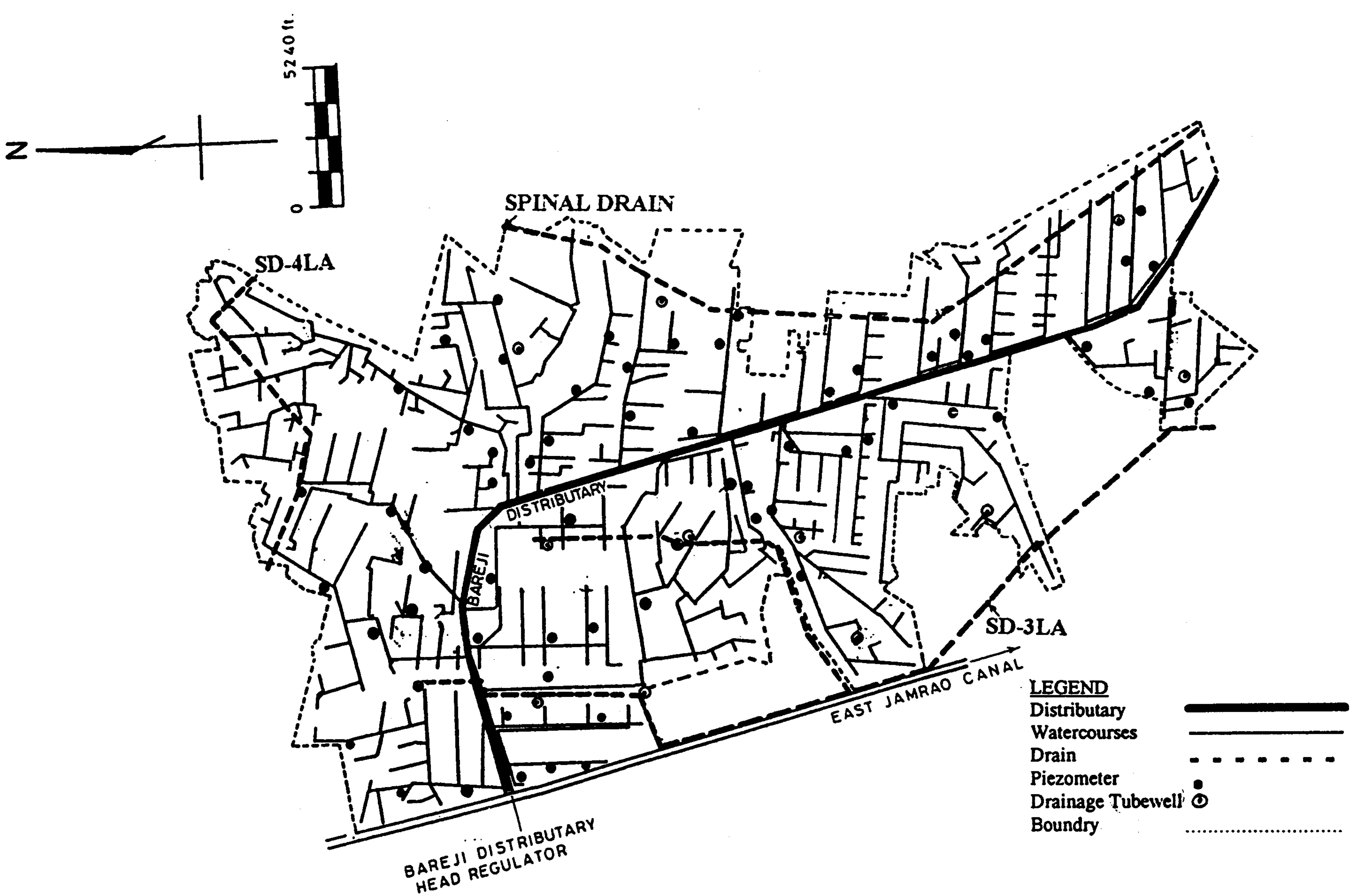


Figure2.2 Layout Plan of the Bareji Distributary Command Area

Table 2.2. Lift machines at the outlets of Bareji Distributary.

No.	WC No.	Name of Land Owner	Land Irrigated (acres)	Running hours per week	Cost of fuel per week (Rs)	Other cost per season (Rs)	HP
1.	11L	Arzi Khan	75	90	1200	7000	16.5
2.	12L	Manjhi Khan	80	128	1650	6500	16
3.	8L	G. Rasool	17	2	20	6000	16.5
4.	10L	Yusif Bhanger	70	69	1900	7000	18
5.	10L	Yusif Jhulan	16	10	180	3000	12
6.	10L	Ghulam Dal	150	99	1550	8000	16
7.	9R	Ch. Saeed	35	28	650	4000	12
8.	9R	Ch. Javed	15	12	250	3000	12
9.	9R	M. Bashir	15	12	250	3000	12
10	9R	G. Shabir	33	28	650	4000	12
10	10R	Aghe Dino	100	147	3000	8000	12
11	10R	Ch. Rashid	20	13	225	3500	16
12	9L	H. G. Hussain	130	66	2100	8000	22
13	9L	H. Peroz	32	20	700	4000	12
14	7L	Gul Mohammad	34	12	400	3000	12
15	7L	H. Imam bux	12	4	50	1000	12

2.5 DRAINAGE SYSTEM

The LBOD project stretches across three districts of Sindh Province. There are two types of drainage facilities available in the Bareji Distributary command area - surface drainage and subsurface (tile) drainage. The total of 13 sump houses for discharging tile drainage to a surface drain are located in the Bareji Distributary command area, which are collecting subsurface water through collectors and lateral lines laid in the pilot command area. The details of the subsurface and surface drains are given in Tables 2.3 and 2.4.

The three surface drains (namely 3L, 4L and 4LA) are located in the command area. Sub-drain 3L is collecting the saline water which is being pumped by the sump houses and Sub-drains 4L and 4LA are being used for surface runoff. The spinal drain is also passing through the pilot command area of Watercourses 6L to 13L. The details about surface drains are shown in Table 2.4.

Table 2.3. Salient features of subsurface (tile) drainage.

Sr. No.	Pump Station	CCA of sump house, acres	Design discharge, cusecs	Length of collector lines, Feet	Length of lateral lines, Feet	Deh* covered
1	3L-26	733	2.5	23520	76340	229
2	SD-19	750	2.5	22484	57080	224
3	SD-24	701	2.5	22324	60740	227
4	3L 25 A	587	2.5	15810	56000	240
5	SD-22	747	2.5	22690	50160	226
6	3L 22 B	533	1.5	15390	39100	239
7	SD 21 A	491	1.5	17080	49490	225
8	3L 22 A	758	2.5	21070	63530	238
9	3L 20	1078	1.5+1.5	35220	104180	238
10	3L 17	1023	1.5+1.5	33350	103490	236
11	31 21 B	1045	1.5+1.5	27406	73070	240
12	3L 23	877	2.5	23256	56459	239
13	3L 24	550	1.5	12660	59430	240

* Deh = Small village.

Table 2.4. Profile of surface drains located in the Bareji Distributary command area.

Sr. No.	Name of drain	Design discharge (cfs)	Total Length (km)	Length in command area (km)	Dispose off into
1	4L Sub drain	25.6	7	4.7	Spinal drain
2	4LA Sub drain	16.5	5	1	4L Sub drain
3	3L Sub drain	NA	30.97	12.98	Spinal drain
4	DC-1R	NA	4	4	3L Sub drain
5	Spinal drain	NA	NA	10	Arabian Sea

2.6. LAND USE

The Gross Command Area (GCA) of the distributary is 14,842 acres from which the Culturable Command Area (CCA) is 13,952 acres (source: Irrigation Department). Some variation was found in the total CCA of the distributary mentioned in the irrigation records and the data collected on warabandi lists from farmers. This could occur because of the following reasons. The most important reason is that once the government settled the land for a particular watercourse, then it does not update the record. For example, about 700 acres of land in seven watercourses of the distributary have come under the spinal drain, whereas this land still exists on the records for the distributary's command area. Also, there is a small area which comes under sand dunes along the watercourses, which does not belong to the farmers, but belongs to the government, which has not been cultivated till today. In the records, these sand dunes are a part of the culturable command area (CCA).

2.7. GROUNDWATER

The ground water in the distributary command area is mostly saline water. During the collection of data on water quality, it was observed that the water quality varies from area to area and sump house to sump house. However, the water pumped from the sump houses is saline and cannot be used for irrigation purposes. The water samples collected from the 65 piezometers installed in the command area showed that the water contains total dissolved solids (TDS), a measure of total salinity, ranging from 400 ppm to 19,000 ppm.

2.8. CROPS

The major crops being cultivated in the Bareji Distributary command area are cotton, sugarcane, chillies, wheat, oilseed, fodder, onion and mango orchards. Data was collected on the cropping pattern and cropping intensities.

2.9. IRRIGATION PRACTICES

Traditionally, there are two common irrigation methods being followed in the area. These are basin irrigation and furrow irrigation. n the case of basin irrigation, the formers traditionally prepare the land without proper levelling. Now, the trend is moving more towards using furrow irrigation because farmers have benefited by using this system in saving water and being able to cultivate more land. Therefore, the water application efficiency has increased by using this method of irrigation.

2.9.1. Basin Irrigation

Some years ago, the basin irrigation method was common, but now this practice is being slowly changed. Now, farmers are concentrating on furrow irrigation, because they have come to realize that for the basin irrigation method, they need precise land leveling.

During the rabi season, mostly wheat, fodder and sugarcane are being cultivated by the basin irrigation method, whereas in the kharif season, fodder crops are being sown by basin irrigation and cotton and chillies are sown using the furrow irrigation method.

2.9.2. Furrow Irrigation

Now the trend towards the furrow irrigation method has increased because farmers can cultivate more land with less water. The water application efficiency has increased by this practice. During the kharif season mostly cotton and chillies are being sown on ridges, while in the rabi season, onions and vegetables are being cultivated by the furrow irrigation method.

3. RESULTS AND DISCUSSION

The results of the monitoring and evaluation activities conducted in the Bareji Distributary Command Area from April to September 1997 are presented and discussed below. As explained earlier, these are limited to Phase I of the monitoring and evaluation, which focuses on the conditions before the irrigation management turnover.

3.1. IRRIGATION DELIVERY SYSTEM

3.1.1. Operations of Irrigation Delivery System

The provision of reliable and equitable irrigation water supplies to the secondary and tertiary units should be a primary operational objective of an irrigation delivery system. Keeping this in view, operations of the Bareji Distributary were monitored to determine the nature and extent of fluctuations occurring in canal water supply and their effects on watercourses. Flows were measured twice a week simultaneously at the head regulator as well as at all the outlets.

3.1.1.1. Irrigation Supplies at Head Regulator

Average monthly values for discharge at the head regulator from April to September 1997 are presented in Figure 3.1. The average monthly discharges show that the supply in the months of May, June and July were not very different from one month to the other. But, the average monthly discharges during the months of August and September were higher than the other months. This could be related to the rainy monsoon season coupled with peak flows in the river system.

The temporal coefficient of variability of irrigation supplies at the head regulator was determined for each month. The results are presented in Figure 3.2. The figure shows that, except for the month of May, they were in the "Good" category, whereas the result for the month of May was in the "Fair" category according to Molden and Gates (1990). The results indicate that the variations observed in the flow at the head regulator were in acceptable range.

3.1.1.2. Irrigation Supplies at Watercourse Outlets

The distribution of water among the outlets is the main concern of the water users. The distribution among the outlets/watercourses was evaluated using "Equity" as the indicator which indicates the ability of a system to distribute water uniformly over space. The discharge of each outlet from the Bareji Distributary was measured at the same time as the discharge measurement at the head regulator. The monthly data (about eight observations in a month) were normalized. The resulting average monthly discharge values of each outlet is presented in Figures 3.3 through 3.8. Figure 3.3 shows that during the month of April, 1997, four outlets located in the middle reach (4L, 6L, 9L and 7R) were drawing exceptionally higher discharge, whereas two outlets of the tail reach (8R and 10R) were drawing less discharge when compared with their old design discharges. This trend continued during other months as well. From these figures it is quite clear that there was a large variation in amounts of water being drawn by different outlets.

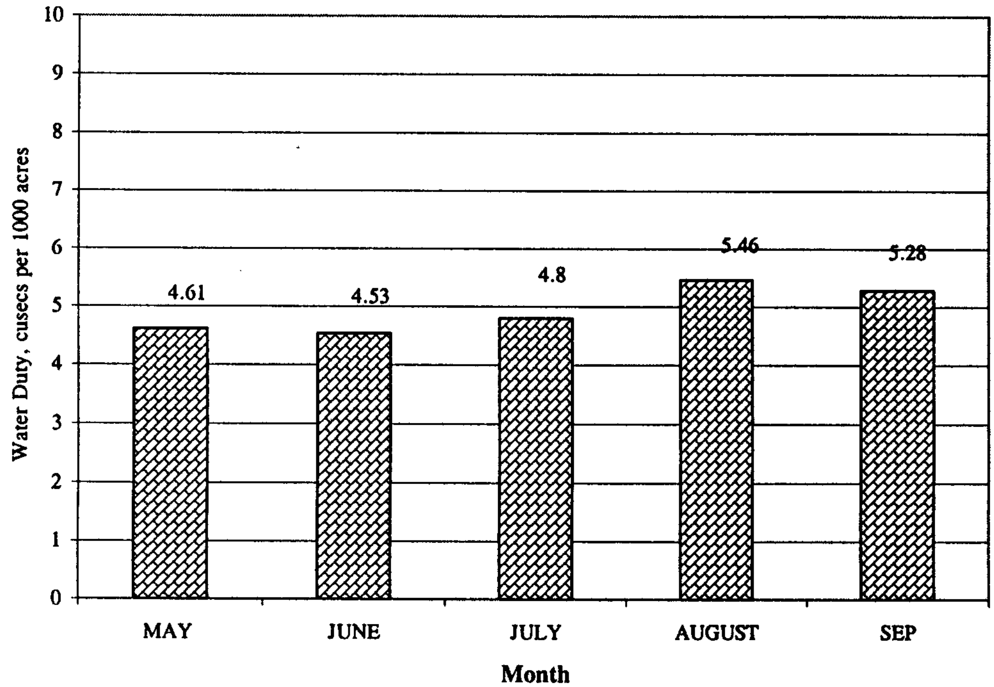


Figure 3.1. Monthly average discharge entering Bareji Distributary of Kharif 1997.

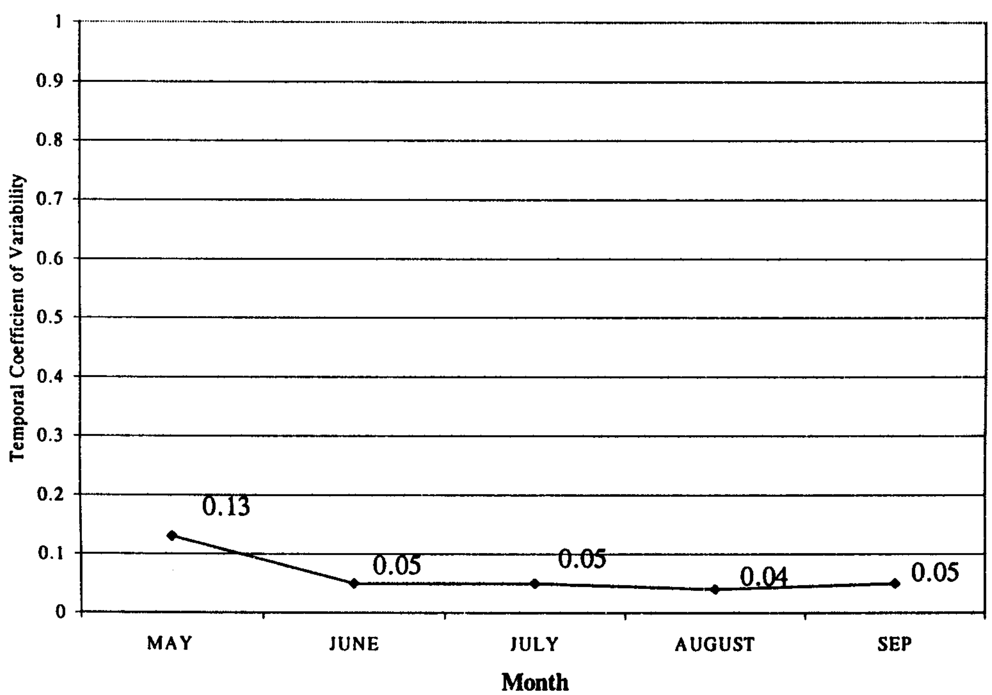


Figure 3.2 Temporal Coefficient of Variability at head regulator of Bareji Distributary o Kharif 1997.

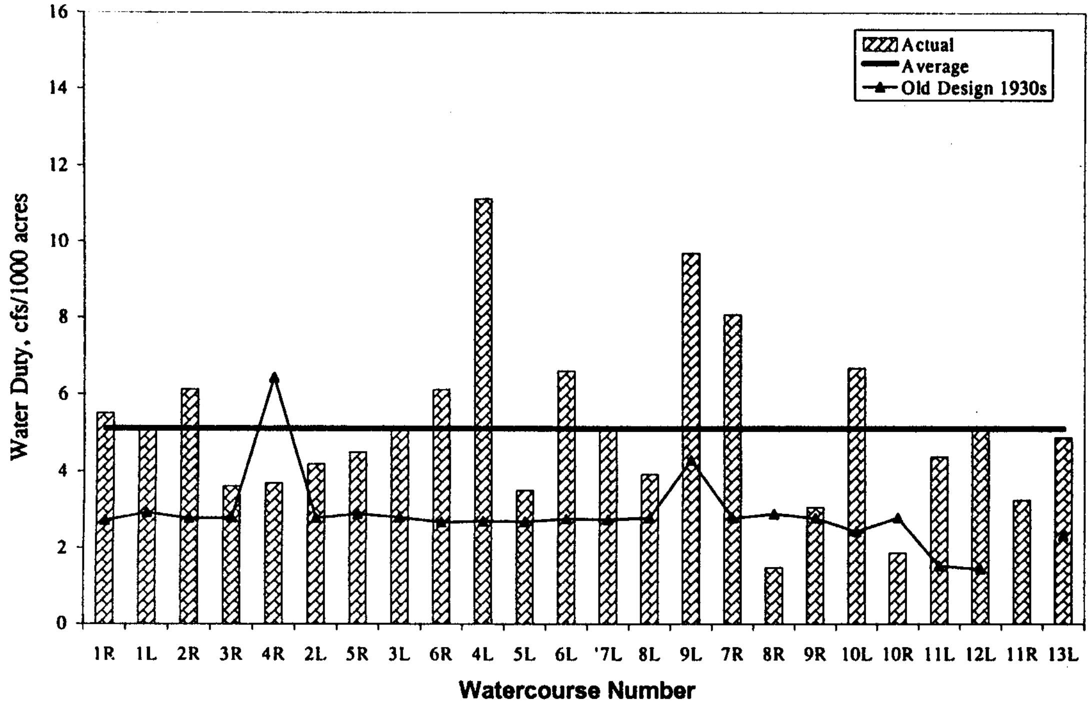


Figure 3.3. Normalized water discharge of outlets from Bareji Distributary for April 1997.

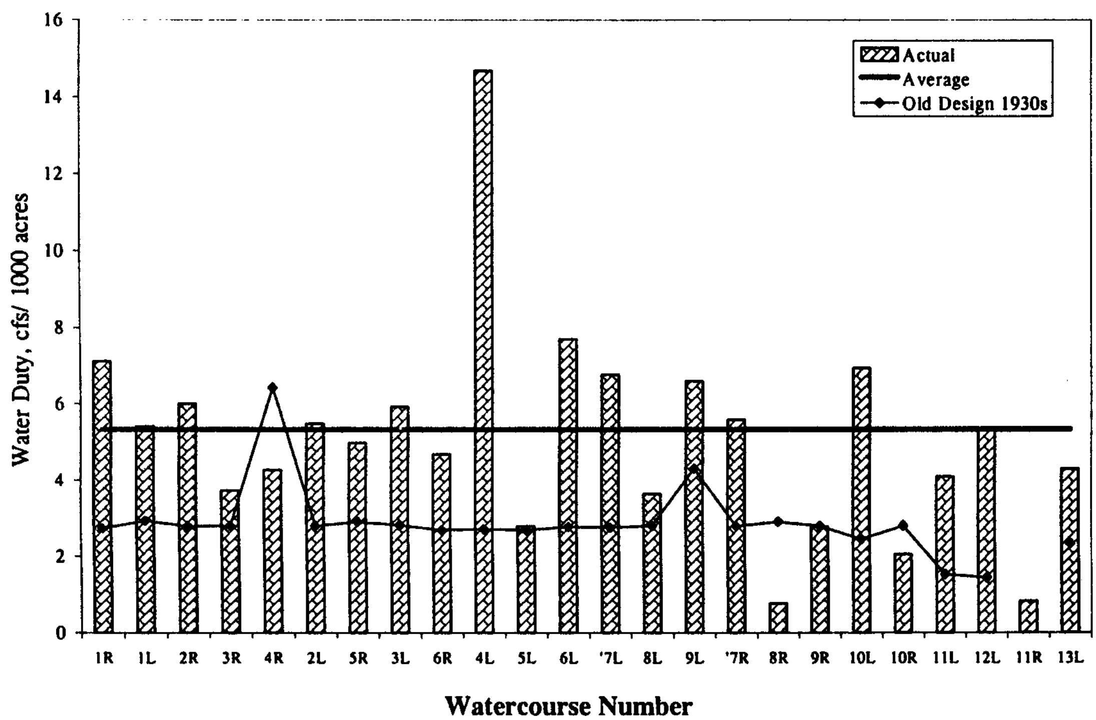


Figure 3.4. Normalized water discharge of outlets from Bareji Distributary for May 1997.

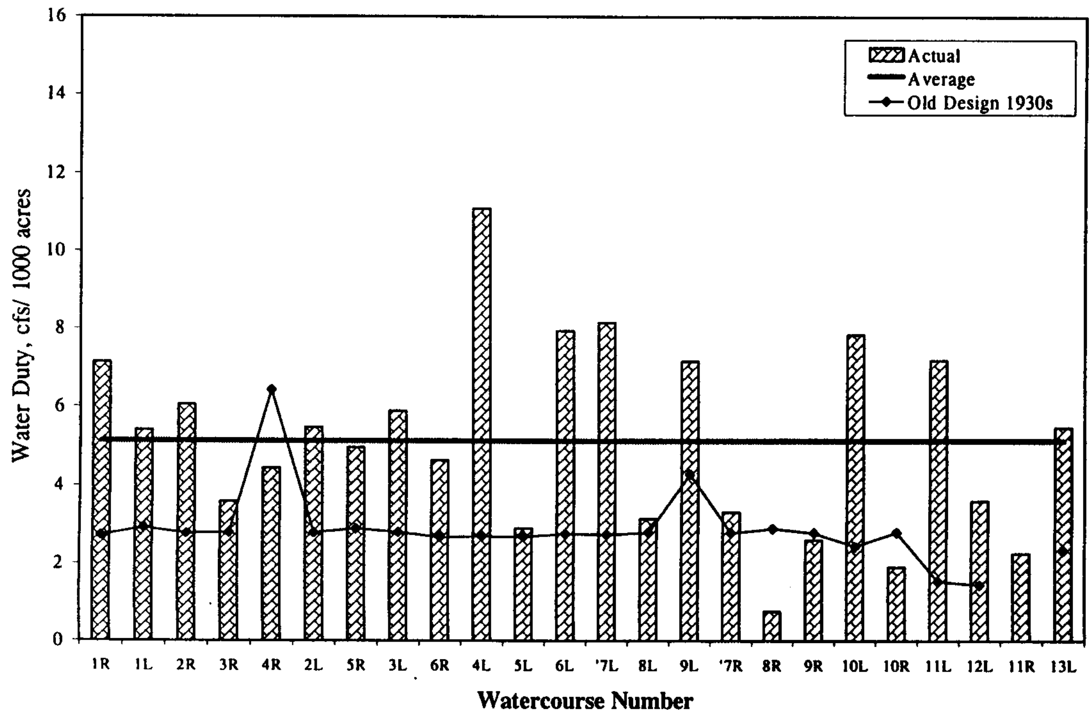


Figure 3.5. Normalized water discharge of outlets from Bareji Distributary for June 1997.

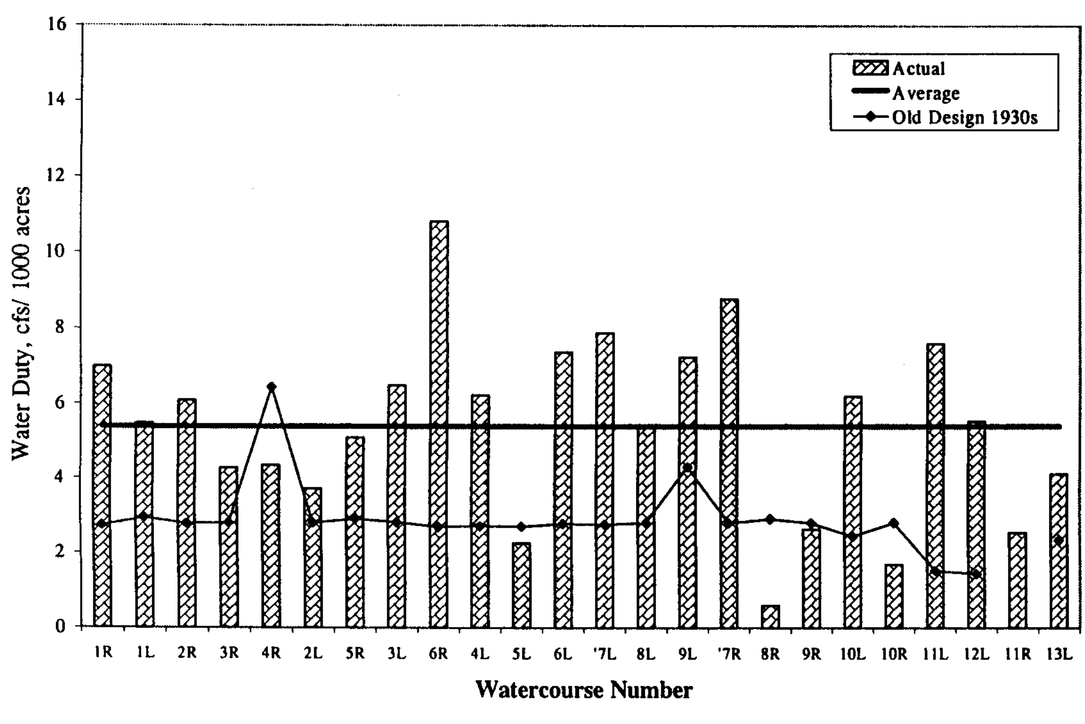


Figure 3.6. Normalized water discharge of outlets from Bareji Distributary for July 1997.

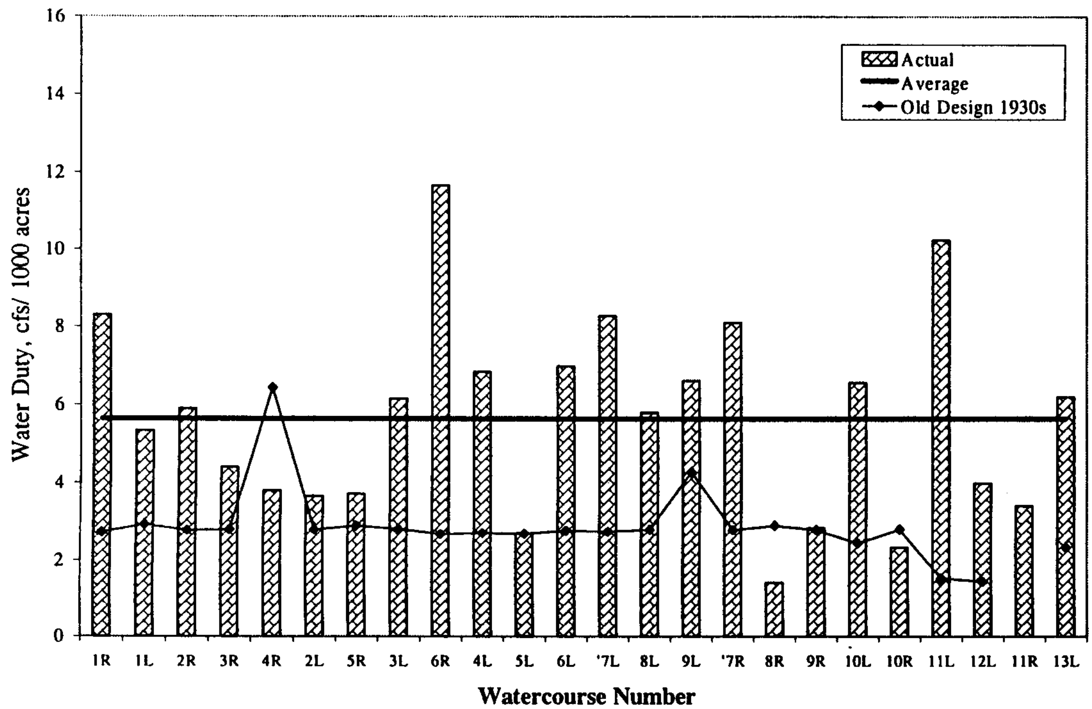


Figure 3.7. Normalized water discharge of outlets form Bareji Distributary for August 1997.

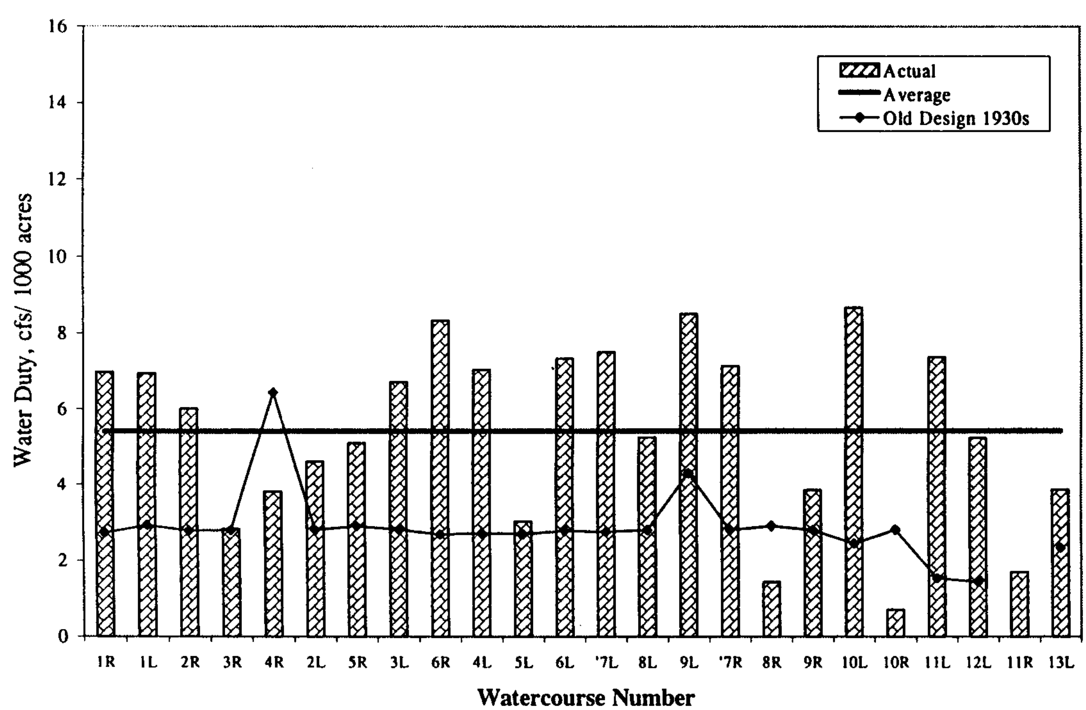


Figure 3.8. Normalized water discharge of lutlets from Bareji Distributary for September 1997.

The data were analyzed to determine the spatial and temporal coefficients of variability. The results are presented in Figures 3.9 and 3.10. Monthly measured discharges are presented in Annex A. Figure 6.9 shows that the spatial coefficient of variability for the outlets was from 0.44 (44%) to 0.58 (58%), which implied that the water distribution along the outlets was in the "Poor" category according to Molden and gates (1990).

Figure 3.10 shows that the temporal coefficient of variability varied from 0.09 to 0.18, which is relatively small, thereby implying that each outlet was drawing proportionally the same amount whether the distributary had increased or decreased irrigation water supplies.

3.1.1.3. Irrigation Delivery Performance

The summary of irrigation delivery performance is given in Table 3.1.

Table 3.1. Performance of Irrigation Delivery System.

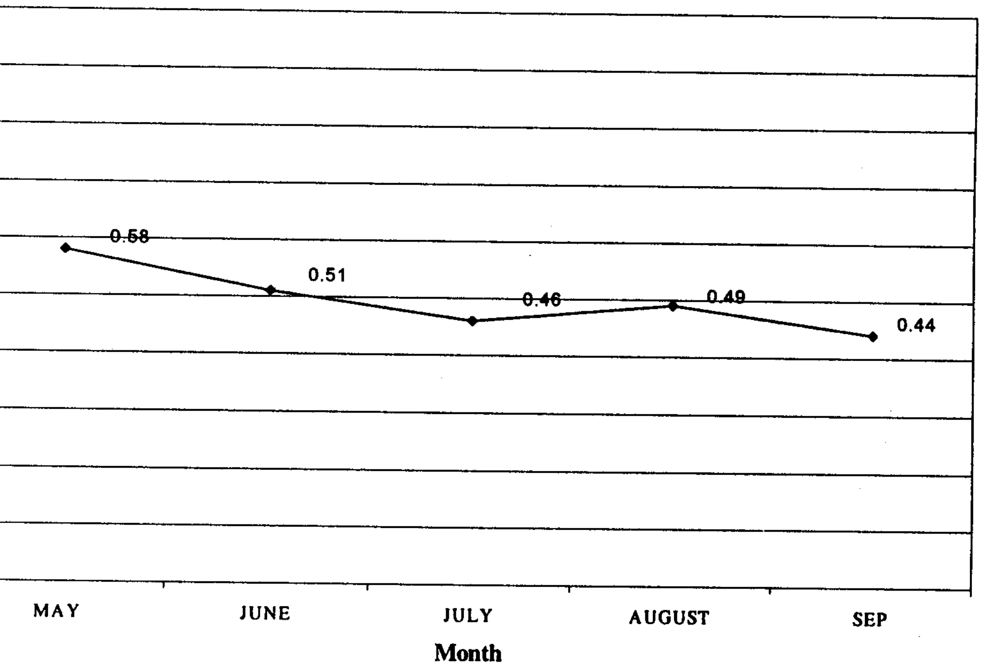
Months 1997	Average Discharge at head regulator (cfs/1000 acres)	Temporal coefficient Of Variability at head regulator	Spatial coefficient of variability at outlets	Temporal coefficient of variability at outlets
May	4.61	0.13	0.58	0.13
June	4.53	0.05	0.51	0.14
July	4.80	0.05	0.46	0.11
August	5.46	0.04	0.49	0.18
September	5.24	0.05	0.44	0.09

3.1.1.4. Fluctuations in Watercourse Supplies

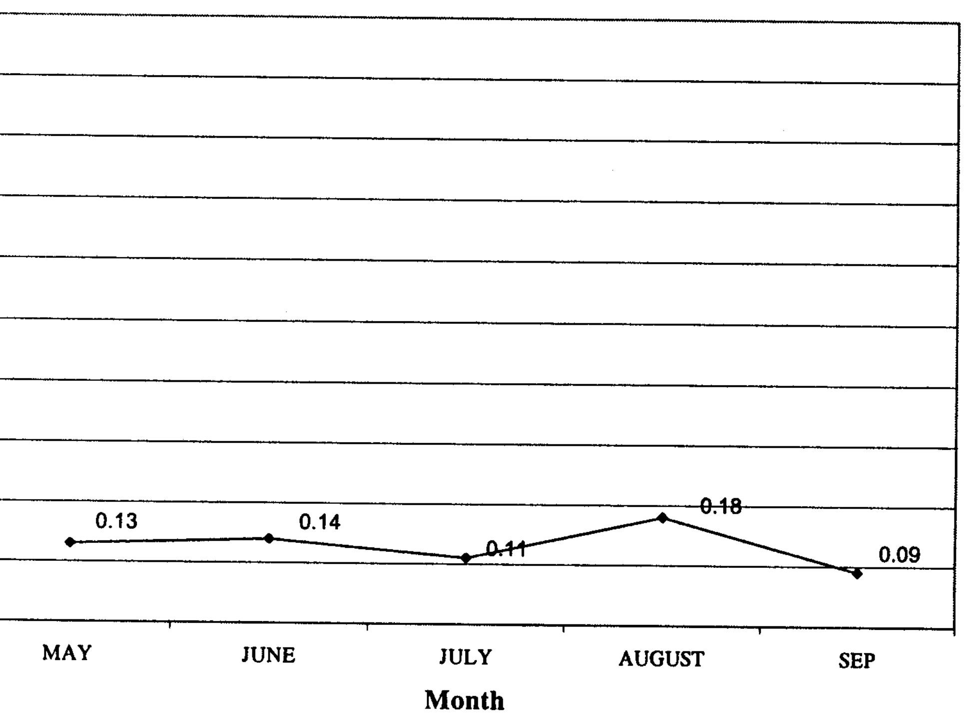
Flow measurements at the head regulator and sample watercourses selected from the head middle and tail portions of the Bareji Distributary were undertaken continuously for 7 days to determine the fluctuations in irrigation supplies. The resulting data are presented in Figures 3.11 through 3.17.

The results show that on 16 August 1997, Watercourse 1-L was drawing about 2.75 cfs/1000 acres from 1900 hrs to 0600 hrs of the following morning. But on 17 August, around 0700 hrs, the discharge suddenly increased to about 5.5 cfs/1000 acres and continued upto 2000 hrs of 19 August 1997, when it was completely closed for about 9 hours. Fluctuations in supplies were observed at Watercourse 6-L on 19/20 August, 1997, and Watercourse 8-R on 22nd/23rd of August, 1997. The data show that the water users occasionally close their outlets partially or completely during the night.

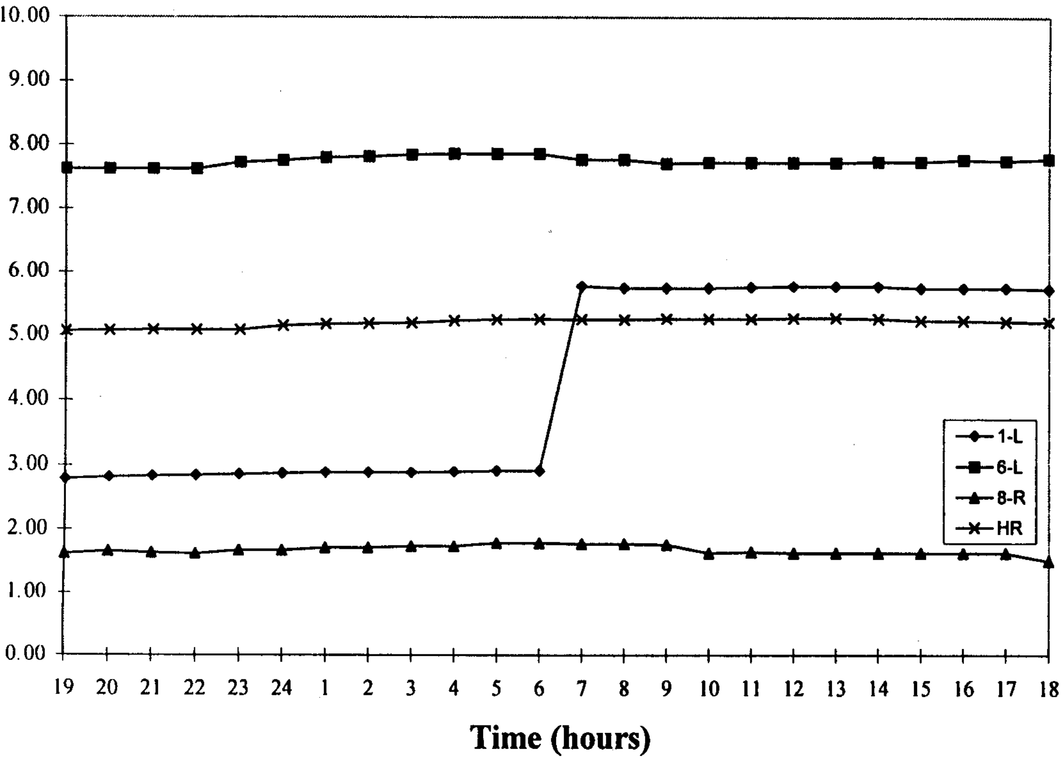
Similarly, head regulator observations show that the supply was reduced on 19 of August 1997, at about 9 pm for about 13 hours before it was increased again. These observations indicate that there were un-scheduled fluctuations in irrigation water supplied at the head regulator.



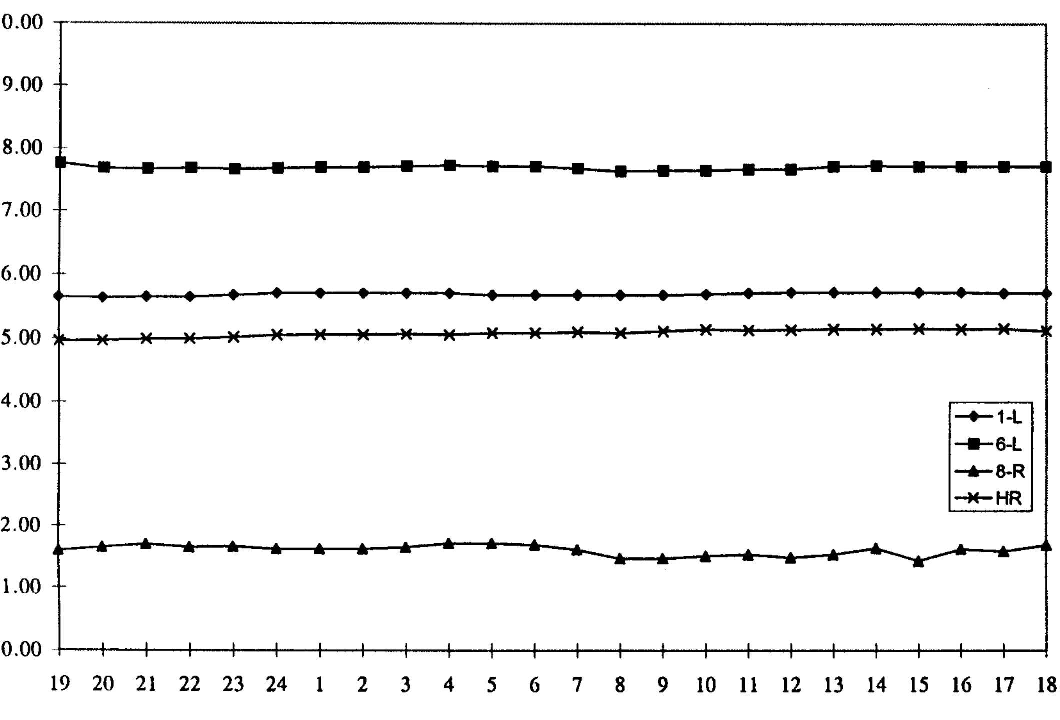
. Spatial Coefficient of Variability among the outlets from Bareji Distributary for Kharif 1997.



). Temporal Coefficient of Variability at outlets from the Bareji Distributary Mirpurkhas for Kharif 1997.



e 3.11. Discharge of Bareji Distributary and some sample outlets (August 16/17, 1997).



e 3.12. Discharge of Bareji Distributary and some sample outlets (August 17/18, 1997).

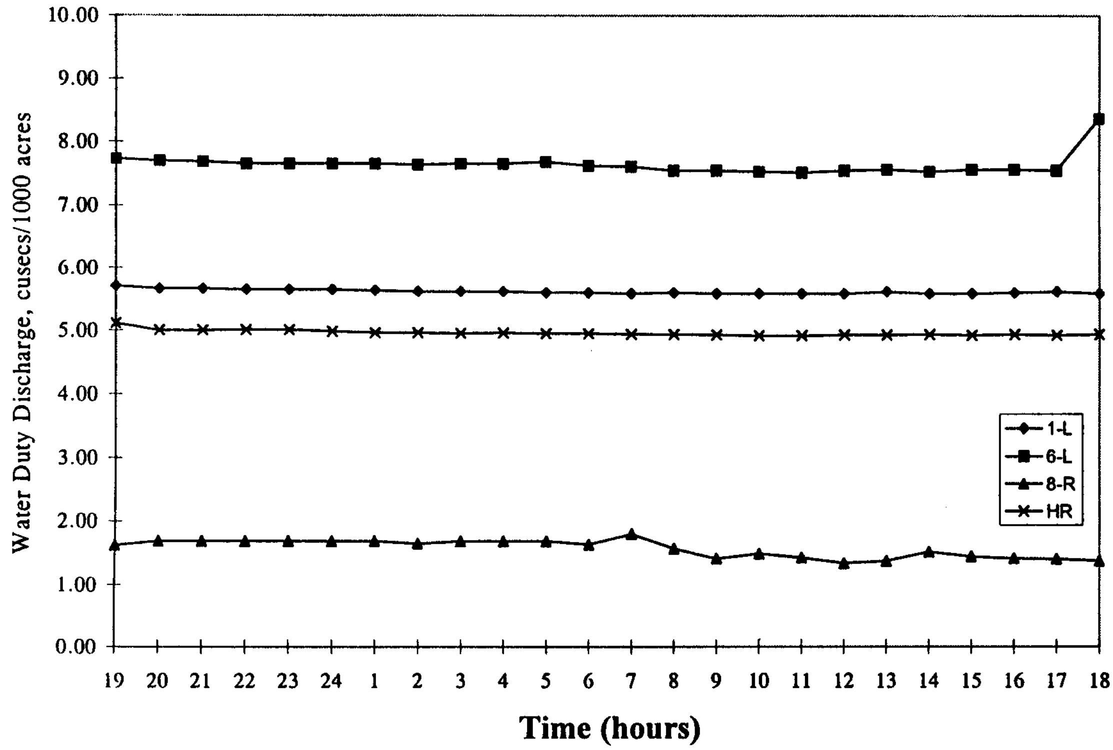


Figure 3.13. Discharge of Bareji Distributary and some sample outlets (August 18/19, 1997).

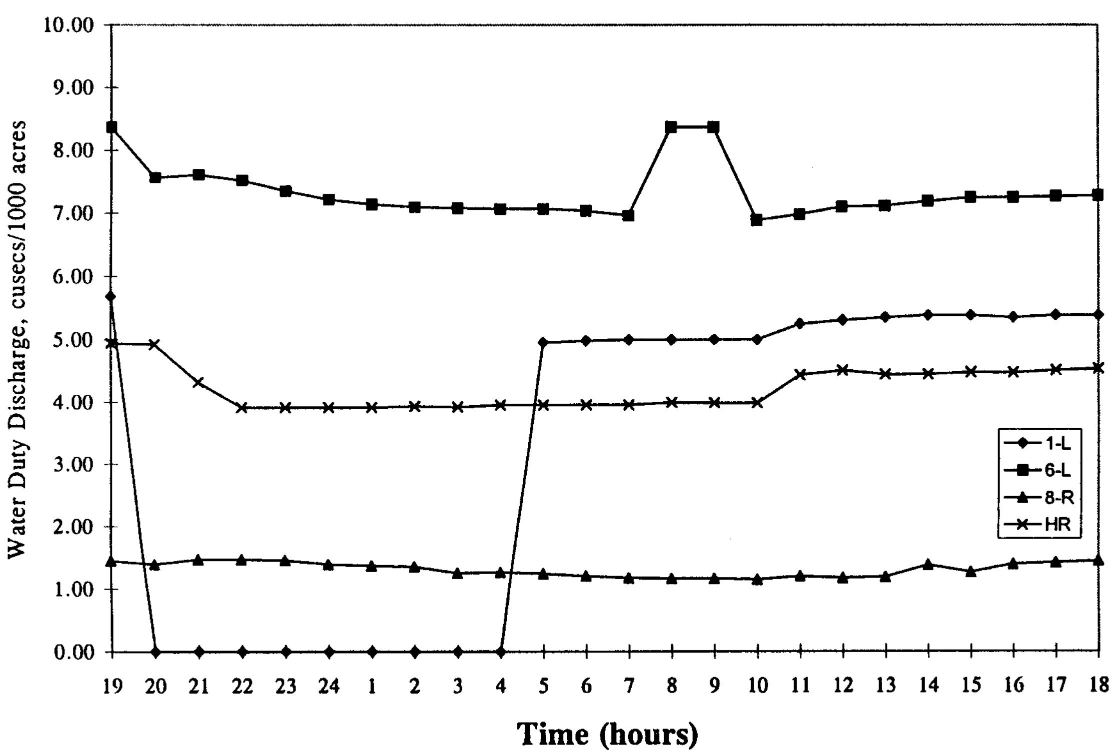


Figure 3.14. Discharge of Bareji Distributary and some sample outlets (August 19/20, 1997).

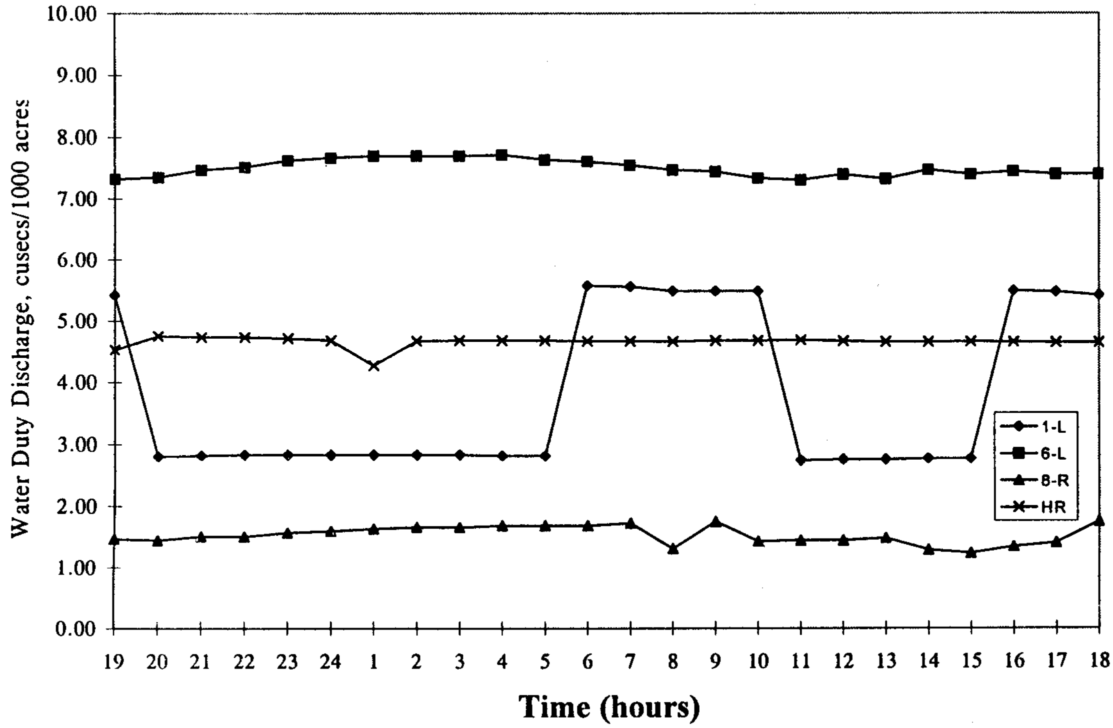


Figure 3.15. Discharge of Bareji Distributary and some sample outlets (August 20/21, 1997).

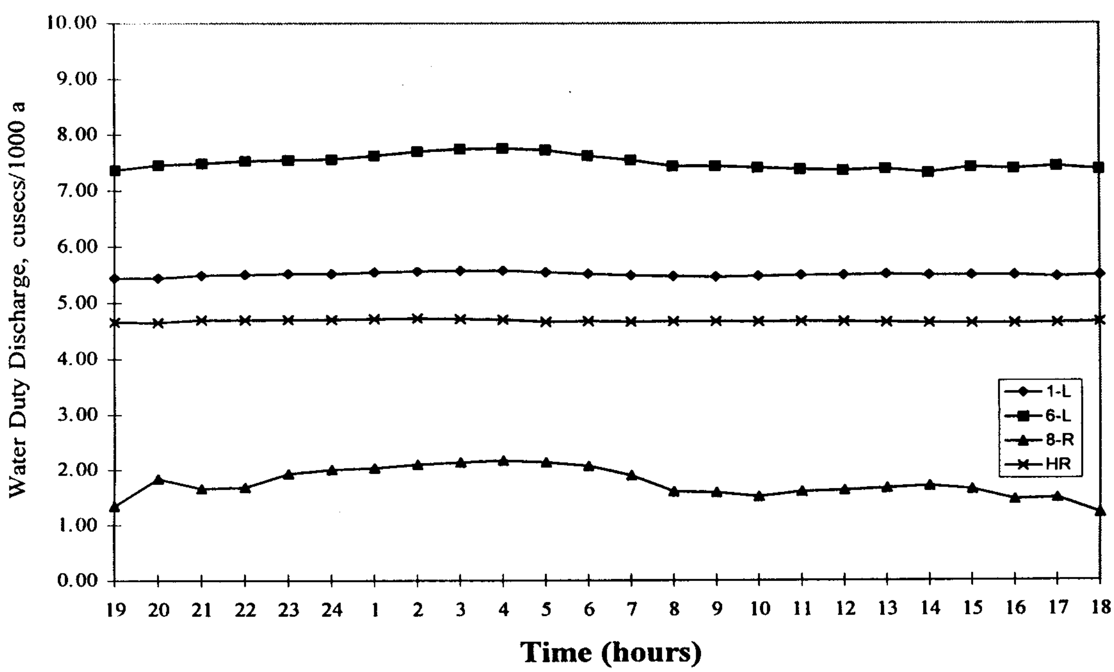


Figure 3.16. Discharge of Bareji Distributary and some sample outlets (August 21/22, 1997).

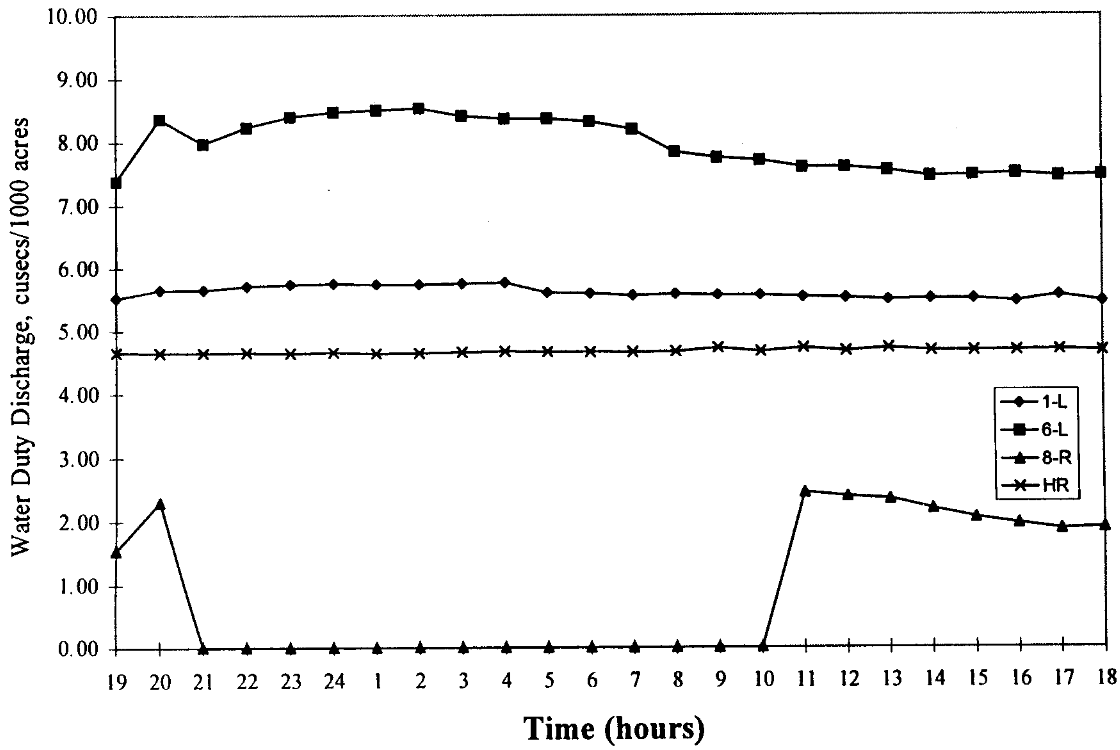


Figure 3.17. Discharge of Bareji Distributary and some sample outlets (August 22/23, 1997).

The irrigation supply to head regulator was more or less uniform during the observation period except for very small variations. This is in line with our findings presented earlier under temporal variation at the head regulator (Figure 3.2). This means that the main system operations were satisfactory.

Coefficients of temporal variation for day and night discharge measurements were calculated for the head regulator as well as for all the three sample watercourses. They are presented in Table 3.2 and 3.3.

Table 3.2. Summary of results for coefficient of variation, CVt on day night discharge measurements of Bareji Distributary, Mirpurkhas.

Date	1L Night	1L Day	6L Night	6L Day	8R Night	8R Day	HR Night	HR Day
16-17	0.010	0.003	0.010	0.003	0.030	0.047	0.010	0.004
17-18	0.005	0.003	0.003	0.004	0.023	0.052	0.001	0.004
18-19	0.005	0.002	0.004	0.031	0.014	0.085	0.009	0.001
19-20	1.814	0.033	0.053	0.068	0.072	0.092	0.095	0.057
20-21	0.318	0.323	0.018	0.009	0.057	0.123	0.028	0.003
21-22	0.008	0.002	0.016	0.008	0.131	0.102	0.005	0.003
22-23	0.010	0.008	0.040	0.028	2.390	0.750	0.000	0.005

Table 3.3. Summary of results for coefficient of variation, CVt for hourly basis of Bareji Distributary Mirpurkhas.

Date	1L	6L	8R	HR
16-17	0.34	0.01	0.04	0.01
17-18	0.005	0.004	0.052	0.012
18-19	0.005	0.022	0.088	0.009
19-20	0.793	0.060	0.089	0.079
20-21	0.349	0.019	0.101	0.020
21-22	0.007	0.018	0.153	0.006
22-23	0.02	0.05	1.23	0.01

3.1.2. Maintenance of Irrigation Delivery System

3.1.2.1. General Maintenance

The Bareji Distributary was monitored periodically for documenting the maintenance conditions and practices. The monitoring was always done through undertaking walk-thru surveys. During these surveys, efforts were made to record vegetation growth, weak points of banks and berms, condition of the inspection path (berm used for traveling) and non-inspection path (berm on opposite side of the channel from the inspection path), and physical condition of the outlets.

The monitoring revealed that the only maintenance activity undertaken was "desilting" which was done during the canal closure period. No other maintenance activity was noticed subsequently. Most of the outlets were found tampered and, therefore, draw more water than their due share.

3.1.2.2. Physical Conditions

The average physical conditions observed during the surveys are presented in Table 3.4. The observations on vegetative growth show that the distributary has flow problems in the head reach due to vegetation which disturbs the flow of water and, consequently, sediment deposition take places. Because of this, the flow condition at the head regulator of the distributary changed to submerged flow. The remaining length was almost free of vegetation. The non-inspection path (NIP) at different portions of the distributary had thick bushes and trees which were creating problems for the maintenance of the distributary bank. The movement of water users along the berm was also not easy.

Table 3.4. Vegetative growth and weak-portion survey of the Bareji Distributary, Mirpurkhas.

Distance "RD"	Vegetation Growth			Weak portion (G=good, W=weak)			
	Right	Bottom	Left	Bank		Berm	
				Left	Right	Left	Right
0.0- 0.16	3	1	4	G	G	W	W
0.16-1.97	3	1	3	W	G	W	G
1.97-2.62	3	1	3	G	G	G	G
2.62-2.95	1	1	3	G	G	G	G
2.95-3.61	3	1	3	G	G	G	G
3.61-5.08	3	1	3	W	W	W	W
5.08-5.74	3	1	3	G	G	G	G
5.74 to 6.23	4	1	3	G	G	G	G
6.23-8.04	3	1	3	G	G	G	G
8.04 to 9.18	3	1	3	G	G	G	G
9.18-11.15	1	1	3	G	G	G	G
11.15-14.26	2	1	1	G	G	G	G
14.26-15.9	2	1	3	G	G	G	G
15.9-16.72	2	1	1	G	G	G	G
16.72-24.25	2	1	4	G	G	G	G
24.25-29.49	2	1	1	G	G	G	G
29.49-31.41	2	1	1	G	G	G	G
31.41-34.37	1	-1	2	G	G	G	G
34.37- 39.31	1	1	2	G	G	G	G

G = Good, W = Weak

3.2. DRAINAGE DISPOSAL SYSTEM (DDS)

There are two types of drainage facilities constructed in the Bareji command area - surface drainage and subsurface (tile) drainage. A total of 13 sump houses for the tile drainage network are located in the command area, which collect subsurface water through collectors and lateral lines laid in the command area. Part of the Spinal Drain, Sub-drains 3L and 4L and Disposal Drain 1R are passing through the command area.

3.2.1. Operations of Drainage System

The network of tile drainage was not functioning regularly as the permanent electric supply was not provided yet. Therefore, the time series data regarding the operational efficiency of tile drains and their impact on lowering the watertable could not be collected. The information on occasional working hours for the pumping sets in the sump houses are given in Table 3.5.

Table 3.5. Operational hours and power consumption of sump houses.

Sr. No.	Pump Station	Operational Hours	Power consumption
1	3L-26	574.5	5727
2	SD-19	1109.2	8155
3	SD-24	1433	13213
4	3L-25 A	583.3	5566
5	SD-22	897	8680
6	3L-22 B	193.5	1139
7	SD-21 A	776.5	2600
8	3L-22 A	314.1	2963
9	3L-20	341 + 316	2764
10	3L-17	747.4+ 229.7	5275
11	3l-21 B	251 + 845.5	6002
12	3L-23	324.9	3086
13	3L-24	491.8	1774

3.2.1.1. Watertable Depth

For monitoring the watertable depth, a total of 65 piezometers were installed in the command area of the Bareji Distributary. All the piezometers were referenced to measure sea level. The water table depth fluctuations were observed on a monthly basis. The data show that the maximum water table depth observed in the command area was 9.11 feet, whereas the minimum watertable depth observed was 0.63 foot. Only 19 out of 65 piezometers had an average watertable depth more than 5 feet. The average watertable depths observed in piezometers are shown in Figure 3.18.

The average monthly watertable depth is given in Table 3.6, which shows that the average water table depth in the Bareji Distributary command area remained between 4-5 feet during Kharif 1997, with no significant variation. However, it is expected that with the commissioning of the tile drainage system in the near future, the watertable will go down.

Table 3.6. Average monthly depth to watertable in feet.

April	May	June	July	August	September
4.20	4.10	4.25	4.30	4.02	4.10

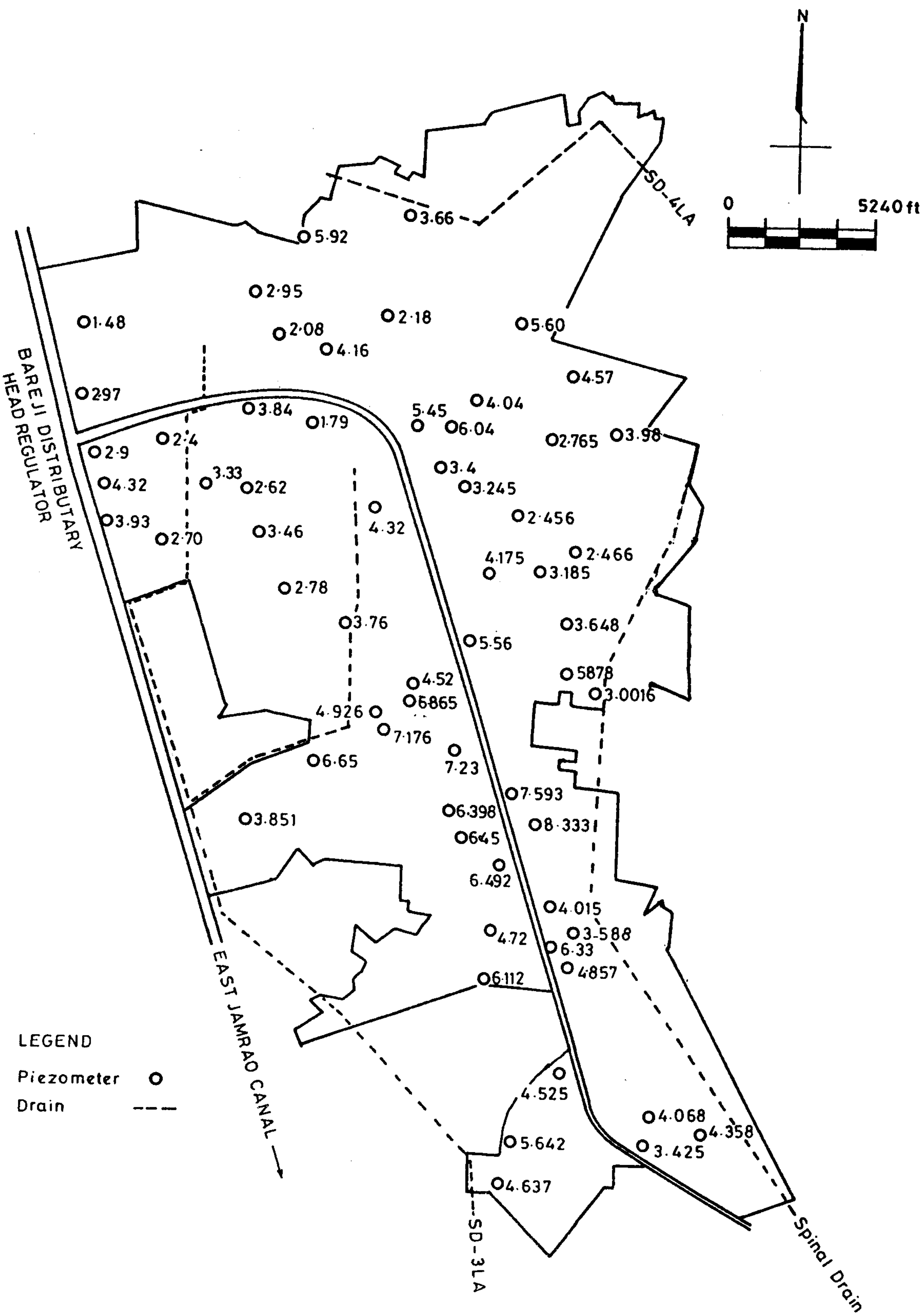


Figure 3.18. Average water table depth in the Bareji Distributary Command Area for Kharif 1997.

3.2.1.2. Groundwater Quality

To monitor groundwater quality, water samples were collected from each piezometer on a monthly basis and the electrical conductivity values were determined for these samples. Also, a detailed chemical analysis of these samples was done at the Agriculture University Tandojam, Sindh, Pakistan on a seasonal basis. Similar observations were made at the sump houses for tile drainage, along with surface drains lying in the command area of the pilot distributary. The results show that about 50% of the water samples were of marginal quality while the remaining 50% were hazardous. The observation are presented in the Annex C.

3.2.2. Maintenance of Drainage System

The tile drainage system, being underground and constructed recently, is considered to be in good shape; therefore, no survey was conducted. However, the surface drains in the command area were surveyed by undertaking walk-thru surveys. The observations are summarized in Table 3.7.

The observations show that the surface drains contain thick vegetation. The vegetation which has been observed is mostly in the ranks 4 and 5. This thick vegetation was creating a hindrance for the flow of water. The flow of water in the drains was mostly found stagnant. Therefore, there will be problems when the tile drainage system will start functioning.

Table 3.7. Vegetative growth and weak portion survey of surface drains in the Command Area of Bareji Distributary.

Distance (RD)	Vegetative Growth			Comments
	Right	Bottom	Left	
4-L				
2.74 to 4.3	4	5	4	Banks and berms were in good condition
4.3 to 6.0	3	3	4	"
6.0 to 7.89	4	5	5	"
7.89 to 8.9	3	5	4	"
8.9 to 10.7	4	5	4	"
10.7 to 12.3	4	3	4	"
12.3 to 14.6	2	5	4	"
14.6 to 16.7	3	3	3	"
16.7 to 18.15	3	3	3	"
4LA				
6.0 to 7.3	4	3	3	Banks and berms were in good condition
7.3 to 9.26	4	2	3	"
Spinal Drain				
576 to 577.3	1	4	1	Banks and berms were in good condition
577.3 to 578.1	5	4	3	"
578.1 to 579.4	1	3	1	"
579.4 to 580.4	3	4	2	"
580.4 to 583.8	5	4	3	"
583.8 to 589.1	5	3	3	"
589.1 to 601.5	3	3	2	"
601.5 to 609	2	1	1	"

1= Clean (vegetation less than 1 feet high)
2= Very little (vegetation between 1-2 feet high)
3= Little (vegetation between 2-3 feet high)
4= Moderate (vegetation between 3-5 feet high)
5= Thick (vegetation greater than 5 feet high)

4. CONCLUSIONS

From the results and discussions presented above, the following conclusions were reached.

- The "reliability" of irrigation water supplies at the head regulator is in an acceptable range according to the criteria of Molden and Gates (1990). Therefore, the main system performance could be considered as satisfactory.
- Irrigation water distribution among the outlets (equity) is found to be poor according to the criteria of Molden and Gates (1990). But, this can be improved through cooperation and concerted efforts to be made by the water users through their WUAs and WUF. Some water users close their outlets partially or completely during the night.
- The operation and maintenance of the distributary canal is playing an important role in the distribution of water. Due to lack of proper maintenance and operations, equitable distribution of water is greatly affected. The interference by influential water users is also making the situation more complicated.
- The vegetation on the banks of the distributary reduces the velocity of flow and increases sediment deposition. Because of deposition, the flow depth (head) increases and more water is drawn by the surrounding outlets.
- There is no check and balance for the distribution of water. Therefore, the distribution of water varies with time.
- The tile drainage system is not functioning and the surface drains are not well maintained. Therefore, the watertable depth is near to four feet. This is adversely affecting crop production.
- The ground water quality is brackish as the water samples, collected from the piezometers and the tile drainage sump houses are in the marginal and hazardous ranges. Hence, this water cannot be used for irrigation purposes.

REFERENCES

Bandaragoda, D.J. and Memon Y. 1997. Moving Forwards Participatory Irrigation Management. IIMI Pakistan, Lahore.

Molden, David I. And Timothy K. Gates. 1990. Measures of Evaluation of Irrigation Water Delivery Systems. In: Journal of Irrigation and Drainage Engineering, Volume 116, No. 6, ASCE.

ANNEX-A
DISCHARGE MEASUREMENTS

Table A1. Monthly average discharge rate for each watercourse along Bareji Distributary Mirpurkhas.

W/c.	Average April	Average May	Average June	Average July	Average Aug.	Average Sept.	Q in cfs Average
1-R	1.39	1.80	1.81	1.77	2.10	1.76	1.77
1-L	3.47	3.70	3.71	3.75	3.65	4.75	3.84
2-R	1.52	1.49	1.50	1.51	1.46	1.49	1.49
3-R	3.00	3.09	2.97	3.54	3.66	2.35	3.10
4-R	1.09	1.25	1.31	1.27	1.12	1.12	1.19
2-L	3.38	4.41	4.42	2.99	2.95	3.72	3.64
5-R	2.71	2.99	2.99	3.05	2.23	3.06	2.84
3-L	3.40	3.97	3.95	4.34	4.12	4.49	4.04
6-R	2.94	2.25	2.23	5.19	5.61	4.01	3.71
4-L	1.60	2.11	1.60	0.90	0.98	1.01	1.37
5-L	5.69	4.51	4.72	3.64	4.36	4.89	4.64
6-L	4.36	5.09	5.25	4.86	4.62	4.84	4.84
7-L	2.69	3.53	4.27	4.12	4.33	3.92	3.81
8-L	2.29	2.12	1.84	3.12	3.38	3.05	2.63
9-L	3.48	2.37	2.57	2.59	2.38	3.05	2.74
7-R	1.10	0.76	0.45	1.19	1.10	0.97	0.93
8-R	1.15	0.60	0.59	0.46	1.10	1.11	0.83
9-R	1.41	1.27	1.20	1.20	1.30	1.76	1.36
10-L	2.57	2.67	3.02	2.38	2.53	3.33	2.75
10-R	1.50	1.65	1.53	1.37	1.88	0.58	1.42
11-L	1.48	1.38	2.44	2.57	3.48	2.50	2.31
12-L	1.97	2.05	1.40	2.14	1.55	2.03	1.86
11-R	1.16	0.30	0.80	0.90	1.21	0.60	0.83
13-L	3.15	2.77	3.55	2.64	4.01	2.49	3.10
Outflow	58.50	58.13	60.11	61.48	65.12	62.88	61.04
Inflow	63.42	62.31	64.79	70.95	72.30	69.50	67.21
Losses	4.92	4.18	4.68	9.47	7.18	6.62	6.17

Table A2. Discharge measurements at each outlet of Bareji Distributary through tape readings for the month of May 1997.

W.C. #	May 3	May 6	May 13	May 16	May 21	May 27	May 31	Mean cfs
1R	0.00	2.14	2.04	2.18	2.23	2.00	2.00	1.80
L	3.79	3.74	3.59	3.82	3.89	3.54	3.54	3.70
2R	1.78	1.48	1.41	1.47	1.50	1.39	1.39	1.49
3R	4.44	3.28	2.75	2.95	4.30	1.94	1.94	3.09
4R	1.24	1.19	1.12	1.23	1.29	1.35	1.35	1.25
2L	4.50	4.44	4.28	4.44	4.64	4.30	4.30	4.41
5R	3.05	3.02	2.90	3.00	3.13	2.91	2.91	2.99
3L	4.46	3.95	3.78	3.87	4.20	3.75	3.75	3.97
6R	2.61	2.24	2.10	2.15	2.43	2.10	2.10	2.25
4L	2.22	2.18	1.54	2.18	2.36	2.16	2.16	2.11
5L	4.69	4.27	3.95	4.04	5.02	4.80	4.80	4.51
6L	5.08	5.25	4.83	5.02	5.39	5.03	5.03	5.09
7L	3.36	3.05	2.53	3.78	4.19	3.91	3.91	3.53
8L	2.01	1.89	1.99	1.93	1.91	2.55	2.55	2.12
9L	1.81	2.70	2.19	2.56	2.78	2.27	2.27	2.37
7R	0.89	0.62	0.42	0.64	0.74	0.99	0.99	0.76
8R	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
9R	1.54	1.28	1.09	1.25	1.52	1.10	1.10	1.27
10L	3.46	4.09	2.51	0.99	3.03	2.29	2.29	2.67
10R	1.65	1.78	1.52	1.55	2.12	1.48	1.48	1.65
11L	0.00	1.50	1.50	1.55	1.64	1.75	1.75	1.38
12L	1.86	2.87	1.57	1.58	2.06	2.20	2.20	2.05
11R	0.38	0.33	0.26	0.27	0.31	0.26	0.26	0.30
13L	3.00	2.20	2.80	3.00	2.80	2.80	2.80	2.77
								58.13

Table A3. Discharge measurements at each outlet of Bareji Distributary through tape readings for the month of June 1997.

W.C. #	June 3	June 6	June 10	June 13	June 17	June 21	June 24	June 27	Mean cfs
1R	0.00	1.98	2.14	1.98	1.87	2.17	2.22	2.09	1.81
1L	3.60	3.60	3.60	3.51	3.89	3.80	3.87	3.78	3.71
2R	1.46	1.40	1.46	1.42	1.54	1.47	1.76	1.52	1.50
3R	3.36	2.88	3.36	1.99	4.13	2.21	2.89	2.94	2.97
4R	1.29	1.20	1.29	1.20	1.53	1.30	1.34	1.31	1.31
2L	4.37	4.31	4.37	4.05	4.64	4.42	4.59	4.57	4.42
5R	2.94	2.88	2.94	2.89	3.15	2.99	3.02	3.09	2.99
3L	3.83	3.84	3.83	3.75	4.21	3.85	4.09	4.18	3.95
6R	2.17	2.13	2.17	1.98	2.39	2.34	2.57	2.10	2.23
4L	2.22	2.14	2.22	2.13	1.05	0.96	1.05	1.03	1.60
5L	4.95	4.59	4.77	4.35	4.88	4.60	5.27	4.33	4.72
6L	5.15	5.15	5.15	5.16	5.44	4.98	5.47	5.52	5.25
7L	4.70	4.16	4.70	4.41	4.17	3.46	4.11	4.41	4.27
8L	1.94	1.74	1.94	2.05	1.10	1.93	1.83	2.22	1.84
9L	2.49	2.47	2.49	2.28	3.00	2.27	2.88	2.72	2.57
7R	0.51	0.35	0.51	0.43	0.50	0.32	0.46	0.53	0.45
8R	0.66	0.62	0.66	0.66	0.57	0.41	0.58	0.52	0.59
9R	1.12	1.10	1.12	1.02	1.38	1.12	1.41	1.30	1.20
10L	2.11	2.92	2.11	1.67	3.90	3.58	4.00	3.88	3.02
10R	1.51	1.43	1.51	1.46	1.72	1.32	1.76	1.55	1.53
11L	2.42	1.86	1.90	2.46	2.76	2.55	2.83	2.75	2.44
12L	1.54	1.49	1.54	1.54	1.51	0.00	1.82	1.74	1.40
11R	1.02	0.22	0.33	0.26	1.46	0.95	0.90	1.27	0.80
13L	3.75	3.52	3.75	3.50	3.60	3.50	3.25	3.50	3.55
									60.11

Table A4. Discharge measurements at each outlet of Bareji Distributary through tape readings for the month of July 1997.

W.C. #	July 12	July 19	July 22	July 23	July 26	July 29	July 30	Mean cfs
1R	1.75	1.81	1.70	1.81	1.94	1.69	1.67	1.77
1L	3.75	3.83	3.68	3.82	3.84	3.66	3.64	3.75
2R	1.51	1.53	1.49	1.52	1.54	1.49	1.48	1.51
3R	3.86	3.07	3.69	4.03	2.78	3.85	3.50	3.54
4R	1.29	1.42	1.29	1.29	1.27	1.18	1.18	1.27
2L	2.99	3.00	2.96	3.03	3.03	2.96	2.95	2.99
5R	3.07	3.09	3.04	3.09	3.02	3.03	3.02	3.05
3L	4.33	4.35	4.29	4.37	4.44	4.44	4.15	4.34
6R	4.81	6.70	4.35	5.26	6.02	4.64	4.58	5.19
4L	1.00	1.01	1.00	1.00	0.26	1.00	0.99	0.90
5L	3.57	4.01	3.46	3.68	3.54	3.69	3.53	3.64
6L	4.87	4.90	4.85	4.89	4.93	4.84	4.76	4.86
7L	4.11	4.21	4.02	4.21	4.43	4.22	3.64	4.12
8L	3.08	3.62	2.91	3.25	3.18	2.79	2.99	3.12
9L	2.42	3.34	2.42	2.43	2.58	2.56	2.40	2.59
7R	1.20	1.47	1.19	1.22	1.28	1.03	0.96	1.19
8R	0.42	0.48	0.41	0.43	0.54	0.47	0.45	0.46
9R	1.13	1.26	1.12	1.14	1.34	1.37	1.05	1.20
10L	2.35	2.45	2.36	2.35	2.49	2.37	2.30	2.38
10R	0.96	1.69	1.64	0.27	1.91	1.62	1.47	1.37
11L	2.53	2.58	2.50	2.57	2.58	2.88	2.34	2.57
12L	1.49	1.40	1.57	1.41	1.99	2.31	4.80	2.14
11R	0.84	0.80	0.82	0.87	1.10	1.00	0.87	0.90
13L	2.40	2.75	2.50	2.26	3.10	2.70	2.80	2.64
								61.48

Table A5. Discharge measurements at each outlet of Bareji Distributary through tape readings for the month of August 1997.

W.C. #	Aug: 6	Aug: 12	Aug: 15	Aug: 19	Aug: 21	Aug: 29	Mean cfs
1R	2.10	1.79	2.20	2.17	2.16	2.18	2.10
1L	3.68	3.10	3.81	3.78	3.77	3.79	3.65
2R	1.49	1.25	1.47	1.52	1.51	1.53	1.46
3R	3.22	3.39	3.59	3.91	3.49	4.33	3.66
4R	1.13	1.07	1.26	1.08	1.11	1.05	1.12
2L	2.94	2.51	3.08	3.06	3.03	3.09	2.95
5R	3.01	2.58	3.15	1.55	3.11	0.00	2.23
3L	2.91	3.76	4.48	4.52	4.40	4.65	4.12
6R	4.62	6.41	6.34	5.43	5.27	5.59	5.61
4L	0.96	0.73	1.05	1.06	1.02	1.09	0.98
5L	4.42	4.40	4.38	4.21	4.02	4.75	4.36
6L	4.69	2.99	4.99	5.02	4.85	5.18	4.62
7L	3.73	5.56	4.38	4.10	3.94	4.27	4.33
8L	3.08	2.41	3.69	3.70	3.45	3.95	3.38
9L	2.14	2.56	3.02	2.19	2.59	1.78	2.38
7R	0.80	1.05	1.35	1.13	1.08	1.19	1.10
8R	0.87	0.98	1.18	0.87	1.11	1.62	1.10
9R	0.84	1.76	1.22	1.33	0.96	1.69	1.30
10L	2.24	2.63	2.47	2.61	2.39	2.82	2.53
10R	1.16	2.15	1.86	2.03	1.62	2.44	1.88
11L	3.79	3.52	2.89	3.55	2.58	4.52	3.48
12L	1.31	0.00	1.66	2.11	1.47	2.75	1.55
11R	1.39	1.51	0.65	1.24	0.82	1.65	1.21
13L	6.00	6.07	3.00	3.00	3.00	3.00	4.01
							65.12

Table A6. Discharge measurements at each outlet of Bareji Distributary through tape readings for the month of September 1997.

W.C. #	Sep. 2	Sep. 9	Sep. 12	Sep. 16	Mean cfs
1R	1.74	1.85	1.72	1.75	1.76
1L	3.65	5.30	5.01	5.06	4.75
2R	1.46	1.54	1.48	1.49	1.49
3R	2.45	2.55	2.07	2.33	2.35
4R	0.83	1.33	1.17	1.16	1.12
2L	2.94	4.06	3.93	3.94	3.72
5R	3.02	3.14	3.03	3.06	3.06
3L	4.23	4.67	4.55	4.49	4.49
6R	3.70	4.40	3.66	4.27	4.01
4L	1.00	1.04	1.00	1.01	1.01
5L	4.45	5.56	4.69	4.86	4.89
6L	4.85	4.96	4.71	4.84	4.84
7L	3.79	4.12	4.16	3.60	3.92
8L	3.37	3.00	3.11	2.73	3.05
9L	3.15	3.22	2.93	2.90	3.05
7R	0.96	0.95	1.00	0.95	0.97
8R	1.18	1.15	1.05	1.07	1.11
9R	1.89	1.84	1.63	1.68	1.76
10L	2.46	3.76	3.54	3.58	3.33
10R	0.57	0.60	0.61	0.52	0.58
11L	2.36	2.71	2.31	2.61	2.50
12L	2.72	2.72	2.68	0.00	2.03
11R	0.51	0.64	0.58	0.67	0.60
13L	2.63	2.45	2.45	2.45	2.49
					62.88

Table A7. Round-the-clock discharge measurements for 7 days at Bareji Distributary Head Regulator (HR) and sample watercourses.

Date	Time (hours)	Water Duty (cfs/1000 acres)			
		1-L	6-L	8-R	HR
16-08-97	19	2.79	7.62	1.62	5.07
	20	2.82	7.62	1.66	5.08
	21	2.83	7.62	1.63	5.08
	22	2.85	7.62	1.62	5.09
	23	2.86	7.73	1.67	5.09
	24	2.88	7.76	1.67	5.15
17-08-97	1	2.89	7.81	1.71	5.18
	2	2.89	7.82	1.71	5.19
	3	2.89	7.85	1.74	5.20
	4	2.91	7.87	1.74	5.23
	5	2.92	7.87	1.79	5.25
	6	2.92	7.87	1.79	5.26
	7	5.78	7.78	1.78	5.25
	8	5.75	7.78	1.78	5.25
	9	5.75	7.72	1.76	5.26
	10	5.75	7.73	1.63	5.26
	11	5.77	7.73	1.65	5.26
	12	5.78	7.73	1.63	5.28
	13	5.78	7.73	1.63	5.28
	14	5.78	7.75	1.63	5.27
	15	5.75	7.75	1.63	5.24
	16	5.75	7.78	1.63	5.24
	17	5.75	7.76	1.63	5.22
	18	5.74	7.79	1.51	5.22
	19	5.65	7.76	1.60	4.96
	20	5.64	7.69	1.65	4.97
	21	5.65	7.67	1.70	4.99
	22	5.65	7.69	1.65	5.00
	23	5.68	7.67	1.66	5.02
	24	5.71	7.69	1.62	5.05
18-08-97	1	5.71	7.70	1.62	5.06
	2	5.71	7.70	1.62	5.06
	3	5.71	7.72	1.65	5.07
	4	5.71	7.73	1.71	5.06
	5	5.68	7.72	1.71	5.09
	6	5.68	7.72	1.69	5.09
	7	5.68	7.69	1.61	5.10
	8	5.68	7.64	1.47	5.09
	9	5.68	7.66	1.47	5.12
	10	5.69	7.66	1.51	5.14

Date	Time (hours)	Water Duty (cfs/1000 acres)			
		1-L	6-L	8-R	HR
	11	5.71	7.67	1.53	5.13
	12	5.72	7.67	1.48	5.14
	13	5.72	7.72	1.53	5.15
	14	5.72	7.73	1.63	5.15
	15	5.72	7.72	1.43	5.15
	16	5.72	7.72	1.62	5.15
	17	5.71	7.72	1.58	5.15
	18	5.71	7.72	1.69	5.12
	19	5.71	7.73	1.62	5.11
	20	5.66	7.70	1.69	5.00
	21	5.66	7.69	1.69	5.00
	22	5.65	7.66	1.69	5.01
	23	5.65	7.66	1.69	5.01
	24	5.65	7.66	1.69	4.99
19-08-97	1	5.64	7.66	1.69	4.96
	2	5.62	7.64	1.65	4.96
	3	5.62	7.66	1.69	4.96
	4	5.62	7.66	1.69	4.96
	5	5.61	7.69	1.69	4.95
	6	5.61	7.62	1.63	4.95
	7	5.59	7.61	1.80	4.94
	8	5.61	7.55	1.57	4.94
	9	5.59	7.55	1.42	4.93
	10	5.59	7.53	1.49	4.92
	11	5.59	7.52	1.43	4.92
	12	5.59	7.55	1.34	4.93
	13	5.62	7.56	1.38	4.93
	14	5.59	7.53	1.52	4.94
	15	5.59	7.56	1.44	4.93
	16	5.61	7.56	1.42	4.94
	17	5.62	7.55	1.40	4.93
	18	5.59	8.37	1.38	4.94
	19	5.68	8.37	1.44	4.94
	20	0.00	7.56	1.39	4.92
	21	0.00	7.61	1.47	4.31
	22	0.00	7.52	1.47	3.91
	23	0.00	7.35	1.45	3.91
	24	0.00	7.22	1.39	3.91
20-08-97	1	0.00	7.14	1.36	3.91
	2	0.00	7.10	1.35	3.93
	3	0.00	7.08	1.25	3.92

Date	Time (hours)	Water Duty (cfs/1000 acres)			
		1-L	6-L	8-R	HR
	4	0.00	7.07	1.26	3.95
	5	4.95	7.07	1.24	3.95
	6	4.98	7.03	1.20	3.95
	7	4.99	6.96	1.17	3.95
	8	4.99	8.37	1.16	3.99
	9	4.99	8.37	1.16	3.98
	10	4.99	6.88	1.15	3.98
	11	5.24	6.97	1.20	4.42
	12	5.30	7.10	1.17	4.49
	13	5.34	7.11	1.18	4.43
	14	5.37	7.19	1.38	4.44
	15	5.37	7.25	1.26	4.47
	16	5.34	7.25	1.39	4.46
	17	5.37	7.26	1.42	4.50
	18	5.37	7.28	1.44	4.52
	19	5.42	7.32	1.47	4.52
	20	2.80	7.35	1.44	4.75
	21	2.82	7.47	1.51	4.73
	22	2.83	7.52	1.51	4.73
	23	2.83	7.62	1.57	4.71
	24	2.83	7.67	1.60	4.68
21-08-97	1	2.83	7.70	1.63	4.27
	2	2.83	7.70	1.66	4.67
	3	2.83	7.70	1.66	4.68
	4	2.82	7.72	1.69	4.68
	5	2.82	7.64	1.69	4.68
	6	5.58	7.61	1.69	4.67
	7	5.56	7.55	1.72	4.67
	8	5.49	7.47	1.31	4.66
	9	5.49	7.44	1.75	4.68
	10	5.49	7.34	1.43	4.68
	11	2.74	7.31	1.44	4.68
	12	2.76	7.40	1.44	4.67
	13	2.76	7.32	1.48	4.65
	14	2.77	7.47	1.29	4.65
	15	2.77	7.40	1.24	4.66
	16	5.49	7.44	1.34	4.65
	17	5.47	7.40	1.40	4.65
	18	5.42	7.40	1.75	4.65
	19	5.45	7.37	1.34	4.65
	20	5.45	7.46	1.84	4.65

Date	Time (hours)	Water Duty (cfs/1000 acres)			
		1-L	6-L	8-R	HR
	21	5.49	7.49	1.66	4.69
	22	5.50	7.53	1.69	4.70
	23	5.52	7.55	1.93	4.70
	24	5.52	7.56	2.01	4.70
22-08-97	1	5.55	7.62	2.03	4.71
	2	5.56	7.70	2.10	4.72
	3	5.58	7.75	2.14	4.72
	4	5.58	7.76	2.18	4.70
	5	5.55	7.73	2.14	4.66
	6	5.52	7.62	2.07	4.67
	7	5.49	7.55	1.90	4.66
	8	5.47	7.44	1.61	4.67
	9	5.46	7.44	1.60	4.67
	10	5.47	7.41	1.52	4.66
	11	5.49	7.38	1.61	4.67
	12	5.49	7.37	1.63	4.66
	13	5.50	7.40	1.67	4.65
	14	5.49	7.32	1.71	4.64
	15	5.49	7.43	1.65	4.63
	16	5.49	7.40	1.47	4.63
	17	5.46	7.44	1.49	4.64
	18	5.49	7.38	1.22	4.66
	19	5.52	7.38	1.54	4.65
	20	5.65	8.37	2.30	4.65
	21	5.65	7.97	0.00	4.65
	22	5.71	8.23	0.00	4.65
	23	5.74	8.40	0.00	4.65
	24	5.75	8.47	0.00	4.66
23-08-97	1	5.74	8.50	0.00	4.64
	2	5.74	8.53	0.00	4.65
	3	5.75	8.41	0.00	4.66
	4	5.77	8.37	0.00	4.67
	5	5.61	8.37	0.00	4.67
	6	5.59	8.32	0.00	4.66
	7	5.56	8.20	0.00	4.66
	8	5.58	7.84	0.00	4.67
	9	5.56	7.75	0.00	4.72
	10	5.56	7.70	0.00	4.67
	11	5.53	7.59	2.46	4.72
	12	5.52	7.59	2.39	4.68
	13	5.49	7.55	2.36	4.72

Date	Time (hours)	Water Duty (cfs/1000 acres)			
		1-L	6-L	8-R	HR
	14	5.50	7.46	2.20	4.68
	15	5.50	7.47	2.06	4.68
	16	5.46	7.50	1.97	4.68
	17	5.56	7.46	1.88	4.69
	18	5.46	7.47	1.90	4.68

ANNEX-B
PIEZOMETER DATA

Table B1. Watertable depth in piezometers located in the command area of Bareji Distributary for April, May and June, 1997.

APRIL 1997					MAY 1997					JUNE 1997				
S. #	P.M. #	Water depth from soil level			S. #	P.M. #	Water depth from soil level			S. #	P.M. #	Water depth from soil level		
		H	M	T			H	M	T			H	M	T
1	1R	3.77	4.36	3.49	1	1R	3.27	4.36	3.64	1	1R	3.4	3.69	4.28
2	1L	3.77	4.03	1 83	2	1L	Chocked	3.62	2	2	1L	Chocked	2.2	0.63
3	2R	2.2	2.55	1.57	3	2R	3.29	4.23	1.83	3	2R	2.28	3.47	3.32
4	3R	2.58	4.26	2.88	4	3R	3.05	3.76	5.5	4	3R	2.8	3.48	5.17
5	2L	2.39	1.14	4.94	5	2L	2.39	3.1	5.898	5	2L	2.26	3.11	5.98
6	5R	3.52	2.71	3.41	6	5R	3.86	2.92	3.33	6	5R	3.73	2.38	2.54
7	3L	4.28	1.97	2.89	7	3L	4.37	2.81	3.35	7	3L	2.2	1.72	4.34
8	6R	2.67	--	3.7	8	6R	2.58	--	5.03	8	6R	2.28	--	3.66
9	4L	5.09	--	5.9	9	4L	5.09	--	5.29	9	4L	4.47	--	5.63
10	5L	3.62	4.11	3.88	10	5L	3.45	4.27	4.71	10	5L	3.87	3.86	5.59
11	6L	3.25	3.78	3.39	11	6L	2.83	2.95	4.97	11	6L	3.41	3.5	4.72
12	7L	3.57	2.48	2.12	12	7L	4.198	2.935	2.87	12	7L	4.15	2.31	1.37
13	8L	2.84	2.88	4.41	13	8L	4.01	3.55	3.67	13	8L	4.84	3.38	3.33
14	9L	4.73	5.58	1.42	14	9L	5.9	4.33	2.14	14	9L	5.23	6.25	2.59
15	7R	5.49	6.64	5.76	15	7R	6.28	7.435	4.975	15	7R	6.87	7.44	5.35
16	8R	6.54	6.74	4.67	16	8R	6.95	5.99	3.63	16	8R	7.95	7.37	5.25
17	9R	6.73	6.31	5.65	17	9R	6.86	5.73	5.32	17	9R	7.7	6.11	6.52
18	10L	6.56	0	7.23	18	10L	7.06	0	7.73	18	10L	7.56	0	8.23
19	10R	5.34	3.77	5.96	19	10R	6.5	4.35	6.58	19	10R	6.34	4.35	5.71
20	11L	5.96	2.44	4.68	20	11L	5.95	2.02	3.97	20	11L	6.54	5.23	3.01
21	12L	4.52	--	5.05	21	12L	4.19	--	3.05	21	12L	4.52	--	Damaged
22	11R	3.44	4.91	4.31	22	11R	5.61	5.15	3.81	22	11R	4.61	5.46	4.27
23	13L	1.49	1.91	3.61	23	13L	1.49	5.53	3.44	23	13L	3.99	3.62	3.52
*** Readings of depths are in fts, while the water quality is in ppm														
*** *NA* Difficult to reach in those areas, due to rain.												4.391304	3.431739	4.130869
.												3.984637		

Table B2. Watertable depth in piezometers located in the command area of Bareji Distributary for July, August and September, 1997.

J U L Y 1997					A U G U S T 1997					S E P T E M B E R. 1997				
S.	P.M.	Water depth from soil level			S.	P.M.	Water depth from soil level			S.	P.M.	Water depth from soil level		
#	#	H	M	T	#	#	H	M	T	#	#	H	M	T
1	1R	2.52	4.94	4.68	1	1R	1.77	4.19	3.82	1	1R	2.69	4.36	3.67
2	1L	Chocked	2.62	2.16	2	1L	Chocked	2.08	1.21	2	1L	Chocked	3.29	1.04
3	2R	1.95	3.556	4.07	3	2R	2.07	2.56	*NA*	3	2R	2.62	3.54	*NA*
4	3R	3.58	4.85	4.13	4	3R	1.88	2.52	4.11	4	3R	2.79	3.68	5.34
5	2L	2.47	2.81	6.19	5	2L	1.47	*NA*	*NA*	5	2L	1.47	4.56	6.61
6	5R	4.86	2.97	4.58	6	5R	4.49	3.13	3.75	6	5R	2.57	1.63	3.16
7	3L	5.2	3.06	4.55	7	3L	4.28	1.226	3.432	7	3L	4.62	2.31	3.39
8	6R	1.32	--	5.2	8	6R	0.78	--	3.91	8	6R	1.11	--	4.4
9	4L	6.59	--	6.58	9	4L	5.92	--	6.67	9	4L	5.51	--	6.17
10	5L	4.95	5.52	6.8	10	5L	4.08	4.11	6.46	10	5L	4.29	5.52	6.13
11	6L	4.25	2.62	4.77	11	6L	3.25	1.87	3.14	11	6L	3.41	1.87	2.89
12	7L	2.16	3.23	5.29	12	7L	1.82	1.89	1.2	12	7L	3.57	1.98	1.95
13	8L	5.26	3.71	4.49	13	8L	3.59	2.46	3.33	13	8L	4.51	3.13	2.66
14	9L	6.07	7	4.22	14	9L	5.61	5.62	3.59	14	9L	5.82	6.49	4.05
15	7R	7.79	7.85	6.35	15	7R	7.41	5.47	3.1	15	7R	7.95	6.35	4.02
16	8R	7.96	8.2	4.92	16	8R	6.62	5.74	2.548	16	8R	7.04	5.86	2.09
17	9R	8.4	7.11	7.45	17	9R	6.24	6.48	7.07	17	9R	7.45	6.65	6.69
18	10L	8.31	--	9.11	18	10L	7.81	0	8.64	18	10L	8.23	--	9.06
19	10R	7.84	4.69	7.09	19	10R	5.92	5.68	5.54	19	10R	7.01	5.48	5.79
20	11L	7.08	5.07	2.47	20	11L	5.91	3.69	2.68	20	11L	6.54	5.64	4.72
21	12L	5.78	--	Damaged	21	12L	4.98	--	Damaged	21	12L	5.15	--	Damaged
22	11R	5.28	6.79	5.52	22	11R	4.02	5.5	4.64	22	11R	4.19	6.04	5.27
23	13L	4.28	5.74	5.82	23	13L	4.19	3.74	4.78	23	13L	5.11	3.87	4.98
		4.952173	4.014608	5.062608			4.091739	2.954608	3.635652			4.506521	3.576086	4.090434
		4.676463					3.560666							4.057681

*** Readings of depths are in fts, while the water quality is in ppm

*** *NA* Difficult to reach in those areas, due to rain.

ANNEX-C
WATER QUALITY

Table C1 Electrical conductivity of water samples from the tile drainage sump houses and surface drains.

Sr. No.	Pump Station	Nearby Watercourse	EC in ppm
1	3L-26	1-L	N.A
2	SD-19	13-L	13504
3	SD-24	6-L	1984
4	3L-25 A	6-R	2752
5	SD-22	8-L	13248
6	3L-22 B	3-R	N.A
7	SD-21 A	9-L	17920
8	3L-22 A	8-R & 9-R	8250
9	3L-20	10-R	8653
10	3L-17	11-R	3264
11	3L-21 B	8-R	8896
12	3L-23	3-R	N.A.
13	3L-24	2-R	3008
14	Spinal	12-L	10048
15	SD-3L	3-R	3283

Table C2 Results of water quality analysis of the piezometers located in the Bareji Distributary command area.

WC No.	Head				Middle				Tail			
	EC, dS/m	PH	SAR	SSP	EC, dS/m	PH	SAR	SSP	EC, dS/m	PH	SAR	SSP
10L	14.7	8.2	33.93	77	30.20	7.3	34.50	77	18.00	7.6	1.42	10
224/2L	2.20	7.7	4.37	52	1.66	8.2	5.81	68	4.80	7.6	14.05	67
224/1L	0.99	8.1	3.80	52	12.50	7.8	34.63	81	13.00	7.7	33.76	80
225/1L	5.25	7.8	11.84	59	2.82	7.5	15.63	79	3.50	7.4	8.82	60
225/2L	1.70	8.1	11.53	79	3.50	7.5	21.95	84	55.30	7.0	50.18	76
226/1L	17.20	7.6	31.55	76	8.50	7.0	15.58	65	1.66	8.1	4.17	34
226/2L	1.53	8.5	2.10	42	1.62	7.0	15.26	86	6.88	7.2	8.51	47
227/1L	1.03	8.3	7.49	45	5.80	7.8	14.17	82	1.11	8.0	4.13	57
227/1AL	2.10	7.9	5.32	53	1.03	8.3	8.24	75	0.68	8.4	5.28	62
228/1L	2.39	8.0	19.02	83	3.00	8.2	13.75	78	29.50	7.2	14.30	47
228/1AL	6.80	7.5	18.16	69	5.80	7.8	9.94	54	1.60	8.2	7.46	72
228/2L	1.00	8.3	1.92	37	0.86	8.4	1.97	38	2.05	7.8	4.41	46
229/1L	1.70	8.0	4.01	46	11.60	7.4	-	-	2.00	8.0	4.72	50
236/1AR	1.89	7.8	7.86	66	12.00	7.3	14.01	55	46.90	7.4	48.98	77
237/1R	15.60	7.5	37.30	79	9.15	7.7	16.71	61	12.30	7.6	31.36	82
238/1R	35.20	7.1	33.22	72	4.66	7.8	21.40	75	4.00	8.3	12.81	74
238/2R	41.70	7.3	30.68	68	11.70	7.2	22.86	70	30.00	7.4	24.80	67
239/2R	16.50	8.5	21.51	67	0.80	8.4	2.11	43	1.30	8.3	5.32	61
239/3R	8.00	7.6	16.40	66	11.60	7.5	19.71	68	9.40	7.7	17.42	67
240/1R	8.60	7.6	-	80	12.80	7.8	22.46	71	2.56	7.6	2.95	31
240/1AR	1.20	7.7	5.04	58	5.40	7.3	14.09	71	2.46	7.8	15.53	81
240/2R	-	-	-	-	2.77	7.6	6.71	55	2.13	7.7	52.75	94
240/2AR	1.81	7.0	6.14	59	-	-	-	-	-	-	-	-
240/3R	1.25	7.7	2.93	41	1.36	8.0	2.94	33	0.72	7.9	5.16	63

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
R-11	Development of Sediment Transport Technology in Pakistan: An Annotated Bibliography	M. Hasnain Khan	Oct 1996

Report No.	Title	Author	Year
R-12	Modeling of Sediment Transport in Irrigation Canals of Pakistan: Examples of Application (M.Sc Thesis published as Research Report)	Gilles Belaud	Oct 1996
R-13	Methodologies for Design, Operation and Maintenance of Irrigation Canals subject to Sediment Problems: Application to Pakistan (M.Sc Thesis published as Research Report)	Alexandre Vabre	Oct 1996
R-14	Government Interventions in Social Organization for Water Resource Management: Experience of a Command Water Management Project in the Punjab, Pakistan	Waheed uz Zaman D.J.Bandaragoda	Oct 1996
R-15	Applying Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) for Building Inter-Agency Collaboration	Derk Kuiper Mushtaq A. Khan Jos van Oostrum M. Rafique Khan Nathalie Roovers Mehmood ul Hassan	Nov 1996
R-16	Hydraulic Characteristics of Chishtian Sub-division, Fordwah Canal Division	Anwar Iqbal	Nov 1996
R-17	Hydraulic Characteristics of Irrigation Channels in the Malik Sub-Division, Sadiqia Division, Fordwah Eastern Sadiqia Irrigation and Drainage Project	Khalid Mahmood	Nov 1996
R-18	**Proceedings of National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan**	M. Badruddin Gaylord V. Skogerboe M.S. Shafique (Editors for all volumes)	Nov 1996
R-18.1	Volume-I: Inauguration and Deliberations		
R-18.2	Volume-II Papers on the Theme: Managing Canal Operations		
R-18.3	Volume-III: Papers on the Theme: Water Management Below the Mogha		
R-18.4	Volume-IV: Papers on the Theme: Environmental Management of Irrigated Lands		
R-18.5	Volume-V: Papers on the Theme: Institutional Development		
R-19	Detailed Soil Survey of Eight Sample Watercourse Command Areas in Chishtian and Hasilpur Tehsils	Soil Survey of Pakistan IIMI-Pakistan	Nov 1996
R-20	Unsteady Flow Simulation of the Designed Pehur High-Level Canal and Proposed Remodeling of Machai and Miara Branch Canals, North West Frontier Province, Pakistan	Zaigham Habib Kobkiat Pongput Gaylord V. Skogerboe	Dec 1996
R-21	**Salinity Management Alternatives for the Rechna Doab, Punjab, Pakistan**	Gauhar Rehman Waqar A. Jehangir Abdul Rehman Muhammad Aslam Gaylord V. Skogerboe	May 1997
R-21.1	Volume One: Principal Findings and Implications for Sustainable Irrigated Agriculture		
R-21.2	Volume Two: History of Irrigated Agriculture: A Select Appraisal	Gauhar Rehman Hassan Zia Munawwar Asghar Hussain	Jan 1997

Report No.	Title	Author	Year
R-21.3	Volume Three: Development of Procedural and Analytical Liniks	Gauhar Rehman Muhammad Aslam Waqar A. Jehangir Abdul Rehman Asghar Hussain Nazim Ali Hassan Zia Munawwar	Jan 1997
R-21.4	Volume Four: Field Data Collection and Processing	Gauhar Rehman Muhammad Aslam Waqar A. Jehangir Mobin Ud Din Ahmed Hassan Zia Munawwar Asghar Hussain Nazim Ali Faizan Ali Samia Ali	Jan 1997
R-21.5	Volume Five: Predicting Future Tubewell Salinity Discharges	Muhammad Aslam	Jan 1997
R-21.6	Volume Six: Resource Use and Productivity Potential in the Irrigated Agriculture	Waqar A. Jehangir Nazim Ali	Feb 1997
R-21.7	Volume Seven: Initiative for Upscaling: Irrigation Subdivision as the Building Block	Gauhar Rehman Asghar Hussain Hassan Zia Munawwar	Apr 1997
R-21.8	Volume Eight: Options for Sustainability: Sector-Level Allocations and Investments	Abdul Rehman Gauhar Rehman Hassan Zia Munawar	Apr 1997
R-22	Salinisation, Alkalinisation and Sodification on Irrigated Areas in Pakistan: Characterisation of the geochemical and physical processes and the impact of irrigation water on these processes by the use of a hydro-geochemical model (M.Sc Thesis published as Research Report)	Nicolas Condom	Mar 1997
R-23	Alternative Scenarios for Improved Operations at the Main Canal Level: A Study of Fordwah Branch, Chishtian Sub-Division Using A Mathematical Flow simulation Model(M.Sc Thesis published as Research Report)	Xavier Litrico	Mar 1997
R-24	Surface Irrigation Methods and Practices: Field Evaluation of the Irrigation Processes for Selected Basin Irrigation Systems during Rabi 1995-96 Season	Ineke Margot Kalwij	Mar 1997
R-25	Organizing Water Users for Distributary Management: Preliminary Results from a Pilot Study in the Hakra 4-R Distributary of the Eastern Sadiqia Canal System of Pakistan's Punjab Province	D.J. Bandaragoda Mehmood Ul Hassan Zafar Iqbal Mirza M. Asghar Cheema Waheed uz Zaman	Apr 1997
R-26	Moving Towards Participatory Irrigation Management	D.J. Bandaragoda Yameen Memon	May 1997
R-27	Fluctuations in Canal Water Supplies: A Case Study	Shahid Sarwar H.M. Nafees M.S. Shafique	June 1997
R-28	Hydraulic Characteristics of Pilot Distributaries in the Mirpurkhas, Sanghar and Nawabshah Districts, Sindh, Pakistan	Bakhshal Lashari Gaylord V. Skogerboe Rubina Siddiqui	June 1997

Report No.	Title	Author	Year
R-29	Integration of Agricultural Commodity Markets in the South Punjab, Pakistan	Zubair Tahir	July 1997
R-30	Impact of Irrigation, Salinity and Cultural Practices on Wheat Yields in Southeastern Punjab, Pakistan	Florence Pintus	Aug 1997
R-31	Relating Farmers' Practices to Cotton Yields in Southeastern Punjab, Pakistan	P.D.B.J. Meerbach	Aug 1997
R-32	An Evaluation of Outlet Calibration Methods: A contribution to the study on Collective Action for Water Management below the Outlet, Hakra 6-R Distributary	Arjen During	Aug 1997
R-33	Farmers' use of Basin, Furrow and Bed-and-Furrow Irrigation Systems and the possibilities for traditional farmers to adopt the Bed-and-Furrow Irrigation Method.	Nanda M. Berkhout Farhat Yasmeen Rakhshanda Maqsood Ineke M. Kalwij	Sep 1997
R-34	Financial Feasibility Analysis of Operation and Maintenance Costs for Water Users Federations on three distributaries in Province of Sindh, Pakistan.	Amin Sohani	Sep 1997
R-35	Assessing the Field Irrigation Performance and Alternative Management Options for Basin Surface Irrigation Systems through Hydrodynamic Modelling.	Ineke Margot Kalwij	Oct 1997
R-36	Socio-Economic Baseline Survey for Three Pilot Distributaries in Sindh Province, Pakistan.	Yameen Memon Mehmood Ul Hassan Don Jayatissa Bandaragoda	Nov 1997
R-37	Socio-Economic Basline Survey for a Pilot Project on Water Users Organizations in the Hakra 4-R Distributary Command Area, Punjab.	Muhammad Asghar Cheema Zafar Iqbal Mirza Mehmood Ul Hassan Don Jayatissa Bandaragoda	Dec 1997
R-38	Baseline Survey for Farmers Organizations of Shahpur and Mirwal Small Dams, Punjab, Pakistan.	Muhammad Asghar Cheema Don Jayatissa Bandaragoda	Dec 1997
R-39	**Monitoring and Evaluation of Irrigation and Drainage Facilities for Pilot Distributaries in Sindh Province, Pakistan**		
R-39.1	Volume One: Objectives, Stakeholders, Approaches and Methodology	M.S. Shafique B.K. Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-39.2	Volume Two: Bareji Distributary, Mirpurkhas District	B.K. Lashari Waryam Balouch Ghulam Mustafa Talpur Muhammad Nadeem Asghar Ali Memon Badrul Hassan Memon M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997
R-39.3	Volume Three: Dhoro Naro Minor, Nawabshah District	B.K. Lashari Abdul Rehman Soomro Nizamuddin Bharchoond Muneer Ahmed Mangrio Parvez Ahmed Pirzado Fateh Mohammad Mari M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997

Report No.	Title	Author	Year
R-39.4	Volume Four: Heran Distributary, Sanghar District	B.K. Lashari M. Naveed Khayal Niaz Hussain Sial Abdul Majeed Ansari Abdul Jalil Ursani Ghulam Shabir Soomoro M. Ghous Laghari M. Akhtar Bhatti M.S. Shafique Gaylord V. Skogerboe	Dec 1997
R-40	**Maintenane Plans for Irrigation Facilities of Pilot Distributaties in Sindh Province, Pakistan.**		
R-40.1	Volume One: Dhoro Naro Minor, Nawabshah District	Abdul Rehman Soomro Munir Ahmed Mangrio Nizamuddin Bharchoond Fateh Muhammad Mari Parvez Ahmed Pirzado Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-40.2	Volume Two: Heran Distributary, Sanghar District	Abdul Majeed Ansari Niaz Hussain Sial Abdul Jalil Ursani Ghulam Shabir M. Ghous Laghari M. Naveed Khayal Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-40.3	Volume Three: Bareji Distributary, Mirpurkhas District	Asghar Ali Memon Waryam Balouch Ghulam Mustafa Talpur Muhammad Nadeem Badrul Hassan Memon Bakhshal Lashari M. Akhtar Bhatti Gaylord V. Skogerboe	Dec 1997
R-41 R-41.1	**Preliminary Business Plans** Volume One: Dhoro Naro Minor, Nawabshah District	Pervaiz Ahmad Pirzada Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-41.2	Volume Two: Bareji Distributary, Mirpurkhas District	Muhammad Nadeem Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-41.3	Volume Three: Heran Distributary, Sanghar District	Niaz Hussain Sial Mohsin Khatri Syed Daniyal Haider	Dec 1997
R-42	Prospects of Farmer-Managed Irrigated Agriculture in the Sindh Province of Pakistan. LBOD Project Final Report	D.J. Bandaragoda Yameen Memon Gaylord V. Skogerboe	Dec 1997
R-43	Study Tour of Pakistani Pilot Project Farmer-Leaders to Nepal	Mehmood Ul Hassan Yameen Memon	Jan 1998
R-44	Self-Help Maintenance Activities by the Water Users Federation of Hakra 4-R Distributary	Waheed uz Zaman	Feb 1998

Report No.	Title	Author	Year
R-45	Semi-Detailed Soil Survey of Chishtian Irrigation Sub-Division	Soil Survey of Pakistan IIMI-Pakistan	Mar 1998
R-46	Tenancy and Water Management in South-Eastern Punjab, Pakistan	Annemiek Terpstra	Mar 1998
R-47	The Collaboration between the International Irrigation Management Institute and Cemagref in Pakistan: Proceeding of a one-day workshop	IIMI Cemagref	Apr 1998