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WATERLOGGING AND SALINITY MANAGEMENT IN THE SINDH PROVINCE

Volume I, Supplement I.B

Farmers' Perspectives on Warah Branch Canal Operations

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I INTRODUCTION

In the Sindh Province of Pakistan, the development of irrigated infrastructure, to include gated canal systems, started with the construction of barrages that facilitated controlled water supplies to off-taking canals. The first of the three barrages, at Sukkur, was commissioned in 1932, and presently commands more than 3.35 million hectares of land on either side of the Indus River. Two other barrage structures of Kotri (downstream) and Guddu (upstream) were commissioned in 1955 and 1962, respectively (Figure 1). In comparison, the Sukkur Barrage system remains the largest in terms of culturable commanded area (3.04 Mha), discharge capacity (1,345 cumecs) and length (11,400 kms). Of the seven major canals that offtake from the main structure, three are located on the Right Bank (Northwest, Rice and Dadu) and the remainder on the areally more extensive Left Bank (Rohri, Nara, East Khairpur and West Khairpur). Typically, the consumptive use patterns of crops are much higher on the Right Bank commands due to cultivation of rice and sugarcane. With the commissioning of extra supplies from Tarbela, the overall water use has further accentuated over the last two decades.

In the period leading to the commissioning of the Sukkur Barrage, the need for drainage was ignored from the planning put into the layout of the irrigation system. This was largely based on the suffciently deep watertables that had been observed in the commanded regime. The need for drainage was felt as early as 1964 whence the continuous application of irrigation waters steadily raised the subsurface water levels to cause waterlogging and salinity. Before 1932, the areas commanded by the Sukkur Barrage had watertables < 4 meters which rose to < 1.5 meters across 75% of the area in sixty years. This recorded rise not only restricted the crop yields but also contributed towards salt accumulation in the root zone. At present, the watertable has been controlled in areas where drainage systems are functional. The remaining areas have had no significant relief from waterlogging because of the dysfunctional drainage systems.

The current estimation is that 6.35 Mha of land in the pre-monsoon period and 4.25 Mha after the monsoon are affected by a watertable of between 1.5 m to 3.0 m in the whole of Pakistan. These areas are considered potentially waterlogged and good management is required to prevent the watertable from rising even higher.

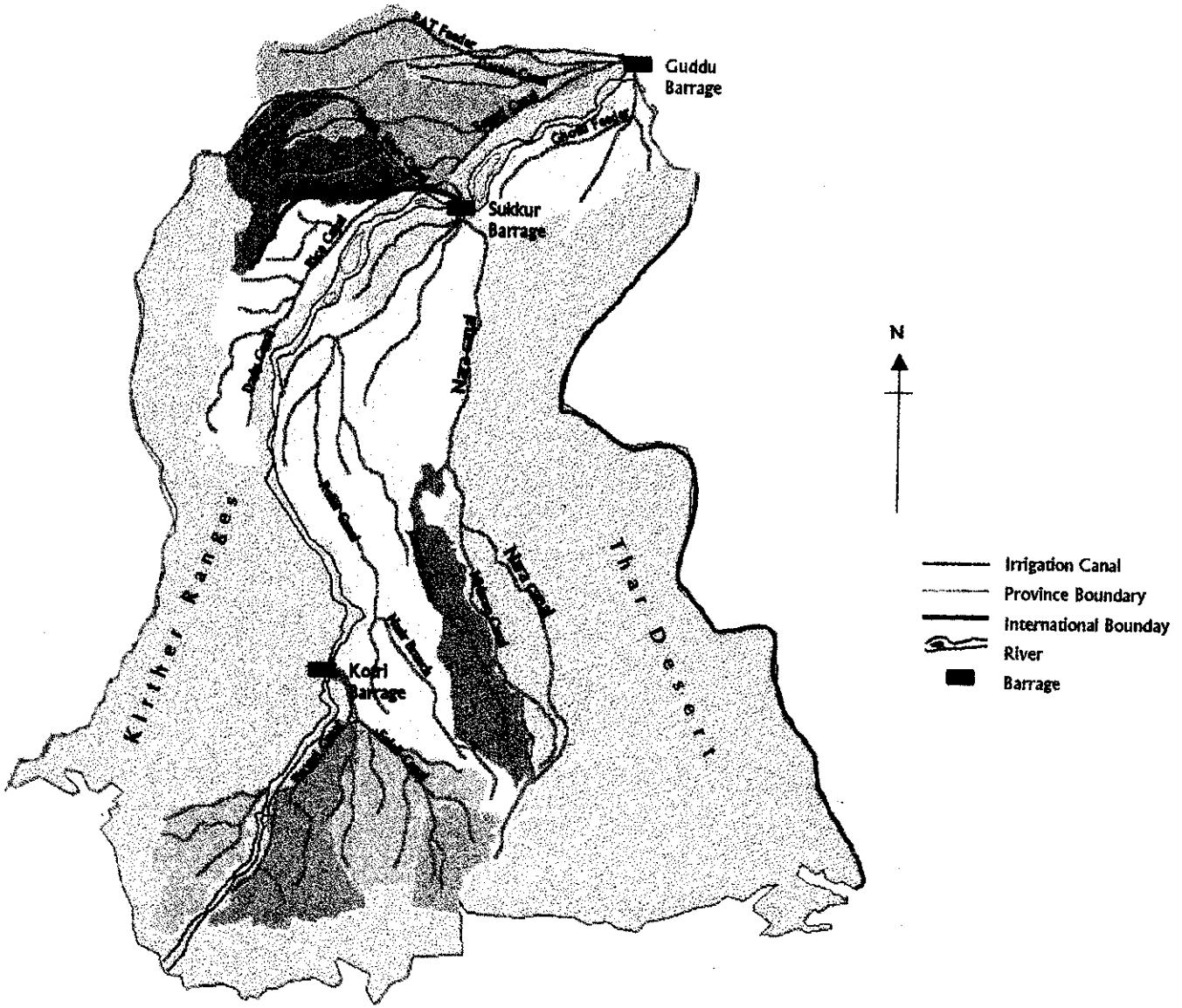

Figure 1 : Map of the Barrage Control System in the Sindh

The continuous flow of the Indus River water, coupled with dysfunctional drainage facilities, has been the cause of problems related to waterlogging in the Sindh Province. This is not only due to seepage from canals, but also attributed to traditional practices of water application in the absence of drainage. Given the seasonal excess in water application, the ponded conditions curtail sufficient time for tillage operations to particular levels. This phenomenon leads to the re-distribution of salts, as well as a compacted soil structure. Under reliable water supply conditions and with intensive irrigation, covered by good drainage facilities, salinity can be controlled by managing the ground watertable at a safe depth.

A Study Overview and Objectives

In the Sindh Province, most canal systems run according to "continuous flow" operational modes established by the colonial regime. However, continuous flows are only possible during the summer months; during the winter months of low supplies, the rotational flow strategy is followed.

To explore the infirmities in the delivery mechanisms associated with poor operational and institutional arrangments, a study survey was conducted (April-August, 1998) in the Warah Branch Canal command (an off-take of the North West Canal system at RD 82.5) (see Annexure-II). The study also aimed to put forward recommendations for the operation of the Warah Branch Canal in the context of incessant waterlogging and salinity prevalent in the area. In doing so, consultations were also made with the actual beneficiaries (farmers) of the system. A team of three social scientists-cum-agricultural engineers with considerable professional background and experience in similar works under IIMI's LBOD pilot projects was stationed in the area to undertake this survey.

The data, gathered against a structured questionnaire, reflects upon farmers' knowledge and pertains to the Warah Branch Canal operations over the years. Farmers have been living with this system for decades. Verifications through field observations and actual measurements were beyond the scope of this study. The overall objective remains to determine farmers' perspectives on the Warah Branch Canal operations and to identify interventions that maximize production based on the existing availability of land and water resources.

B Warah Branch Canal

The study area, located in the heart of the Indus Right Bank, is characterized by perennial canal irrigation in an otherwise arid subtropical continental climate with intense summer heat and mild cool winters. The Warah Branch Canal, with a design discharge of 55 cumecs, runs very close and parallel to the Rice Canal for the first 10 kilometers of its off-take point from the North West (NW) Canal. The North West Canal itself off-takes from the right bank of the Sukkur Barrage and has a design discharge capacity of 146 cumecs. The 1,598 km length of the system irrigates the northern area of the barrage command. The GCA and CCA of the NW Canal are 387,854 ha and 385020 ha, respectively. The maximum ten-day average discharge was 272 cumecs in 1988.

The Warah Branch Canal is a perennial canal and feeds an area of 122,393 ha in the Shikarpur and Larkana Districts. The total length of the Warah Branch Canal is 106.07 km (348,000 feet or 348 RDs). Administratively, the system has been divided into three sub-divisions of Madeji, Miro Khan and Warah. There are 48 secondary channels (30 are perennial and 18 non-perennial) that offtake from the main branch and cover a CCA of 125,782 ha across 1,033 watercourses; 121 of these outlets offtake directly from the Warah Branch Canal (Figure 2).

1). Cropping

The Warah Branch system was designed for upland crops with a design intensity of 27% in the kharif and 54% in the rabi seasons. The water allowance is 190 lps/1000 ha (2.7 cusecs per 1000 acres). The delta for the rice crop is 1.08 ha-m/ha (3.54 acre-feet/ac). With the passage of time, this cropping pattern has changed overwhelmingly in favor of rice. This change in the cropping pattern has been influenced to a great extent by the cropping practices in the adjacent Rice Canal system that supplies water for the paddy crop. The rice crop requires 5 times more water than dry crops, and hence the primary cause of inequitable irrigation supplies across the system, with recurrent shortages in the tail. Therefore, there remains considerable demand to increase the available discharges over and above the permissible allowances. Currently, a discharge of 175.6 cumecs is being released into the Warah Branch Canal which is 3 times over the design capacity.

Cropping patterns in all three sub-divisions of Warah Branch Canal command are similar, i.e. rice in the kharif season and wheat during rabi cultivation. Rice is the major kharif crop, estimated to be about 43 percent of the total CCA. Wheat is the major rabi crop, estimated to be 40 percent of the total CCA (Interim report on N.W.C Remodelling Project, 1995).

Cropping intensities in the Madeji and Miro Khan Sub-divisions are reasonably good during both seasons due to adequate and timely water supplies, while the Warah Sub-division has poor intensities. The main reasons were the poor applications of water due to water shortages, extended sowing periods and an increasing watertable problem.

In the Warah Division, the kharif intensity was less than during the rabi season (Table 1). The reason is attributed to the late canal water supply because of the absence of a warabandi system, negligence restricting the flow of canal water into drains, lack of maintenance for the secondary canal and remodeling.

Table 1. Cropping Intensities along the Warah Branch Canal for Kharif and Rabi, 1992.

Season	Madeji Sub-division (Head Reach)	Miro Khan Sub-division (Middle Reach)	Warah Sub-division (Tail Reach)
Kharif	73 %	65 %	34 %
Rabi	68 %	61 %	49 %
Kharif	71 %	67 %	49 %
Rabi	76 %	69 %	66 %

Source: Interim Report on N.W. Canal Remodeling Project, 1995.

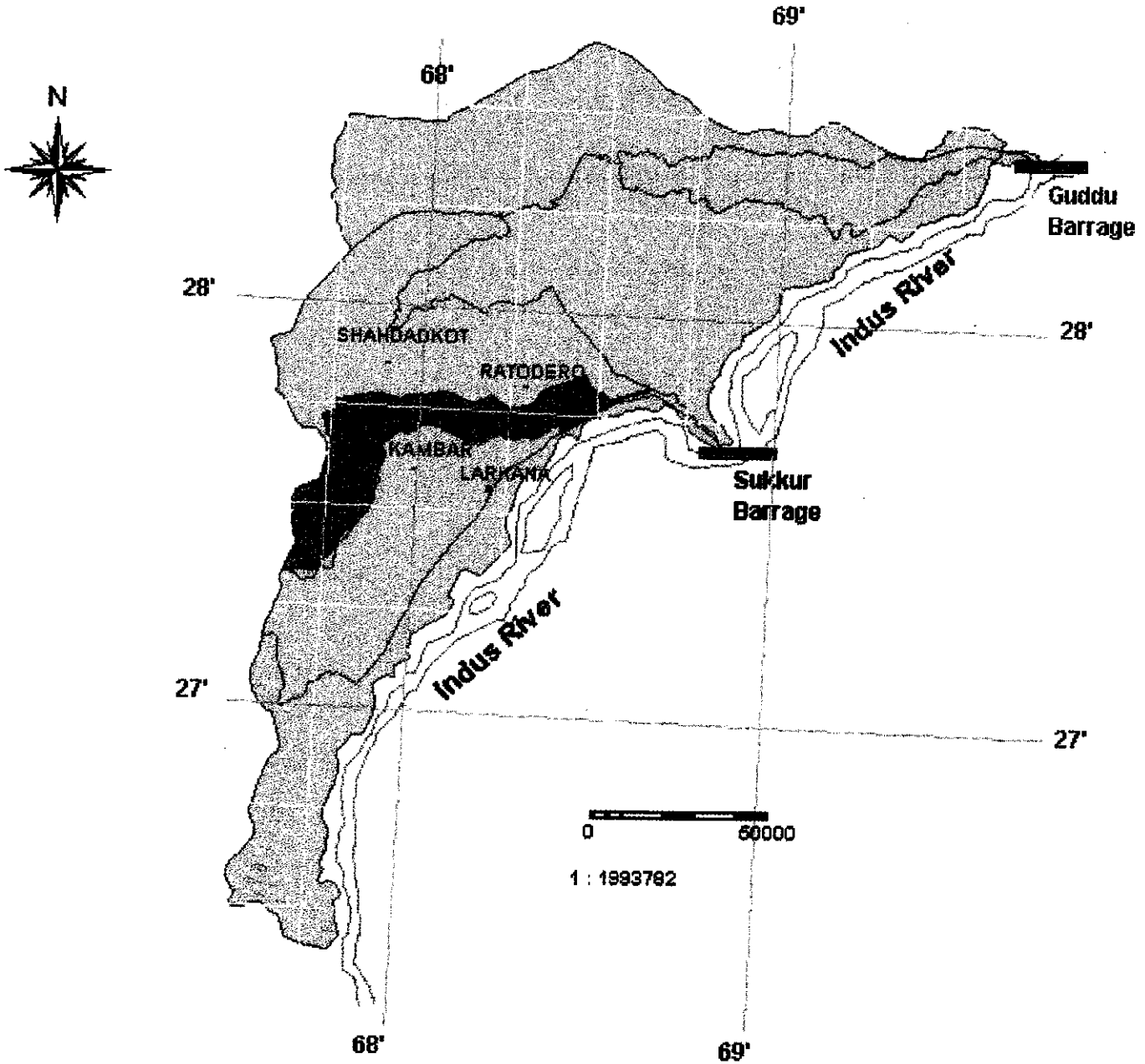

Figure Location of Warah Branch Canal Command, Right Bank, Lower Indus Basin.

2). Soils

The soils characteristics are owed to two kinds of parent materials; namely, the Indus Alluvium and Piedmont Alluvium. The alluvia are of mixed mineralogical origin and are differentiated by their characteristic colors, specific textures and peculiar depositional pattern.

Soils of the River Plain

These soils range from sandy to clayey in texture, with the dominant clayey texture deposited in a typical riverine pattern marked by levees, basins and channels. Excluding the very sandy soils, approximately all the soils are moderately well or imperfectly drained. These have good porosity with sufficient organic matter for up to 60-90 cm (2-3 feet), good structure and are moderately calcareous. The pH values for normal soils range between 8.0 to 8.4, and never above 8.5 for saline soils, but instead, dropping to 8.0 and indicating the presence of gypsum. Saline-sodic soils are rare with pH values ranging from 8.5 to 10.0. Due to prolonged rice cultivation, the surface layer has become dense.

Soils of the Piedmont Plain (Kirthar Range)

These soils, in texture, consist of silty, loamy and clayey but the clayey texture dominates, deposited in regular textural sequence along the piedmont slope. Mostly, the clayey portion is under the Warah Canal Command. These are mostly moderately well drained, saline, gypsuferous, calcareous and with low organic matter. The pH value ranges between 8.0 to 8.6 (some, moderately sodic) up to 120 cm.

Poor soil surface conditions due to compaction prevent plant roots from easily penetrating soil pore space to acquire food. This restricts the variety of crops that can be grown and the crop yields. Physical conditions can be improved through the application of farmyard manure and green manuring.

3). Land Suitability

By determining the soil characteristics, the land use sustainability can be ascertained. For this purpose, the existing soil data collected by the Soil Survey Department during the period of 1970-76 was updated through field data collected by IIMI in 1998. The IIMI surveys, pertaining to soil characteristics, soil salinity, soil sodicity, waterlogging and land use, were aided by high resolution satellite images for ground truthing and interpretation. The on-site observations included:

- Land form/physiographic position
- Surface salinity
- Crop and its condition
- Watertable
- Texture
- Structure
- Porosity
- Color, mottling

- Calcareousness
- pH value (with Thymol blue)
- Irrigation status (perennial or non-perennial)

The resultant classification for land use suitability was based on a collective consideration of all these observations (Figure 3). The classification categories were borrowed from the FAO Soils Bulletin 44. However, in view of the local soil conditions, some modifications have been made (Annexure-III). The four land use suitability categories and six sub-classes for the Warah Branch Canal Command are:

SI:	Highly suitable land without any significant limitations for a given use. However, the recent survey indicated that some parts of this class lies in comparatively low areas with a high watertable (between 90-200 cm) that may create some hindrance for deep-rooted crops or fruit orchards.
SIIh:	Moderately suitable clayey land due to low permeability and workability. Both limitations can be overcome by avoiding flood irrigation and applying mechanical cultivation at proper moisture levels, respectively. In the low-lying area, the watertable may be classified as 90-200 cm.
SIIs3w2:	Moderately suitable land because of moderate salinity associated with high watertable (90-200 cm). During the soil survey, it was noted that some areas have been reclaimed and can be placed in SI - highly suitable land.
SIIIs4w2:	This group of soils has marginal suitability because it is clayey in nature with severe salinity associated with a high watertable (90-200 cm). The reclamation of such soils, which have low permeability and need before applying any remedial measures to lower the watertable.
SIIIs:	This class contains very sandy land with complex topography. These soils have very low inherited fertility, water and nutrient-holding capacities. Such soils must not be irrigated before fulfilling the needs of good and moderately good soils.
NIIS:	Permanently unsuitable sand dunes.
NIIw:	Permanently unsuitable marshland and water bodies.

The areal extents of the land use suitability classes and sub-classes for the Warah Branch Canal command are summarized in Table 2.

The total CCA of the Warah Branch Canal comprises 126,641 hectares, of which about 20,000 hectares (15.8%) form highly suitable land, mostly occupying the central command area. These soils are generally without significant limitations and can produce a variety of crops with high yields. The major area, of about 85,500 ha (67.5%), scattered throughout the command is also suitable for production. The tail is more saline with high watertable (90-200 cm). These soils are moderately suitable with moderate limitations for crop growth, but modern management will be responsive and high yields can be obtained.

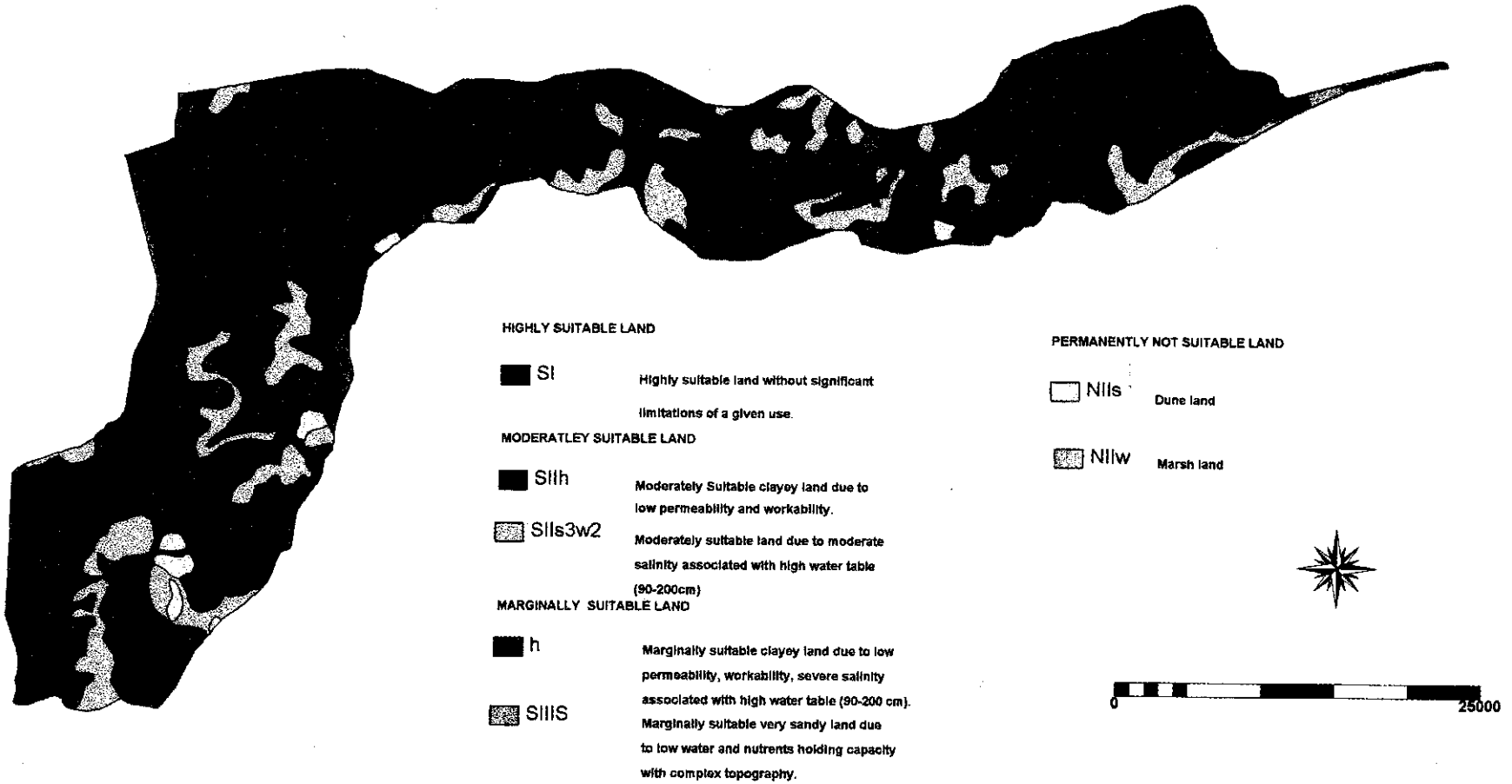

Figure : Land Use Suitability Classification.

Table 2. Land Use Suitability of the Warah Canal Command.

Suitability Class	Suitability Sub-classes in hectares						Total	
							ha	%age
	SIIh	SIIs3w2	SIIIh4sw2	SIIIs	NIIs	NIIw		
SI	-	-	-	-	-	-	2000	15.8
SII	70753	14747	-	-	-	-	85500	67.5
SIII	-	-	18620	180	-	-	18800	14.8
NII	-	-	-	-	1420	484	1904	1.5
Urban	-	-	-	-	-	-	437	0.4
Total	-	-	-	-	-	-	126641	100

The remaining 18,800 ha (14.8%) consist of marginally suitable land with severe limitations, and mostly constitutes the northwestern part with some scattered areas (sandy) accross the entire command. These soils have a very narrow range for crop selection with poor yields. Intensive modern management, together with major expenditures on drainage, and/or correction of unfavorable soil conditions, would be required for moderate to high yields. A small area, about 1,904 ha (1.5%), is permanently unproductive and comprises sand dunes. About 437 ha (0.4%) are under *abadi* and has no agricultural value.

For arable crops, moderately suitable land can be increased by about 25 percent by reclaiming severe profile salinity under proper soil and water management. The current and permanent limitations to rice and arable crops of the Warah Division are given in Table 3.

Table 3. Land Suitability for Rice and Arable Crops in the Warah Branch Canal.

Crop	Class	Current (%)	Permanent (%)	Change (%)
Rice	1	40.6	3.7	-36.9
	2	31.3	79.3	48.0
	3	23.1	10.3	12.8
	5	3.8	0.0	-3.8
	6	1.3	6.7	5.4
Arable	1	5.7	10.5	4.8
	2	37.6	62.5	24.9
	3	51.6	27.0	24.6
	5	3.8	0.0	-3.8
	6	1.3	1.3	0.0

Class 1 = Highly suitable, Class 2 = Moderately suitable, Class 3 = Marginally suitable
Class 5 = Temporarily unsuitable, Class 6 = Unsuitable
Source: Interim Report on N.W. Canal Remodeling Project, 1995.

4). Crop Suitability

The crop suitability classification is a method of rating soils in terms of relative suitability for the sustained production of specified crops. The ratings are called crop suitability classes, and range from Class I for the most suitable land to Class 4 for the least suitable. This is based on two factors, i.e., climate and soils. Identical soils, if located in different climate zones, e.g. Hyderabad and Peshawar, are not equally suited for the same crops. Different

crops require widely different sets of climatic conditions. Such conditions include elements of temperature, rainfall, humidity, wind velocity, incidence of frost, amounts of sunshine, daylight hours, length of the growing season and height above sea level. In Pakistan, local conditions for these elements vary when one moves from the coast to higher elevations. This necessitates the recognition of crop ecological zones. Accordingly, the Indus Plains have been divided into eleven ecological zones. Within an ecological zone, the suitability of crops are alike on identical soils, but vary widely on different soils.

For the Warah Branch Canal command, about 12 percent of the land is marginally suitable for rice cultivation, with severe salinity hazards that could be reclaimed. For arable crops, moderately suitable land can be increased by about 25 percent by reclaiming severe profile salinity under appropriate soil and water management conditions. The current and permanent limitations to rice and arable crops of the Warah Division appear in Table 3 above.

II SAMPLE SURVEYS

Satellite images were obtained for the Warah Branch command area to select the target areas for this study. Sample villages were selected randomly within these target areas. The sample villages selected were representative of the whole area to ensure that the data gathered reflected the conditions and normal practices followed in the area. The scale of the satellite images, provided on 12 separate field-worthy sheets, varied between 1:15,000 and 1:18,000 to ensure easy identification of sample villages and access routes (Figure 4).

The primary data collection process was undertaken through farmer interviews and field observations of key practices. For this purpose, a detailed questionnaire was developed and tested (Annexure-IV). The questions were arranged in a logical sequence to facilitate smooth interviewing. The questionnaire was field-tested and revised to accommodate the practical difficulties faced when asking questions and recording answers.

Two farmers were randomly selected in each of the sample villages for interviews. The interviews were conducted separately and independently to seek unbiased information from every individual interviewee.

Three IIMI staff members, with related experience, undertook the collection of field data. A senior staff supervised, and spent time in the field, with the team. The data collection was undertaken in the months of May and June 1998.

On the day selected for interviews, farmers were chosen on the basis of their land, knowledge, experience and availability. Some interviews were conducted in farmer-groups to enable interviewees to consult with others when responding to questions. Secondary data was also collected from several agencies. These included:

- Irrigation Department, Warah Division
- Agriculture Department, Extension Wing, Larkana
- Rice Research Institute, Dokri
- Wheat Research Institute, Sakrand

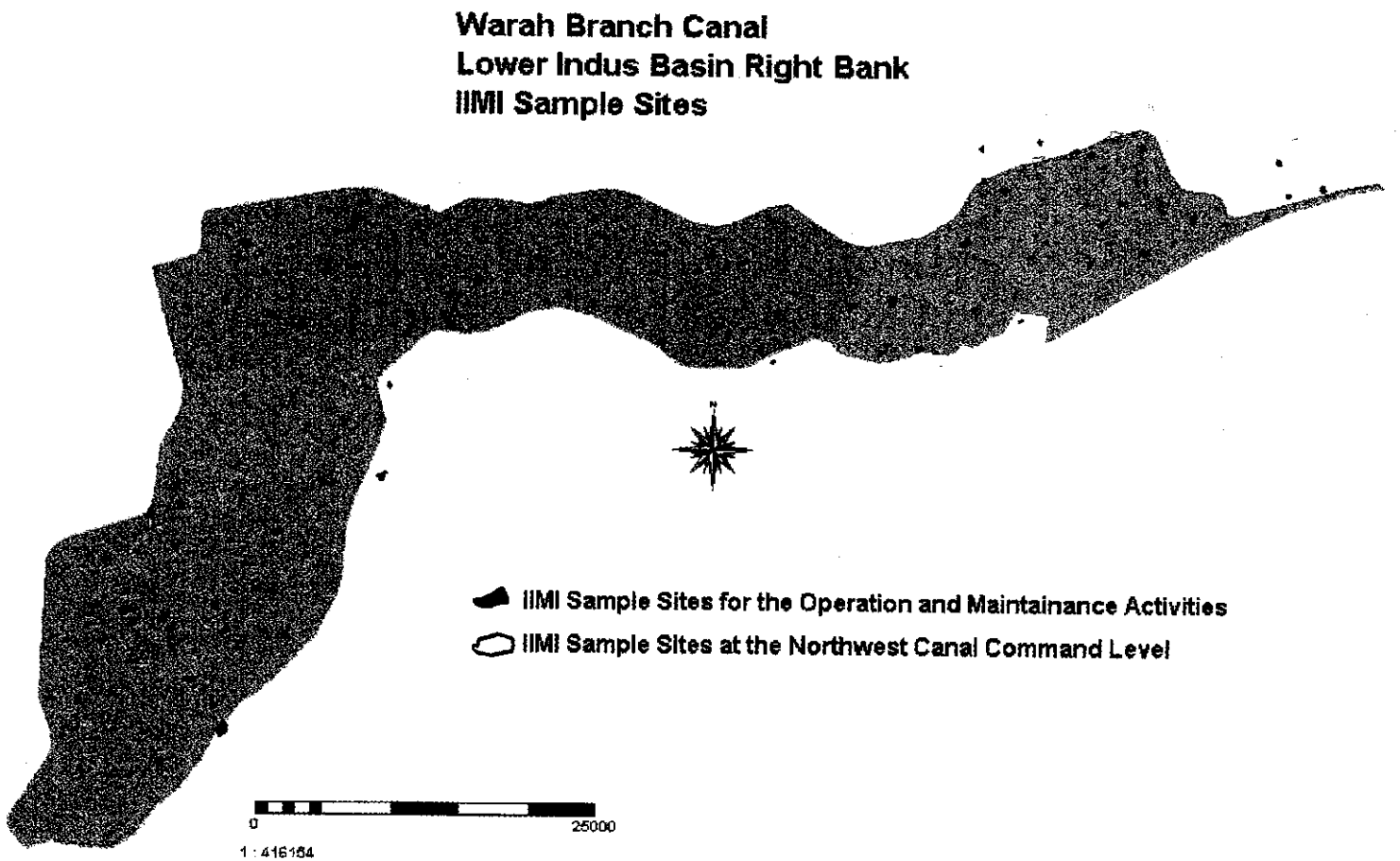

Figure : IIMI Sample Sites in the Warah Branch Canal Command during surveys in 1988.

Most farmers use local terms for land measurement, i.e. jareb instead of acres (i.e. 1 acre = 2 jarebs). To measure weight, they use kharar instead of maunds (i.e. 1 kharar = 20 maunds). The data collected was converted into standard units.

A SAMPLE SIZE

The sample comprises 306 farmers/respondents from 153 villages scattered throughout the Warah Command, i.e., two respondents from each village. Their names and locations are provided in Annexure-V. Initially, the sample selected had 169 villages, but 16 villages were situated outside the Warah Command and, therefore, were excluded from the sample for data collection.

B SAMPLE IDENTIFICATION AND DISTRIBUTION

The sample villages are identified in a series each for NW (North West) and OM (Operations and Maintenance). The villages tagged with NW numbers are part of a larger sample drawn under the main study of salinity management in the Sindh Province, and total 33 in number. Whereas, the villages tagged with OM numbers represent the sample villages selected specifically for the purpose of the O&M study of the Warah Canals, in addition to NW sample villages. The total number of sample villages is thus 120. Based on the administrative divides of the Irrigation Department, Table 4 gives the distribution of these sample villages for each of the three irrigation subdivisions.

Table 4. Distribution of Sample Villages within the Irrigation Sub-divisions of the Warah Branch Canal Command.

Sub-division	Villages Selected		Villages Surveyed		Outside the Warah Command	
	NW	OM	NW	OM	NW	OM
Madeji	8	38	7	32	1	6
Mirokhan	8	53	8	49	0	4
Warah	17	45	17	40	0	5
Total	33	136	32	121	1	15

C FARM LEVEL CHARACTERISTICS

The ownership status of the sample farms shows that a majority of the land owners are situated in the tail portions of the system, whereas leasing and tenancy arrangements are much less common (Table 5).

Table 5. Distribution of Land Ownership in the Warah Branch Canal Command.

Status	Madeji	Miro Khan	Warah
Landowner	38	40	44
Owner-operated	46	44	44
Tenant	12	16	11
Lease	0	1	0
Manager-operated	3	0	1

The minimum, maximum and average farm sizes for each of the three sub-divisions are given in Table 6. From the table, it appears that the average size of the sample farms is relatively larger in the tail portion of the Warah Canal Command.

The frequency distribution of the sample farm sizes is presented in Table 7. The frequency distribution also shows that the average size of sample farms is relatively larger in the tail portion of the command area.

The total farm area of the 306 sample farmers was 6383 hectares. The details on area under different size categories of the sample farms are presented in Table 8.

Table 6. Minimum, Maximum and Average Farm Sizes (in hectares).

Subdivision Size	Madeji ha	Miro Khan ha	Warah ha
Minimum	1.5	1	2
Maximum	600	1000	800
Average	50	47	64

Table 7. Farm Size Frequency Distribution.

Sub-division Size(ha)	Madeji %	Miro Khan %	Warah %
<5	47	48	33
5 to 10	17	15	18
10 to 20	13	12	15
20 o 40	6	15	18
>40	17	10	16

Table 8. Area of the Sample Farms within the Warah Branch Canal Command.

Sub-division Size (ha)	Madeji ha	Miro Khan ha	Warah ha	Total for Warah Division ha
< 5	105	145	103	353
5 to 10	138	173	200	501
10 to 20	136	332	323	801
20 to 40	175	235	401	811
>40	1021	1320	1903	4244

The farm locations along the watercourse for each farm was inquired from the owner/ operator of each of the sample farms. The details are presented in Table 9. The highest proportion of the sample farms is located in the middle portions of their respective watercourses. This implies that the sample represents average conditions found in the watercourses.

Table 9. Percentage Distribution of Farm Locations with respect to Administrative Divides.

Subdivision	Miro Khan	Madeji	Warah	Total (for Warah Division)
Head	37	32	41	37
Middle	36	42	38	39
Tail	27	25	21	24

D LAND USE

The land use pattern of the sample farms is presented in Table 10. More areas are under cultivation in the head and middle reaches when compared to the tail reach. This shows the inequity of water distribution along the Warah Branch.

Table 10. Land Use Pattern for Sample Farms in the Warah Branch Canal Command.

Subdivision Areas	Miro Khan ha	Madeji ha	Warah ha	Total (For Warah Division)
Total Command Area	1590	2205	2585	6388
Cultivated A rea	1287	1757	1650	4694

III SCOPE FOR MANAGEMENT INTERVENTIONS

A CANAL WATER AVAILABILITY

The Warah Branch Canal starts official operation on May 15 every year for the kharif season. However, there is a time lag between the starting date of canal operations and the actual time when water becomes available from the head to tail reaches. Considering the length of the canal (348,000 feet), filling of the canal takes about one week. Sample farmers were asked about the start and termination dates of the canal water supplies. Farmers' reports of timings of the starting and termination dates of the canal supplies/ operations for the kharif season are summarized in Table 11 below.

Table 11. Canal Supply Start and End Dates for the Kharif Season.

Sub-division	Madeji	Miro Khan	Warah	Average
Start Date				
Average	29th May	13th June	11th June	7th June
Earliest	15th May	15th May	18th May	15th May
Latest	7th Aug	31st Aug	30th Sep	30th Sep
End Date				
Average	5th Dec	24th Dec	3rd Jan	20th Dec
Earliest	22nd Sep	15th SEP	31st Oct	15th Sep
Late	31st Jan	17th Jan	7th Jan	31st Jan

From the above table, it is clear that there are considerable variations in the starting and termination dates of canal water supplies. Farmers receive their canal water supply as early

as May 15 (Madeji Sub-division) and as late as September 30 (Warah Sub-division). This variability negatively affects the farmers' ability to plan their operations and take risks.

The sample farmers were also asked to quantify the delays after the official start date (i.e. May 15 every year). The delays reported ranged from 1 to 20 weeks. They are calculated on the basis of percent of respondents. The results are presented in Table 12.

Table 12. Delays in the Start of Canal Supplies for the Kharif Season.

Delays	Madeji (%)	Miro Khan (%)	Warah (%)	Average (%)
On Time	48	50	31	43
Week 1	4	7	4	5
Week 2	25	24	16	22
Week 3	2	6	12	7
Week 4	10	2	11	8
Week 5	3	1	3	2
Week 6	7	4	8	6
Week 7	0	0	2	1
Week 8	1	4	3	3
Week 10	0	0	2	1
Week 12	0	2	0	1
Week 14	0	0	4	1
Week 16	0	0	2	1
Week 18	0	0	0	0
Week 20	0	0	2	1

From the table, it appears that considerable delays occur over and above the normal filling time required for the canal.

The canal supplies continue until the general canal closure (Natal Bandi), which is implemented during the months of December and January every year. Resultantly, canal supplies are available during early rabi. After the canal closure, canal water supplies start again around January 14 and last until the next termination around April 7. Farmers' response to the start and termination dates is summarized in Table 13.

Table 13. Canal Supply Start and End Dates for the Rabi Season.

Sub-divisions Indicators	Madeji	Miro Khan	Warah	Total
Rabi (Start)				
Average	Jan 03	Jan 18	Jan 20	Jan 14
Earliest	Sep 13	Oct 01	Sep 20	Sep 20
Late	March 07	Feb 19	Feb 15	March 07
Rabi (End)				
Average	Apr 04	Apr 08	Apr 10	Apr 07
Earliest	March 15	Jan 01	March 31	Jan 01
Late	Apr 15	May 07	30 April	May 07

The sample farmers were asked for their general opinions regarding the canal supply timing for the rabi season. About 81 percent of the sample farmers found the canal irrigation supply in rabi to be on time, while only 18 percent found that they were 2 to 4 weeks late.

B ADEQUACY/EQUITY OF SUPPLY

The current operation of the secondary channels (distributaries and minors) of the N.W. Canal is far from satisfactory. Farmers claim that they never receive the water they request and field observations confirm that the water allocation between the head and tail reaches of these channels is far from equitable. The socio-economic survey also highlights problems with timing, quantity, and distribution of water within minor canals.

Farmers were asked their opinions regarding the adequacy of canal irrigation supplies. To find a common base for comparison, they were asked what time was needed, on average, to irrigate/fill one acre of land. The results are summarized in Table 14.

Table 14. Time to Irrigate One Acre of Land (in hours).

Sub-division	Madeji	Miro Khan	Warah
Average	2.6	3.3	3.7
Minimum	1.0	1.0	1.0
Maximum	6.0	12.0	12.0

It appears that more time is needed to irrigate or fill a one-acre field in the tail areas. This reflects that either, the flow size or its amount is not sufficient in the tail areas. Or, at least, more time is required to irrigate one acre in the tail areas.

Similarly, equity considerations are summarized in Table 15. The sample farmers were asked to give their perceptions about equity according to their experience at various levels of the system. According to their perception, the equity at the branch canal and distributary levels is found to be on the lower side (43 and 40%, respectively). Equity seems to be better at the tertiary level (71%). This indicates that the equity problem is much more pronounced at the branch and the distributary levels compared to the tertiary level.

Table 15. Equity in Canal Supplies within Warah Branch Canal Command.

Sub-division Channels	Madeji	Miro Khan	Warah	Average
Branch Canal	59	46	14	43
Secondary Canal	49	49	22	40
Watercourse	72	70	72	71

C OPERATION AND MAINTENANCE

Farmers described the following as the main reasons for fluctuations in canal water and shortage of water in the tails:

- Lack of maintenance of distributaries/minors; and
- Improper conditions and operation of the regulators.

When asked about the general operation and maintenance of the Warah Canal, only 17 respondents were satisfied compared to 83 percent who were not satisfied. Their suggestions were invited to rectify the present situation to improve the performance of the Warah Canal system. Their suggestions are summarized in the Table 16.

D WATER CHARGES ASSESSMENT AND COLLECTION

The sample farmers were asked about the water charges being paid by them in connection with irrigation water. Their responses are summarized in Table 17. From the table, it is clear that the farmers were paying different amounts, which is surprising. There should be a more or less uniform system. This needs looking into, as the figures are much higher when compared to official figures reported at various levels.

Table 16. Sample Farmers' Suggestions to Improve Canal Operations.

Suggestions	Canal Water Supply	Water Equity	O&M
	Percentage Respondents		
Satisfactory	31.9	6.8	17.1
Early Water Supply	2.6	0.8	2.8
More Water Supply	16	22.9	8.7
Control, Tampering	8.2	20.0	2.8
Maintenance of Channels	17.6	8.3	11.3
Control, Tampering + Maintenance of Channel	3.5	1.7	2.5
Control, Corruption/ Situation Control Through Law & Order	10.6	25.5	40.9
Water Supply According to Crop Need	9.2	4.7	5.6
Agriculture Knowledge	0.0	0.0	2.1
Farmer Organization	0.0	1.6	1.7
Warabandi	0.3	0.8	4.7

Table 17. Water Charges Paid by Sample Farmers (in Pak Rupees).

Sub-divisions	Madeji	Miro Khan	Warah	Average
Average	270	247	233	250
Minimum	140	50	70	87
Maximum	400	400	400	400

E DRAINAGE SYSTEM

The Warah Division has a surface (horizontal) drainage system, whereas the Madeji Sub-division has surface (horizontal) as well as tubewell (vertical) drainage systems. The sample farmers were asked questions regarding the presence of the drainage facility near their farms and its proper functioning. Their responses are summarized in Table 18.

From Table 18, it appears that 33 percent of the respondents have access to one, or more, types of drainage facilities. About 62 percent reported the drainage system to be functional, and only 45 percent felt that they were being maintained properly. However, a vast majority think (79%) that these will be maintained by the Government, compared to 21 percent who

feel that the farmers will maintain them. About 51 percent feel that the drainage system is effective and 54 percent feel that the drainage facilities are effective in controlling the watertable. At the canal command level, the head and middle reaches have better drainage facilities when compared to the tail portion.

Table 18. Farmers' Perceptions on Drainage Operations in the Warah Division.

Description	Response (%)			
	Madeji	Miro Khan	Warah	Average
Presence of drains	46	35	16	32
Drains in working condition	74	68	44	62
Drains with maintenance	69	55	11	45
Maintenance by government	96	91	50	79
Maintenance by farmers	4	9	50	21
Control on watertable	64	50	39	51
Impact on crops	71	54	39	54

Of the 306 respondents, only 45 percent agreed that the system is being maintained. The rest of them did not observe any evidence for the maintenance. Most of the respondents were of the view that the government conducted maintenance operations, but 21 percent said that the farmers conducted maintenance of the drainage system.

Maintenance of the irrigation system at the watercourse level is concerned with farmers, whereas secondary channels are the responsibility of government agencies. About 7.4 percent of respondents were in favor of the excavation of the secondary channels being conducted after 1 to 2 years. About 20 percent, 17 percent and 27 percent of respondents were in favor of the excavation of the secondary channels after 3, 4 and 5 years, respectively. Only 6, 4, 3, 8, 1 and 1 percent of respondents favored excavation after 6, 7, 8, 10, 12, 15 and 25 years of desilting intervals, respectively.

Most respondents would be satisfied if maintenance of the secondary channels was undertaken every 4 to 6 years. However, the quality of maintenance remains questionable as excavations do not cover the entire length of the channels. Moreover, excavations are not wilfully conducted, but occur at the behest of informal pressures from influential landowners who are mostly in the head reaches of the system. Accordingly, the tails of the distributaries and minor canals are seldom maintained, and that too with the mutual cooperation of the tail-enders.

The excavation of the secondary channels was, mostly, not conducted during the annual water closure period, especially in the peak transplantation period.

Maintenance of the watercourses was conducted by about 99 percent of the respondents, but the frequency of cleaning the watercourses varied. About 74.2 percent and 25 percent of respondents cleaned the watercourses once, and twice, per year, respectively.

F WATERTABLE DEPTH AND QUALITY

The sample farmers were asked about the watertable condition in the Warah Canal command, and its fluctuations during the year. They were also asked to comment on the quality of the groundwater. Their responses are summarized in Table 19.

The normal watertable depth in the Warah Division appears to be close to 1.1 ft during the kharif season and above the ground surface at times. Rarely, but also goes down to 7.33 ft. Towards the end of the rabi season, the watertable depth reached 8 ft on average, while in some areas it was observed at a minimum of 2 ft and maximum of 20 ft. depth.

When asked about the quality of the groundwater, 31 percent of the respondents found it to be okay. About 9 percent felt that the quality is marginal and about 60 percent felt that the water is unfit for use in irrigating.

Farmers were also asked to comment on the impact of the watertable depth on crops in the rabi season. About 52.8 percent and 33.5 percent were of the view that the impact is highly negative and negative, respectively, while the remaining perceived negligible or no impact. In the kharif season, 45.1 percent and 41.9 percent of respondents were of the opinion that there is a highly negative and negative impact, respectively. The remaining percentage expressed negligible or no impact on crops.

Table 19. Watertable Depth and Groundwater Quality within the Warah Branch Command.

Sub-division Indicators	Madeji	Miro Khan	Warah	Average
Watertable (Lowest) Ft				
Average	1.3	1.0	1.0	1.1
Minimum	0.0	0.0	0.0	0.0
Maximum	8.0	8.0	6.0	7.33
Watertable (Highest) ft				
Average	10.0	7.0	7.0	8.0
Minimum	3.0	1.0	2.0	2.0
Maximum	25.0	15.0	20.0	20.0
Quality (%)				
o.k	80.3	11.4	2.6	31.4
Marginal	10.5	11.4	4.4	8.8
Unfit	9.2	77.2	93.0	59.8

G IRRIGATION PRACTICES

1). Rice

Rice is the major crop grown extensively in the Warah Canal Command during the kharif season, i.e., from May to October. The total farm area, cultivated and rice areas of the sample farms are shown in Table 20.

Currently, rice is the most popular crop and is being grown on 91 percent of the cultivated area of the sample farms. Most farmers grow the IRRI-6 variety. However, some farmers do grow *basmati*, colonel and other varieties as well. The different rice varieties, and areas sown under them, are shown in Table 21.

Table 20. Area under Rice Crop on Sample Farms (hectares).

Sub-division Areas	Madeji	Miro Khan	Warah	Average
Farm Area	1590	2205	2588	6383
Cultivated Area (Kharif)	1287	1757	1650	4694
Rice Area	1205	1727	1346	4278

Table 21. Rice Varieties in Percent Area on Sample Farms.

Sub-division Description	Madeji	Miro Khan	Warah	Average
IRRI-6	90	68	90	83
Basmati	1	27	8	12
Colonel	0	2	0	1
Others	2	1	2	1
Mix	7	2	0	3

The farmers start preparing seedlings as and when the canal water supply becomes available. Therefore, canal water availability (timing as well as adequacy) plays a crucial role in the crop cycle in the Wara Canal command. The information collected regarding sowing dates of the rice crop is summarized in Table 22.

Table 22. Sowing Dates for Rice Seedlings in the Warah Branch Command.

Sub-division Sowing Date	Madeji	Miro Khan	Warah	Average
Average	21st June	2nd July	13th July	2nd July
Earliest	31st May	31st May	1st June	31st May
Late	7th Aug	31st Aug	7th Sep	7th Sep

The sowing dates are very related to the location of the farm in the system. This means that the water goes down the system only after meeting the requirements of the head areas. This implies that the operational control is almost non-existent.

The farmers transplant seedlings to the fields about one month after sowing. Transplanting seedlings generally starts from the first week of July and continues to the end of August. The belief is that the rice crop yields better in both quantity and quality when transplanted between July 1st and 15th when compared to other periods. Farmers believe that the late transplantation attracts insect attacks.

The depth of standing water in the rice fields varies between 5 to 20 centimeters to protect against weed growth. The depth of water maintained also reflects indirectly upon the availability of water on sample farms, date of last watering, and harvesting dates and yields.

The farmers' response to the cultivation practices for the rice crop are summarized in Annexure-VI.

There appears to be a big gap between the minimum and maximum rice yields obtained in the Warah Canal command at present. This gap is considered to be the result of several factors in which irrigation water plays the major role. The key reasons for low yields of rice were reported to be shortage of water, late sowing, improper applications of inputs, pest attacks due to late sowing, etc.. In the tail areas of the Warah Canal, considerable proportions of rice sown late (40 to 45%) does not ripen due to low temperatures, and is used as fodder. Therefore, the conclusion is that the improvement of operations of the Warah Canal can contribute substantially to fill this gap.

A vast majority of the sample farmers were not satisfied with the present status of their rice yields. They consider the yields low, and primarily relate this to irrigation water availability.

2). Wheat

Wheat is the second major crop after rice, which is also extensively grown in the Warah Canal command during the rabi season (i.e. from November to April). Wheat is grown in the same fields where rice is grown to make use of the residual moisture available in the soil. The main varities being cultivated in the area are Maxi Pak, Sindhi (local variety), 711, TJ 83, and Sar Sabz. The sowing starts in November and continues until the end of January. The harvesting starts from first week of April and continues until first week of May. The number of irrigations applied to wheat ranges from zero to three.

The important characteristics of wheat farming are summarized in Tables VI-6 to VI-11 of Annexure-VI. A vast majority of the sample farmers were not satisfied with the present status of their wheat yields (vary from 80 to 1280 kgs per hectare). They consider it low and primarily relate this to irrigation water availability.

H FARMERS' PARTICIPATION

Farmers manage the best, operated irrigation systems in the world, not government agencies (Skogerboe and Merkly, 1996). The sample farmers were asked about their views to participate in the process of O&M of the Warah Canal command. Particularly, they were asked about the kinds of benefits they can expect, and what are their real constraints. Their responses are summarized in Table 23.

Table 23. Opportunites for Farmers' Participation in the Management of Irrigation and Drainage System within the Warah Branch Command (figures represent percentage of respondents).

Benefits	Madeji	Miro Khan	Warah	Average
Benefits				
To Solve Water Shortage Problems	20.0	15.4	27.1	20.8
Proper Management, Yield Improvements and Equity	36.7	19.8	21.5	26.0
Control Conflicts	0.0	3.3	0.0	1.1
Agricultural Inputs	1.7	1.1	0.0	0.9
Developing Unity	6.7	4.4	1.9	4.3
Proper Tax Collection	3.3	2.2	0.9	2.2
Solving Agricultural Problems	30.0	44.0	43.0	39.0
Getting Help from Agricultural Agencies	1.7	9.9	5.6	5.7
Constraints				
Selfishness/ No Need	70.6	61.9	14.3	48.9
Illiteracy	5.9	4.8	28.6	13.1
No Interest Due to Poverty	5.9	19.0	0.0	8.3
Conflicts Raised Due to Big Landowners	5.9	14.3	42.9	21.0
Existing Organizations Are Solving Problems	5.9	0.0	14.3	6.7

IV CONCLUSIONS

Based on the information presented and discussed in the previous chapters, the following preliminary conclusions can be reached:

- There are serious deficiencies in the operations of the Warah Branch Canal, which need to be addressed in addition to the physical improvements carried out recently.
- These deficiencies can only be addressed if farmers are encouraged to participate at various levels, and their meaningful representation can be ensured in canal operations.
- The yields of both major crops are low and have considerable potential for improvement.
- The Warah Branch Canal operations, in support of farmers' irrigation practices, can ensure achieving this potential substantially.
- Farmers are willing to participate and contribute on the condition that they should be properly informed, encouraged and supported to increase their crop yields.

REFERENCES

Skogerboe, G. V. and Merkley G. P. 1996 Irrigation Maintenance and Operations Learning Process. Water Resources Publications, LLC. Colorado, U.S.A.

ANNEXURES

ANNEXURE I. THEORY OF CANAL OPERATIONS AND MAINTENANCE

Operations of a canal system mainly deal with the delivery of water to the secondary (branch, distributary and minor canals) and tertiary (watercourses) channels. The key objective is to ensure that sanctioned irrigation supplies are delivered to the farms on time, especially as water is translated into crucial agricultural produce.

A. Canal Operations

Canal operations may be defined as the control and regulation of canal structures to realize desired/sanctioned discharges and water levels in the entire canal system. There are three common types of canal operations, as described below.

Regressive

The regressive system mines out the physical system. The canal laterals and appurtenant structures are, generally, in poor conditions. As could be expected, there is little planning inherent in this type of operation, and the service to water users is generally inequitable and unreliable.

Static

A static operation may be characterized as one that limits the system's deterioration, but is unable to implement improvements in facilities or services. This may be a perfectly acceptable type of operation for short-term use, or for a system in such good condition that further improvements would bring only marginal benefits. Many progressively managed systems have undergone periods of difficulty to manage their existing operations due to adverse economic factors. Under the circumstances, services to water users may range from indifferent to reasonably good.

Progressive

Efficiency and competency characterizes a progressive operation. The distribution and drainage systems are open, weed free, and in good repair. Structures are in good conditions and are repaired, or replaced, on regular bases. Needless to say, a great deal of planning goes into a progressive operation. For the long-term period, a progressive operation brings the largest return for the money invested.

B. Delivery Modes

There are several operating modes used to manage canal systems. The two most common are:

Continuous Flow

Enough water in the river means that all the canals run continuously up to their design discharges. This is generally possible during the summer months.

Proportional Flow

This applies when flow in the river, which is not enough to run the main canal at authorized full supply discharge, can be reduced by some proportion. One variation of this is to reduce all canal discharges by equal proportions.

Rotational Flow

In this system available water is delivered to one, or more, distributary canals according to a rotation. During this rotation, a canal is totally closed for pesticides period of time before its full supply discharge. The delivery periods frequently extend to multiples of seven days.

Demand Deliveries

When farmers occasionally request additional amounts of water, or ask for reductions, in delivery to a distributary canal.

C. Regulation System

The regulation system refers to the supply controlled through canal regulators and cross regulators.

Canal Head Regulators

A regulator that controls supplies entering a main canal from a river a head regulator. A number of spans many be separated by piers and operated by gates that are similar to those of a barrage. Head regulators allow the easy regulation of supplies in the canals as well as the control of silt entry.

Cross Regulator

A regulator on a main canal that raises the canal water surface by using gates to feed off-taking channels is a cross regulator. A cross regulator helps absorb fluctuation in water supply to the canal system and offers some immediate relief during emergencies.

Outlets

These small structures admit water from the canal (distributaries, minors, and rarely, main canals) to watercourses used to irrigate lands. The responsibility for maintenance of outlets rests with the government. However, the maintenance of the watercourses downstream of these outlets is the responsibility of the farmers who use these.

D. Canal Maintenance

Canal maintenance is the continuous process of repairing, or servicing, the canal prism, embankments and appurtenant structures to conform to canal maintenance standards. Canal standards are designed to keep the canal in what is described as an "as-built" condition. Because canals carry moving water containing sediment, and because embankments are exposed to weather and animal and human activities, some leeway is allowed with regard to

practical and economic considerations. A primary consideration is to utilize cost effective procedures. An effective maintenance program includes the following components.

Routine Maintenance

Routine maintenance comprises those tasks that must be performed on a daily, or weekly, basis by an individual who does not require check sheets. Particularly, it is applicable to embankment maintenance work such as vegetation control, raincut repairs and berm cutting by groins and lubrication of gates and painting hoists, etc.. As will be noted below, many similarities exist between routine and preventive maintenance.

Preventive Maintenance

Preventive maintenance can consist of an effective, but simple, method of scheduling the work at specific intervals, keeping records of inspections and repairs, and using a checklist to ensure that the inspection and work meet certain specified standards. In the canal maintenance program, preventive measures are particularly well suited for maintenance of structures and related mechanical equipment. A preventive maintenance program should be mandatory for the maintenance of equipment and vehicles.

Seasonal Maintenance

Seasonal maintenance includes works such as grading inspection paths, repairing animal crossings and large scale raincuts and groin programs. Gradually, seasonal work is accomplished under force account procedures using casual labor.

Annual Maintenance

Annual maintenance refers to major work tasks or programs that are scheduled ahead of time. These include works that are located in the canal prism and must be carried out during the closure periods. Annual maintenance also refers to tasks that are carried out over all the years such, as the freeboard restoration program.

Annual maintenance is distinguished from routine activities by its greater cost, complexity, and equipment requirements. Annual maintenance is separated from seasonal work. Although many annual maintenance programs have been accomplished with crew labor, it is often more cost effective to include equipment in order to ensure that soil compaction specifications and other criteria are met, or exceeded. Annual maintenance work is scheduled for specific canal reaches.

Unscheduled Maintenance

These activities originate due to weather, or other unpredictable causes. Unscheduled maintenance requires unforeseen and unscheduled repairs, but must be performed quickly to return the system to normal operation.

Next >>

Emergency Maintenance

Emergencies, such as breaches, result from deferred maintenance, error in operation of water control structures, unusual weather occurrences, or unnoticed burrowing by rodents. Because its occurrence and severity cannot be predicted, contingency funds are held in reserve to cover the cost of these repairs. Emergency repairs must be carried out immediately to contain the damage and to prevent additional losses. Emergency repairs differ from unscheduled maintenance in the degree of damage, and because damage extends beyond the irrigation system.

ANNEXURE II. CHARACTERISTICS OF THE WARAH BRANCH CANAL SYSTEM

Table II-1 System-Level Components of the Warah Branch Canal Command.

Off-taking canal	: North West Canal
Off-taking R.D	: 82.5
Total length of canal	: 348 RDs
Designed discharge	: 176 cumecs
Number of sub-divisions	: 3
Number of branch canals	: 2
Number of distributaries	: 15
Number of minors	: 30
Length of secondary channels	: 1123 RD (342 km)
Number of watercourses	: 1033
Number of X-regulators	: 9
Geographical area	: 135,191 ha
GCA	: 130,876 ha
CCA	: 126,590 ha
MCA	: 128,060 ha

Table II-2. List of Cross Regulators along the Warah Branch Canal.

S.#.	NAME OF CROSS REGULATORS
01	Head Regulator
02	Gahija Regulator
03	Tarai Regulator
04	Salar Regulator
05	Khairo Dero Regulator
06	Shah Pur Regulator
07	Hakim Shah Regulator
08	Dost Ali Bungalow Regulator
09	Ghari Kartio Regulator
10	Gul Regulator

Table II-3. Physical Characteristics of the Warah Branch Canal Distribution System.

	CANAL	Watercourse No.	Discharge (cumecs)	Gross Area (ha)	Commanded Area (ha)	Culturable Commanded Area (ha)
1	Warah Branch	121	1951	59075	46800	47351
2	Gaheja Distry	23	45.60	5007	4720	4952
3	Kalhora Minor	20	20	3252	3110	3225
4	Palija Minor	4	2.66	1346	1260	1306
5	Tarai Distry	12	12.32	2998	2820	2933
6	Drakhan Branch	47	282.07	9097	8800	9017
7	Buxio Minor	14	54.56	3935	3710	3883
8	Faiz Minor	14	34.61	2131	2010	2131
9	Taib Minor	17	34.61	1960	1840	1960
10	Wasand Distry	9	72.33	6171	5950	6144
11	Nazar Distry	10	58.32	5225	4930	5186
12	Sadhayo Minor	14	18.10	2924	2860	2907
13	Unar Distry	32	49.70	1857	1750	1857
14	Kado Minor	6	21.99	2154	2070	2146
15	Zangeja Minor	16	20.11	1203	1120	1203
16	Akil Distry	42	76.70	18662	9400	10201
17	Ali Sher Distry	42	83.91	8382	7460	7676
18	Ahmed Minor	15	18.07	1711	1650	1711
19	Juneja Minor	15	17.77	3072	2420	2695
20	Chandia Minor	6	11.56	897	770	897
21	Allah BuxMinor	29	32.64	9899	8650	8887
22	Shah Ali Minor	16	25.37	1696	1490	1596
23	Tharo Minor	11	5.91	2440	2290	2415
24	Pir Bux Minor	6	16.13	1986	990	1083
25	Kurdato Minor	28	41.94	7896	7490	7596
26	Thul Distry	42	114.54	18972	18750	18943
27	Mohat Minor	20	49.16	4075	3550	3691
28	Chhori Branch	10	182.53	3485	3310	3443
29	Chhori Distry	34	93.97	13015	12750	12925
30	Gopang Distry	19	72.07	4667	4480	4646
31	Menhal Minor	12	30.13	1962	1820	1903
32	Buthai Minor	4	6.89	1276	1160	1272
33	Qaim Minor	7	7.87	3530	3440	3522
34	Panwharo Minor	61	128.16	26695	22990	23125
35	Murad Ali Minor	5	11.84	787	710	787
36	SeulemanMinor	31	42.96	10286	9920	10259
37	Kamal Minor	5	30.7	1491	1180	1229
38	Supra Minor	6	12.33	11564	11110	11364
39	Bhangar Minor	8	14.01	3482	3140	3250
40	Kanwar Distry	38	77.93	13935	13080	13889
41	Punna Distry	51	84.04	15559	14100	14760
42	Tunia Minor	7	8.08	2074	1960	2026
43	Nasir Distry	42	57.02	16805	16200	16787
44	Nawab Distry	37	57.02	11698	11100	11449
45	Hamid Minor	17	22.06	4572	4490	4572
46	Hamal Rabi	2	7.80	1550	1250	1358
47	Mirpur Minor	3	7.26	1354	1260	1331
48	Garhi Minor	3	59.82	3320	3260	3319

Table II-4. Details of Distributaries and Minors on the Warah Branch Canal.

S#	Channel	Parent Channel	Irrigation Status	Off-take (RD, ft)	Length (RD, ft)	Discharge (cumecs)	
						Design	Actual
1	Warah Branch	Warah Branch	Perennial	Head	348	1950	3900
2	Gaheja Distry	- do -	Perennial	4600	29	45.60	68.0
3	Kalhora Minor	Gaheja Distry	N.P	9600	20	20.0	30.0
4	Paleja Minor	Uner Distry	N.P	2000	4	2.66	4.0
5	Tarai Distry	Warah branch	P	69000	17.6	12.32	17.6
6	Drakhan Branch	- do -	N.P	69000	54	282.07	423
7	Buxio Minor	Drakhan Brch	N.P	6500	19	51.56	77
8	Faiz Minor	- do -	N.P	9000	18	34.61	52
9	Taib Minor	- do -	N.P	9000	5.5	34.61	52
10	Wasand Distry	Warah Branch	N.P	8000	53	72.33	108
11	Nazar Distry	- do -	P	8000	37.5	58.32	87
12	Sadhayo Minor	- do -	P	8000	14.7	18.10	27
13	Unar Distry	- do -	P	12000	10.6	49.70	75
14	Kado Minor	- do -	P	28000	40	21.99	33
15	Zangeja Minor	Unar Distry	N.P	2000	6.3	20.11	30
16	Akil Distry	Warah Branch	P	134000	48	76.70	115
17	Ali Sher Distry	- do -	P	134000	51	83.91	126
18	Ahmed Minor	Akil Distry	N.P	2550	18.6	18.07	27
19	Juneja Minor	Warah Branch	P	134500	33	17.77	27
20	Chandia Minor	- do -	N.P	134500	19.8	11.56	18
21	Allah Bux Minor	- do -	P	185500	21	32.64	49
22	Shah Ali minor	- do -	N.P	185500	11	25.37	38
23	Tharo Minor	- do -	P	187500	11	5.91	9
24	Pir Bux Minor	- do -	N.P	215000	8	16.13	24
25	Kurdato Minor	- do -	P	217000	28.7	41.94	63
26	Thul Distry	- do -	P	227300	40.8	114.54	172
27	Mohbat Minor	Thul Distry	N.P	25510	20	49.16	74
28	Chhori Branch	Warah Branch	N.P	227000	36	93.97	141
29	Chhori Distry	ChhoriBranch	N.P	28010	36	93.97	141
30	Gopang Distry	- do -	N.P	28010	23	72.07	108
31	Menhal Minor	- do -	N.P	1800	12	30.13	45
32	Buthi Minor	Warah Branch	P	238000	6	6.89	10
33	Qaim Minor	- do -	P	254000	6.5	7.87	12
34	Panwharo Distry	- do -	P	266000	75.7	128.16	192
35	Murad Ali Minor	- do -	P	266000	11.65	11.84	18
36	Suleman Minor	- do -	P	266000	44.4	42.96	64
37	Kamal Minor	- do -	P	266000	10	23.7	36
38	Supra Minor	- do -	P	263000	5.6	12.33	18
39	Bhangar Minor	- do -	P	297000	8.9	14.01	21
40	Kanwar Distry	- do -	P	309000	57	77.93	117
41	Punna Distry	Warah Branch	P	309000	55.2	84.04	126
42	Tunia Minor	- do -	P	3200	11	8.08	12
43	Nasir Distry	- do -	P	348000	57.55	57.02	86
44	Nawab Distry	- do -	P	348000	45.1	57.02	86
45	Hamid Minor	Nasir distry	P	20000	42.65	22.06	33
46	Hamal Rabi	Hamid Minor	N.P	----	1.7	7.80	12
47	Mirpur Minor	Nasir Distry	P	54000	1.7	7.26	11
48	Garhi Minor	Nawab Distry	P	31000	20.8	59.82	90

Perennial = P, Non-perennial = N.P, Distry = Distributary

ANNEXURE III. LAND USE AND CROP SUITABILITY RANKINGS

Land Use Suitability Rankings:

Class SI: Highly suitable (without significant limitations for a given use)
Class SII: Moderately suitable (with moderate limitations)
Class SIII: Marginally suitable (with severe limitations)
Class VI: Currently unsuitable
Class VII: Permanently unsuitable (with severe limitations that make it impossible to change the conditions to an "S" class for a given use.

Crop Suitability Rankings:

Suitability class 1: Well suited:
For the crop under consideration, the soil has favorable physical, chemical and drainage characteristics; a favorable climate during growing season; and is responsive to good management. Under traditional management, the crop grows well and gives moderate to good yields. Under modern management, the crop would produce high, or very high, yields.

Suitability class 2: Moderately suited.
For the crop under consideration, the soil has somewhat unfavorable physical, chemical or drainage characteristics; a medium or low fertility holding capacity; somewhat unfavorable climate; or response to management is moderate. Under traditional management, the crop produces poor to moderate yields, or is subject to occasional hazards of failure. Under modern management, the crop yields would be moderate to high.

Suitability Class 3: Poorly suited.
For the crop under consideration, the soil has unfavorable physical, chemical and drainage characteristics; low fertility-holding capacity; unfavorable climate; and response to management is low. Under traditional management, the crop would give poor yields, or would be subject to great hazard of failure.

Intensive modern management, together with major expenditure on drainage and /or correction of unfavorable soil conditions would be required for the crop to give moderate to high yields. If the climate is unsuitable, high yields cannot be obtained. Generally, the crop must be considered as marginal and is not recommended for the soil under consideration.

Suitability Class 4: Unsuited.
The soil has severe physical chemical drainage or climate limitations. Under traditional management, little, if any, produce may be expected from the crop. Only with prohibitively high expenditure for major improvement or special management could moderate crop yields be produced in some cases. This, however, would be uneconomic, on the basis of field observations, the experience of progressive farmers and findings of the agricultural research stations.

ANNEXURE IV. QUESTIONNAIRE FOR O&M PRACTICES ON THE WARAH BRANCH CANAL

1. Date
2. Sample number
3. Respondent name
4. Village
5. Deh
6. Taluka
7. District
8. Distributary Name & Location
9. Watercourse No. & Location
10. Watercourse Lined (yes, number, length in meters)
11. Land holding, size and location
12. Status (owner/owner-operator/tenant/lessee/manager/other
13. Cultivated land (acres)

Rabi Crops	Area (acres)	Yield (kg per acre)

Kharif Crops	Area (acres)	Yield (kg per acre)

14. Rice
    a. Variety
    b. Time of Sowing
    c. Time of Harvesting
    d. Depth of Standing Water
    e. When was Last Watering
    f. Yield Level (very low/low/satisfactory
    g. How to improve yield (R)

15. Wheat
    a. Variety
    b. Time of Sowing
    c. Time of Harvesting
    d. No. of Irrigation turns
    e. Timing of Irrigation turns (Ist-3rd)

f. Time to irrigate one acre
g. Level of yield (very low/low/satisfactory)
h. How to improve yield (W)

16. Canal Water Supply

Kharif Start..... End.....
On time .....
Weeks Late
Sufficent / Insufficient .....%
Rabi Start..... End.....
On time..... Weeks Late.....
Sufficent/Insufficent .....%

17. How to Improve Canal Water Supply

18. Water Distribution
Branch Distribution (equitable/inequitable)
Distributary
Watercourse

19. How to Improve Equity

20. Warabundi Yes/No
If Yes, Explain

21. Maintenance
Desilting of Distributary Yes / No ..... per year
Desilting of Watercourse Yes / No .....per year
Cost of Desilting Watercourse per acre Rs.....

22. Waterlogging
a. Watertable depth in feet lowest....., highest.....
b. Water Quality (fit/Marginal/unfit)
c. Impact on crop yields
Rabi [nil/negligible (<10%)/negative (10-25%)/highly negative (> 50%)]
Kharif
d. If watertable is very high, what measures should be taken

23. Salinity
a. Do you have salinity problem? Yes / No
b. Impact on crop yields
Rabi [nil/negligible (<10%)/negative (10-25%)/highly negative (> 50%)]
Kharif
c. If salinity is a problem, what measures should be taken?

24. Tubewell
    a. Number of Tubewells on your watercourse
    b. Tubewell Ownership (public/private)
    c. Working Condition
    d. Approximate working hours, Kharif..... Rabi.....
    e. Purpose of Tubewell (irrigation/drainage/both)
    f. Maintenance Cost
    g. Sharing of Maintenance Cost

25. Drain
    a. Presence of a Drain (Yes/No)
    b. Working Condition of the Drain
    c. Maintenance of Drain (Yes/No)
    d. Cost of Maintenance
    e. Sharing of Cost
    f. Controls Watertable Yes/No ....., satisfactory/un-satisfactory
    g. Effect on Crop Yields Yes/No
    h. Willingness to Share O & M (Yes/No)

26. Interest and Participation in Farmers' Organizations
    a. Is there any Association (Yes/No)
       If yes, give the Name and Purpose
    b. Irrigation and Drainage are Included (Yes/No)
    c. How to Manage Irrigation and Drainage (individually/collectively)
    d. Do you feel the need for an organization (Yes/No)
    e. Why?

27. Taxes
    a. Water Charges ..... b. Land Charges....
    c. Ushar..... d. Agricultural Tax.....
    e. Drainage Cess ..... f. Tubewell Charges
    g. Local Cess..... h. Others
    Total .....

28. Agricultural Services
    a. Do you receive extension messages? Yes / No
    b. Have you got your W/C lined? Yes / No
    c. Do you get good quality seed? Yes / No
    d. Do you get good quality fertilizer? Yes / No
    e. Do you get good quality pesticides? Yes / No

29. Are you willing to replace rice crop? Yes / No
30. Crop Preferences
31. Key Constraints
32. Key Interventions for Improving O&M

ANNEXURE V. SAMPLE FARMERS

SURVEY OF O&M AT WARAH BRANCH

MEERO KHAN SUB DIVISION

SAMPLE NO	FARMER NAME	VILLAGE
NW 25-A	MUHAMMAD BUDHAL	DAO KALHORO
NW 25-B	MOHD. SALEH KALHORO	DAO KALHORO
NW 44-A	MOHD. YUNIS MASTOI	QUBO BALOCH KHAN
NW 44-B	GHULAM MUSTAFA MASTOI	QUBO BALOCH KHAN
NW 45-A	MOHD. MALOOK JAGEERANI	HAJI ALI NAWAZ
NW 45-B	AHMED NAWAZ JAGEERANI	HAJI ALI NAWAZ
NW 46-A	JUMAN KHAN JATOI	BANO JI WAANDH
NW 46-B	GHULAM MUSTAFA SHAR	BANO JI WAANDH
NW 50-A	NAUREZ ALI BROHI	HAKUMDAD BROHI
NW 50-B	UDHAL KHAN BROHI	HAKUMDAD BROHI
NW 51-A	KHALIL AHMED BROHI	BADALABAD
NW 51-A	JUMA KHAN BROHI	BADALABAD
NW 52-A	BADARUDDIN GOPANG	MANJHEE GOPANG
NW 52-B	ABDUL GHANI GOPANG	MANJHEE GOPANG
NW 53-A	QAZI BAGAN	QAZI
NW 53-B	DILSHAD ALI QAZI	QAZI
OM 38-A2	MOHD. ASLAM LAGHARI	SAINDAD LAGHARI
OM 38-B2	SAINDAD LAGHARI	SAINDAD LAGHARI
OM 39-A	SHAHNAWAZ DEENARI	MEHBOOB JO BUNGALOW
OM 39-B	QALAB HUSSAIN SANGI	MEHBOOB JO BUNGALOW
OM 40-A	GHAZI KHAN LASHARI	NANGAR SANGI
OM 40-B	MOULA BUX LASHARI	NANGAR SANGI
OM 41-A	M. QABOOL JATOI	HASSAN JATOI
OM 41-B	M. MURAD JATOI	HASSAN JATOI
OM 43-A	M. USMAN CHANDIO	DIBH CHANDIO KHAN
OM 43-B	GHULAM M. CHANDIO	DIBH CHANDIO KHAN
OM 44-A	SAIFULLAH JATOI	DARYA KHAN JATOI
OM 44-B	ABDUL MAJEED JATOI	DARYA KHAN JATOI
OM 45-A	ABDUL NABI GOPANG	ALI SHER GOPANG
OM 45-B	KHAN M. GOPANG	ALI SHER GOPANG
OM 46-A	M. YOUSUF BHUTTO	MEHMOOD ABAD
OM 46-B	SHABIR AHMED BHUTTO	MEHMOOD ABAD
OM 47-A	M. PANAH KORAI	SAHAB KHAN
OM 47-B	ALI MURAD KORAI	SAHAB KHAN
OM 48-A	GHULAM ALI LASHARI	ALI JI WAANDH
OM 48-B	CHAKAR KHAN MAGSI	ALI JI WAANDH
OM 49-A	ALI MARDAN LAGHARI	LAL BUX LAGHARI
OM 49-B	GHULAM SARWAR LAGHARI	LAL BUX LAGHARI
OM 50-A	NOOR M. CHANDIO	ALLAHYAR MASTOI
OM 50-B	SHAUKAT ALI CHANDIO	ALLAHYAR MASTOI
OM 52-A	SADA HUSSAIN KHOKHAR	SHAHPUR KHOKHAR
OM 52-B	HIMAT ALI KHOKHAR	SHAHPUR KHOKHAR
OM 53-A	M. PINJIAL BARAACH	THARO PURANO

OM 53-B	JAN MOHD. BARAACH	THARO PURANO
OM 54-A	M. AYOOB GOPANG	JALAL GOPANG
OM 54-B	TALIB HUSSAIN GOPANG	JALAL GOPANG
OM 55-A	HAJI AALAM LASHARI	GUHRAM LASHARI
OM 55-B	HAJI SOOMAR LASHARI	GUHRAM LASHARI
OM 56-A	MUNIR HUSSAIN TUNIO	MEHBOOB TUNIO
OM 56-B	UBEDULLAH TUNIO	MEHBOOB TUNIO
OM 57-A	M. SALEH MASTOI	SIRAI KHADIM
OM 57-B	M. SHARIF MASTOI	SIRAI KHADIM
OM 58-A	GUL BAHAR MAGSI	GHULAM RASOOL
OM 58-B	GHULAM MUHAMMAD	GHULAM RASOOL MAGSI
OM 59-A	HAMZO KHAN LAGHARI	SARDAR MEHRULLAH
OM 59-B	ZAFARULLAH BROHI	SARDAR MEHRULLAH
OM 60-A	MULLAH FAIZ MUHAMMAD	MULLAH FAIZ MUHAMMAD
OM 60-B	ABDUL KHALIQ BROHI	MULLAH FAIZ MUHAMMAD
OM 73-A	UBEDULLAH SOLANGI	MEERAN MACHI
OM 73-B	MUHAMMAD ALI SOLANGI	MEERAN MACHI
OM 74-A	PEERAL CHANDIO	DOST ALI
OM 74-B	SHER BAIG CHANDIO	DOST ALI
OM 75-A	ABDUL KHALIQ MAGSI	KHABBAR
OM 75-B	AZIZULLAH MAGSI	KHABBAR
OM 76-A	QAIM KHAN MAGSI	QAIM KHAN
OM 76-B	ABDUL GHANI MAGSI	QAIM KHAN
OM 77-A	DAADAN KHAN CHANDIO	MUHAMMAD BUX CHANDIO
OM 77-B	WAZIR KHAN CHANDIO	MUHAMMAD BUX CHANDIO
OM 78-A	ABDUL JABBAR CHANDIO	RAPP WATOO KHAN
OM 78-B	SHAHMIR KHAN CHANDIO	RAPP WATOO KHAN
OM 79-A	MIR GUL KHOSO	ABDUL HAQUE KHOSO
OM 79-B	MANZOOR KHOSO	ABDUL HAQUE KHOSO
OM 80-A	PIRAL KHAN KHOSO	KEVAL JO TAK
OM 80-B	AZIZULLAH MAGSI	KEVAL JO TAK
OM 81-A	ABDUL AZIZ JANWRI	ALI MUHAMMAD JANWRI
OM 81-B	ABDUL HAQ JANWRI	ALI MUHAMMAD JANWRI
OM 82-A	SUHBAT ALI CHANDIO	KHAIRO GADHI
OM 82-B	ALI HASSAN CHANDIO	KHAIRO GADHI
OM 83-A	QALANDAR BUX MAGSI	MUHAMMAD RAFIQ
OM 83-B	RAZA M. MAGSI	MUHAMMAD RAFIQ
OM 84-A	LUTUF ALI JANWRI	TEJO KHAN
OM 84-B	SAIN RAKHIO JANWRI	TEJO KHAN
OM 85-A	HAJI KHAN PATOOJO	NIAZ HUSSAIN KHOSO
OM 85-B	AHMED KHOSO	NIAZ HUSSAIN KHOSO
OM 86-A	ABDUL REHMAN MAGSI	DEENO KOTHO
OM 86-B	IMDAD ALI MAGSI	DEENO KOTHO
OM 87-A	ANWAR SOOMRO	M. AMIN MENGAL
OM 87-B	KARIM BUX BROHI	M. AMIN MENGAL
OM 88-A	GHULAM HAIDER MAGSI	KANDI
OM 88-B	MUHEEM KHAN MAGSI	KANDI
OM 89-A	ALI JAN MAGSI	CHAAKAR SULTAN

OM 89-B	DEEDAR ALI MAGSI	CHAAKAR SULTAN
OM 91-A	ABDUL QAYOOM KHOSO	M.YAQOOB KHOSO
OM 91-B	MUHAMMAD YAQOOB KHOSO	M.YAQOOB KHOSO
OM 92-A	ABDUL SATTAR KHOSO	SUHNO KHOSO
OM 92-B	SUHNO KHAN KHOSO	SUHNO KHOSO
OM 93-A	SAIFAL MAGSI	SAIFAL MAGSI
OM 93-B	AHMAD KHAN	SAIFAL MAGSI
OM 94-A	M.MURAD HEESBANI	VEERAN KHAN
OM 94-B	RAIS VEERAN KHAN	VEERAN KHAN
OM 95-A	ABDUL MAJEED HAKRO	BATHI HAKRA
OM 95-B	QAZI SAADULLAH HAKRO	BATHI HAKRA
OM 96-A	ROZI KHAN CHANNA	SHAH MUHAMMAD
OM 96-B	ALI GOHAR KHOSO	SHAH MUHAMMAD
OM 97-A	ABDUL LATIF BROHI	FIDA HUSSAIN
OM 97-B	RASOOL BUX BROHI	FIDA HUSSAIN
OM 98-A	MUHAMMAD ALAM BROHI	GUL M. BROHI
OM 98-B	GUL MUHAMMAD BROHI	GUL M. BROHI
OM 99-A	MOULA BUX MAGSI	M. NAWAZ MAGSI
OM 99-B	GUL HASSAN MAGSI	M. NAWAZ MAGSI
OM 100-A	ABDUL HAQ GOPANG	UMAR GOPANG
OM 100-B	NASRULLAH BROHI	UMAR GOPANG
OM 134-A	ALI MURAD BROHI	SHER M.BROHI
OM 134-B	SHER MUHAMMAD BROHI	SHER M.BROHI

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DEH	TAL	DIST	DISTY	LOC	W/C	LOC	LIN
KALAR DARO	4	2	KOOR DATO	2	7-L	1	0
KALAR DARO	4	2	KOOR DATO	2	7-L	1	0
KANDI	4	2	WARAH BRANCH			1	0
KANDI	4	2	WARAH BRANCH			1	0
FATOOHAL	4	2	WARAH BRANCH			1	0
FATOOHAL	4	2	WARAH BRANCH			1	0
LASHKARI	4	2	ALI SHER MINOR	2	4-L	1	0
LASHKARI	4	2	ALI SHER MINOR	2	4-L	1	0
ZAKRYA MAHESAR	3	2	AHMED MINOR	2	5-R	1	0
ZAKRYA MAHESAR	3	2	AHMED MINOR	2	6-R	1	1
JALAL	4	2	WARAH BRANCH			1	1
JALAL	4	2	WARAH BRANCH			1	1
QAIM GOPANG	4	2	CHAORI DISTRY	2		1	1
QAIM GOPANG	4	2	CHAORI DISTRY	2		1	0
KOOR MOHABBAT	4	2	CHAORI DISTRY	2		1	0
KOOR MOHABBAT	4	2	CHAORI DISTRY	2		1	0
JALIL KALHORO	4	2	AQIL HAKRO MINOR	2	8-L	1	0
JALIL KALHORO	4	2	AQIL HAKRO MINOR	2		1	0
M. GUJRANI	4	2	AQIL HAKRO MINOR	2	7-R	1	0
M. GUJRANI	4	2	AQIL HAKRO MINOR	2	6-BR	1	0
NANGAR SANGI	3	2	JUNEJO MINOR	2		1	0
NANGAR SANGI	3	2	JUNEJO MINOR	2	3-AL	1	0
CHUTTO MAHESAR	3	2	QADO MINOR	2		1	0
CHUTTO MAHESAR	3	2	QADO MINOR	2		1	0
DIBH CHANDIO	4	2	AQIL MINOR	2		1	0
DIBH CHANDIO	4	2	AQIL MINOR	2		1	0
FATOOHAR	4	2	WARAH BRANCH			1	0
FATOOHAR	4	2	WARAH BRANCH			2	0
ALI SHER GOPANG	4	2	WARAH BRANCH			2	0
ALI SHER GOPANG	4	2	WARAH BRANCH		181-L	2	0
BELARO	4	2	ALI SHER MINOR	2	9-CR	2	0
BELARO	4	2	ALI SHER MINOR	2	1-DR	2	0
KORAI	4	2	WARAH BRANCCH		RD 158	2	0
KORAI	4	2	WARAH BRANCCH		156-R	2	1
PIR BUX DHORI	4	2	WARAH BRANCH		211-L	2	0
PIR BUX DHORI	4	2	PIR BUX MINOR	2		2	0
THARO WATTO	4	2	THARO MINOR	2		2	0
THARO WATTO	4	2	THARO MINOR	2		2	0
MISRI	4	2	SHAH ALI MINOR	2		2	0
MISRI	4	2	SHAH ALI MINOR	2		2	0
THARO WADHO	4	2	SHAH ALI MINOR	2		2	0
THARO WADHO	4	2	THARO MINOR	2		2	0
ALLAH BUX	4	2	SHAH JI KOOR	2	4-L	2	0

ALLAH BUX	4	2	SHAH JI KOOR	2		2	0
DINGHRI	4	2	SHAH JI KOOR	2	3-R	2	0
DINGHRI	4	2	SHAH JI KOOR	2		2	0
KANDI	4	2	WARAH BRANCH			2	0
KANDI	4	2	WARAH BRANCH			2	1
BUTHI	4	2	PIR BUX MINOR	2	1-R	2	0
BUTHI	4	2	PIR BUX MINOR	2	1-R	2	0
KANDI	4	2	WARAH BRANCH			2	0
KANDI	4	2	WARAH BRANCH			2	0
KANDI	4	2	WARAH BRANCH			2	0
KANDI	4	2	WARAH BRANCH			2	0
THARO WATO	4	2	THARO MINOR	2		2	0
THARO WATO	4	2	WARAH BRANCH			2	0
ALLAH BUX	4	2	ALLAH BUX MINOR	2	2-L	2	0
ALLAH BUX	4	2	ALLAH BUX MINOR	2	2-L	2	0
KOOR ISMAIL	4	2	MEENHAL MINOR	2	1-BL	2	0
KOOR ISMAIL	4	2	MEENHAL MINOR	2	1-CL	2	1
DOST ALI	5	2	GOPANG MINOR	2		2	0
DOST ALI	5	2	GOPANG MINOR	2		2	0
KOOR MOHABBAT	4	2	MOHABBAT MINOR	2	2-BL	2	0
KOOR MOHABBAT	4	2	MOHABBAT MINOR	2	2-L	2	0
RAPP	4	2	MOHABBAT MINOR	2		2	0
RAPP	4	2	MOHABBAT MINOR	2		2	0
DHEERO	6	2	MEENHAL MINOR	2		2	1
DHEERO	6	2	MEENHAL MINOR	2		2	1
PHOLHRO	4	2	THULL MINOR	2	12-DR	2	0
PHOLHRO	4	2	THULL MINOR	2	12-DR	2	0
ALLAH RAKHIO	4	2	THULL MINOR	2		2	1
ALLAH RAKHIO	4	2	THULL MINOR	2		2	1
KALHORA	4	2	QAIM MINOR	2	3-R	2	0
KALHORA	4	2	QAIM MINOR	2	3-R	2	0
KOOR IBRAHIM	4	2	THUL MINOR	2		2	0
KOOR IBRAHIM	4	2	THUL MINOR	2		2	0
KOOR ISMAIL	4	2	CHAORY DISTRY	2		2	0
KOOR ISMAIL	4	2	CHAORY DISTRY	2		2	0
ALLAH RAKHIO	4	2	THUL MINOR	2		2	0
ALLAH RAKHIO	4	2	THUL MINOR	2		2	0
KALHORA	4	2	QAIM MINOR	2	4-R	2	0
KALHORA	4	2	QAIM MINOR	2	1-L	2	0
VEE	4	2	WARAH BRANCH		6-R	2	1
VEE	4	2	WARAH BRANCH		6-R	2	1
JALAL	4	2	WARAH BRANCH			2	1
JALAL	4	2	WARAH BRANCH			2	1
MEHMOO	4	2	WARAH BRANCH			2	0
MEHMOO	4	2	WARAH BRANCH			2	0
KALAR DARO	4	2	KOOR DATO	2	1-L	2	0
KALAR DARO	4	2	KOOR DATO	2	1-L	3	0
KANDI	4	2	KOOR DATO	2		3	0

KANDI	4	2	KOOR DATO	2		3	0
GOLO KHUHAWAR	4	2	KOOR DATO	2	9-L	3	0
GOLO KHUHAWAR	4	2	KOOR DATO	2	9-L	3	0
KALAR DARO	4	2	KOOR DATO	2	6-L	3	0
KALAR DARO	4	2	KOOR DATO	2	6-L	3	0
CHAORI	4	2	THUL MINOR	2	3-R	3	0
CHAORI	4	2	THUL MINOR	2	3-R	3	0
GANWHAR	6	2	THUL MINOR	2		3	0
GANWHAR	6	2	THUL MINOR	2		3	0
KOOR ALI KHAN	4	2	BATHI MINOR	2	2-L	3	1
KOOR ALI KHAN	4	2	BATHI MINOR	2	2-L	3	0
CHHOARI	4	2	CHHAORI DISTRY	2		3	0
CHHOARI	4	2	CHHAORI DISTRY	2		3	0
ALLAH RAKHIO	4	2	WARAH BRANCH			3	0
ALLAH RAKHIO	4	2	WARAH BRANCH			3	0
BAHRAM	4	2	WARAH BRANCH		230-L	3	0
BAHRAM	4	2	WARAH BRANCH		227-L	3	0
GANWHAR	6	2	THUL MINOR	2		3	0
GANWHAR	6	2	THUL MINOR	2		3	0
QAIM	4	2	LUNDI MINOR	2		3	0
QAIM	4	2	LUNDI MINOR	2		3	0
CHHUTO MAHESAR	3	2	JUNEJO MINOR	2		3	0
CHHUTO MAHESAR	3	2	JUNEJO MINOR	2		3	0
						114	
						27	16
	0					62	
	0					25	114
	8					114	
	98						
	2						
	6						
	0						

SURVEY OF O&M AT WARAH BRANCH

MADEJI SUB DIVISION

SAMPLE NO	FARMER NAME	VILLAGE	DEH	TAL
NW 48-A	TAJ MOHD. TUNIO	SAJJAN HAKRO	AAQIL	2
NW 48-B	AMIR BUX	SAJJAN HAKRO	AAQIL	2
NW 49-A	KHUDA DINO JUNEJO	THULL	MUMOO JUNEJO	2
NW 49-B	NAWAB ALI JUNEJO	THULL	MUMOO JUNEJO	2
NW 91-A	NAZIR AHMED KALHORO	KHAN KALHORO	KHAN KALHORO	1
NW 91-B	INAYATULLAH BHATTI	KHAN KALHORO	KHAN KALHORO	1
NW 92-A	MUNNAWAR ALI LASHARI	LASHARI	DAKHAN	1
NW 92-B	MOHD. IBRAHIM LASHARI	LASHARI	DAKHAN	1
NW 93-A	GHULAM MOHD. SANGHROO	HABIB SANGHROO	CHATTO MANGI	1
NW 93-B	RAJAB ALI SANGHRO	HABIB SANGHROO	CHATTO MANGI	1
NW 94-A	AKHTAR HUSSAIN CHANDIO	SAMMAN JUNEJO	JINDO DERO	1
NW 94-B	GHULAM QADIR CHANDIO	SAMMAN JUNEJO	JINDO DERO	1
NW 95-A	MOULA BUX MANGRIO	ARAIN	PALIO KALHORO	1
NW 95-B	SHABIR AHMED BHUTTO	ARAIN	PALIO KALHORO	1
OM 1-A	HIMMAT ALI KHAN KAMARIO	TARAI	TARAI	1
OM 1-B	HAZOOR BUX SOOMRO	TARAI	TARAI	1
OM 2-A	IMDAD HUSSAIM UJJAN	RAMZAN UJJAN	BAKHSHO UJJAN	1
OM 2-B	NUSRAT HUSSAIN	RAMZAN UJJAN	BAKHSHO UJJAN	1
OM 4-A	SIRAJ AHMED JARWAR	KHAN WAH	KHAN WAH	2
OM 4-B	ALI GUL JARWAR	KHAN WAH	KHAN WAH	2
OM 5-A	NADEEM AHMED JALBANI	MASOODERO	MASOODERO	2
OM 5-B	SIKANDAR ALI	MASOODERO	MASOODERO	2
OM 6-A	NAZEER AHMED MANGI	CHATTO MANGI	CHATTO MANGI	1
OM 6-B	ALI NAWAZ MANGI	CHATTO MANGI	CHATTO MANGI	1
OM 7-A	GHULAM MUSTAFA JEHO	SHUMBH	PANJO KENARO	2
OM 7-B	ATTA MOHD. JEHO	SHUMBH	PANJO KENARO	2
OM 8-A	NOOR AHMED ABRO	WASSAYO JEHO	WASSAND JEHO	2
OM 8-B	MOHD. BUX JEHO	WASSAYO JEHO	WASSAND JEHO	2
OM 9-A	MOHD. SALAH DAL	NEW AMROT	MASTI KHAN	1
OM 9-B	GHULAM HUSSAIN DAL	NEW AMROT	MASTI KHAN	1
OM 10-A	AMANULLAH JUNEJO	MIRZAPUR	MIRZAPUR	1
OM 10-B	IJAZ AHMED JUNEJO	MIRZAPUR	MIRZAPUR	1
OM 12-A	RASOOL BUX JAMALI	MITHAL JAMALI		1
OM 12-B	MEENHAL KHAN JAMALI	MITHAL JAMALI		1
OM 13-A	MOHD. PANJAL ABRO	GAHEJA	GAHEJA	1
OM 13-B	MOHD. BACHAL ABRO	GAHEJA	GAHEJA	1
OM 14-A	SHAHNAWAZ MAGSI	JAMIL SIDIQI	MANGIO	1
OM 14-B	ALI MUHAMMAD	JAMIL SIDIQI	MANGIO	1
OM 15-A	HAJI MUSTAFA ABRO	FAQIRPUR	JINDODERO	1
OM 15-B	ABDUL HAMID BROHI	FAQIRPUR	JINDODERO	1
OM 16-A	ALTAF HUSSAIN JAKHRO	SALAAR JAKHRO	JALAL JAKHRO	1
OM 16-B	HIDAYATULLAH JAKHRO	SALAAR JAKHRO	JALAL JAKHRO	1
OM 17-A	GHULAM QADIR BHUTTO	JINDODERO	JINDODERO	1

OM 17-B	QADIR BUX	JINDODERO	JINDODERO	1
OM 18-A	MOHD. ISMAIL KORKANI	MUSHTAQ KORKANI	AAQIL	2
OM 18-B	WATTAR KHAN KORKANI	MUSHTAQ KORKANI	AAQIL	2
OM 19-A	ATTA MOHD. BHATTI	KHAIRODERO	KHAIRODERO	2
OM 19-B	GUL HASSAN MEMON	KHAIRODERO	KHAIRODERO	2
OM 20-A	GHULAM UMMAR ABRO	AGHAM No. 2	MULAAN KALHORO	2
OM 20-B	ALI AKBER ABRO	AGHAM No. 2	MULAAN KALHORO	2
OM 21-A	NADIR ALI BHUTTO	KOT BHUTTO	DODA KHAN	2
OM 21-B	NAZIR AHMED BHUTTO	KOT BHUTTO	DODA KHAN	2
OM 22-A	GHULAM SHABIR BHUTTO	BANGULDERO	BANGULDERO	2
OM 22-B	MUHAMMAD YAQOOB	BANGULDERO	BANGULDERO	2
OM 23-A	NADIR HUSSAIN ABRO	AACHAR FAQIR	SANJAR ABRO	2
OM 23-B	ANWAR ALI ABRO	AACHAR FAQIR	SANJAR ABRO	2
OM 24-A	MUNAWAR ALI KHATIAN	TAQI KHATIAN	PIR BUX	2
OM 24-B	M.UMAR KHATIAN	TAQI KHATIAN	PIR BUX	2
OM 26-A	GHULAM ABBAS SHAH	LOUNGANI	DAKHAN	1
OM 26-B	BASAR SHAH	LOUNGANI	DAKHAN	1
OM 29-A	GHAZANFAR ALI SOOMRO	SAHAB KHAN	SAHAB KHAN	1
OM 29-B	INAM SHAR	SAHAB KHAN	SAHAB KHAN	1
OM 30-A	MUMTAZ ALI JALBANI	YAR MOHD.	DAKHAN	1
OM 30-B	ROSHAN ALI JALBANI	YAR MOHD.	DAKHAN	1
OM 34-A	ALLAH RAKHIO ABRO	PIR CHANDAM	BAKHSHO UJJAN	1
OM 34-B	DOOLH DARYA KHAN	PIR CHANDAM	BAKHSHO UJJAN	1
OM 35-A	GHULAM MUSTAFA	ALI KHAN	ALI KHAN	1
OM 35-B	MUKHTIAR AHMED	ALI KHAN	ALI KHAN	1
OM 36-A	MUZZAFAR HUSSAIN JUNEJO	BAGRA JUNEJO	EHSAN JUNEJO	1
OM 36-B	GHULAM NABI KAKEPOTO	BAGRA JUNEJO	EHSAN JUNEJO	1
OM 37-A	TALIB HUSSAIN CHANDIO	JAWABPUR	KHAN KALHORO	1
OM 37-B	MUHARRAM CHANDIO	JAWABPUR	KHAN KALHORO	1
OM 38-A1	MOHD. ALI SIAL	BAKHSHO SIAL	DAKHAN	1
OM 38-B1	MOHD. KHAN SIAL	BAKHSHO SIAL	DAKHAN	1
OM 132-A	ALI SHER SHAR	MAHI KHAN SHAR	UMMAR	1
OM 132-B	MAHI KHAN SHAR	MAHI KHAN SHAR	UMMAR	1
OM 133-A	GHULAM RASOOL BROHI	GHULAM RASOOL	BAKHSHO UJJAN	1
OM 133-B	WAHID BUX BROHI	GHULAM RASOOL	BAKHSHO UJJAN	1

DIST	DISTY	LOC	W/C	LOC	LIN	LIN-M	FARMA	LOC	STA
2	UNNAR MINOR	2	4-R	3	0		4	1	2
2	UNNAR MINOR	2	4-R	3	0		17	3	2
2	JUNEJO MINOR	2	1-L	1	0		30	1	1
2	JUNEJO MINOR	2	RD 4.5	1	0		3	3	2
1	BAKHSHO MINOR	1		3	0		50	2	2
1	BAKHSHO MINOR	1		3	0		4.5	3	2
1	BAKHSHO MINOR	1					4	3	3
1	BAKHSHO MINOR	1		3	0		250	2	5
1	WARAH BRANCH			1	1	500	6.75	3	2
1	WARAH BRANCH		RD 80	1	1	500	12	2	1
1	WARAH BRANCH			1	1	800	150	1	1
1	WARAH BRANCH			1	1	800	125	1	1
1	KALHORO MINOR	1	1-R	1	1	300	70	1	1
1	KALHORO MINOR	1		1	0		10	2	2
1	TARAI MINOR	1	1-R	1	1	300	25	2	1
1	TARAI MINOR	1	1-R	1	1	300	12	2	2
1	WARAH BRANCH		RD 76	1	1	1100	15	2	2
1	WARAH BRANCH		RD 76	1	1	1100	50	2	1
2	WASSAND DISTRY	1		2	0		15	1	1
2	WASSAND DISTRY	1		2	0		1.5	2	3
2	SADAHI MINOR	1		3	0		16	2	2
2	DAKHAN DISTRY	1		3	0		9	3	2
1	SADAHI MINOR	1	2-R	1	0		4.5	3	1
1	SADAHI MINOR	1	1-R	1	0		150	3	1
2	WASSAND DISTRY	1		1	0		6	3	2
2	WASSAND DISTRY	1		1	0		5	2	3
2	SADAHI MINOR	1		3	0		200	1	1
2	SADAHI MINOR	1		3	0		10	2	2
1	WARAH BRANCH			1	0		8	2	2
1	WARAH BRANCH			1	0		10	2	2
1	WARAH BRANCH			1	0		25	2	1
1	WARAH BRANCH			1	0		10	2	2
1	WARAH BRANCH		RD 3	1	0		11	2	2
1	WARAH BRANCH		RD 3	1	0		12	2	2
1	GAHEJA MINOR	1	1-AL	1	1	1000	250	1	1
1	KALHORA MINOR	1		1	0		128	2	1
1	WARAH BRANCH		RD 40	1	1	600	600	1	1
1	WARAH BRANCH		RD 40	1	1	600	15	1	3
1	WARAH BRANCH			1	0		12	1	2
1	WARAH BRANCH			1	1	500	4	1	2
1	GAHEJA MINOR	1	7-L	3	1	200	20	3	1
1	GAHEJA MINOR	1	7-L	3	1	200	47	3	2
1	PALIJO MINOR	1	1-R	1	0		7	1	2

1	PALIJO MINOR	1	1-R	1	0		2	1	2
2	UNNAR MINOR	1	5-R	3	0		20	3	2
2	UNNAR MINOR	1	5-R	3	0		35	3	2
2	QADO MINOR	1	1-R	1	0		4.5	3	1
2	QADO MINOR	1		1	0		15	2	1
2	WASSAND DISTRY	1		2	0		5	2	2
2	WASSAND DISTRY	1		2	0		11	1	2
2	WASSAND DISTRY	1		2	1	200	200	1	5
2	WASSAND DISTRY	1		2	0		6	1	3
2	WARAH BRANCH			1	0		7	1	3
2	WARAH BRANCH			1	0		20	3	2
2	WARAH BRANCH			1	1	800	30	2	1
2	WARAH BRANCH			1	1	600	3.5	3	2
2	DAKHAN DISTRY	1	12-L	3	0		10	2	2
2	DAKHAN DISTRY	1	16-L	3	0		20	1	2
1	DAKHAN DISTRY	1		2	1	200	25	2	1
1	DAKHAN DISTRY	1		2	0		3	3	2
1	DAKHAN DISTRY	1	6-R	2	1	500	8	2	1
1	DAKHAN DISTRY	1		2	0		4.5	3	3
1	DAKHAN DISTRY	1	9-L	3	0		45	1	1
1	DAKHAN DISTRY	1		3	0		100	1	1
1	BAKHSHO MINOR	1	1-R	1	1	300	10	2	1
1	BAKHSHO MINOR	1	3-R	1	1	300	62	1	1
1	GAHEJA MINOR	1		3	0		500	1	1
1	GAHEJA MINOR	1	8-L	3	0		100	1	1
1	GAHEJA MINOR	1		3	0		5	2	2
1	GAHEJA MINOR	1		3	0		25	1	1
1	BAKHSHO MINOR	1		3	0		15	3	2
1	BAKHSHO MINOR	1		3	0		18.5	3	2
1	DAKHAN DISTRY	1		1	0		50	1	1
1	DAKHAN DISTRY	1	2-R	1	0		100	1	1
1	DAKHAN DISTRY	1		3	0		5	2	3
1	DAKHAN DISTRY	1		3	0		25	3	1
1	WARAH BRANCH			1	1	1000	13	1	2
1	WARAH BRANCH			1	1	1000	10	1	3

78	571	78	
42		29	
10		28	
26		21	
78		78	
		37.2	
		35.9	
		26.9	

SURVEY OF O&M AT WARAH BRANCH

WARAH SUB DIVISION

SAMPLE NO	FARMER NAME	VILLAGE	DEH
NW 56-A	ABDUL SALAM CHANDIO	LASHKAR KHAN	DHEERO
NW 56-B	HUSSAIN ALI CHANDIO	LASHKAR KHAN	DHEERO
NW 57-A	ROSHAN ALI SUPRO	FATEH M. SUPRO	KOOR KAMAL0
NW 57-B	GHULAM HUSSAIN SUPRO	FATEH M. SUPRO	KOOR KAMAL0
NW 58-A	ALI SHER CHANDIO	NABI BUX CHANDIO	WARASO
NW 58-B	IMDAD CHANDIO	NABI BUX CHANDIO	WARASO
NW 59-A	GUL HASSAN BROHI	MEENHAL SHABRANI	MURAD ALI
NW 59-B	HIDAYATULLAH SHABRANI	MEENHAL SHABRANI	MURAD ALI
NW 60-A	RASOOL BUX CHANDIO	MEHBOOB CHANDIO	NOZAMAN
NW 60-B	ALI GOHAR	MEHBOOB CHANDIO	NOZAMAN
NW 61-A	GHOUS BUX CHANDIO	GUL KARTIO	PANWHARO
NW 61-B	SAINDAD	GUL KARTIO	PANWHARO
NW 62-A	RAIS MUHAMMAD BHANGAR	BHANGAR AACHA	BHANGAR AACHA
NW 62-B	NIAZ HUSSAIN BHANGAR	BHANGAR AACHA	BHANGAR AACHA
NW 63-A	MITHAL KHAN BURIRO	KHAIR M. BURIRO	BAAG JAAGIR
NW 63-B	MOHD. YAQOOB BURIRO	KHAIR M. BURIRO	BAAG JAAGIR
NW 64-A	QURBAN ALI LASHARI	TAJO WAANDH	KUNWAR
NW 64-B	AMIR BUX LASHARI	TAJO WAANDH	KUNWAR
NW 65-A	ABDUL SATTAR TUNIO	NIHAL TUNIO	JAKHAR
NW 65-B	HAJI KHAN TUNIO	NIHAL TUNIO	JAKHAR
NW 66-A	YAR MUHAMMAD GORGEJA	GORGEJA	POTHO
NW 66-B	PIR MUHAMMAD GORGEJA	GORGEJA	POTHO
NW 67-A	SHARAFUDDIN ABRO	KHANDO	POTHO
NW 67-B	HAJI BADARUDDIN	KHANDO	POTHO
NW 68-A	LAL BUX CHANDIO	UMAID ALI CHANDIO	KAROHAR JAAGIR
NW 68-B	RAIS RAHOO KHAN	UMAID ALI CHANDIO	KAROHAR JAAGIR
NW 69-A	GUL MUHAMMAD BROHI	DEPUTY	SAFAR
NW 69-B	UMAID ALI BROHI	DEPUTY	SAFAR
NW 70-A	MASHOOQ ALI CHOLIANI	DAIM KHAN	JOONANI
NW 70-B	SIKANDAR CHOLIANI	DAIM KHAN	JOONANI
NW 71-A	HUBDAR ALI CHANDIO	PINJIAL KHAN	NAANG
NW 71-B	PINJIAL KHAN CHOLIANI	PINJIAL KHAN	NAANG
NW 72-A	NAJAMUDDIN BHATTI	GARHI MAKORO	GARHI MAKORO
NW 72-B	HAJI MUHAMMAD BHATTI	GARHI MAKORO	GARHI MAKORO
OM 61-A	MUHAMMAD BUX BULEDI	BHUNDA BULEDI	MOHABBAT KHAN
OM 61-B	MUHAMMAD URS	BHUNDA BULEDI	MOHABBAT KHAN
OM 62-A	ALI NAWAZ BULEDI	SHER MUHAMMAD	MOHABBAT KHAN
OM 62-B	GHULAM SHABIR BULEDI	SHER MUHAMMAD	MOHABBAT KHAN
OM 63-A	ANWAR ALI SHABRANI	KOOR SULEMAN	KOOR SULEMAN
OM 63-B	ASIF ALI SHABRANI	KOOR SULEMAN	KOOR SULEMAN
OM 65-A	MUHAMMAD RAMZAN MAGSI	JIO KHAN MAGSI	KALHORA
OM 65-B	ALLAH DINO MAGSI	JIO KHAN MAGSI	KALHORA
OM 66-A	M. IBRAHIM SHAIKH	M. IBRAHIM SHAIKH	KHAHEE MEENHO(

OM 66-B	MUMTAZ ALI	M. IBRAHIM SHAIKH	KHAHEE MEENHOO
OM 67-A	M. RAFIQ SHAIKH	NOOR M. SHAIKH	KHAHEE MEENHOO
OM 67-B	M. PUNHAL PHULAN	NOOR M. SHAIKH	KHAHEE MEENHOO
OM 68-A	MUHAMMAD PUNHAL	MADAD CHANDIO	NOZAMAN
OM 68-B	MUHAMMAD AKRAM CHANDIO	MADAD CHANDIO	NOZAMAN
OM 71-A	MAHBOOB ALI CHANDIO	BOOHAR	NOZAMAN
OM 71-B	KARIM BUX BOOHAR	BOOHAR	NOZAMAN
OM 72-A	MACHI KHAN CHANDIO	DUR MUHAMMAD	DHEERO
OM 72-B	LIAQAT ALI CHANDIO	DUR MUHAMMAD	DHEERO
OM 101-A	KORO KHAN TUNIO	JOONANI SHARIF	JOONANI
OM 101-B	GHULAM NABI TUNIO	JOONANI SHARIF	JOONANI
OM 102-A	RAZA M. CHOOLIANI	ALLAH RAKHIO	HAMID
OM 102-B	DUR M. CHOOLIANI	ALLAH RAKHIO	HAMID
OM 103-A	ALLAH DINO CHANDIO	GHULAM HUSSAIN	GARHI JAAGIR
OM 103-B	ALLAHANDO CHANDIO	GHULAM HUSSAIN	GARHI JAAGIR
OM 105-A	SHABIR AHMED BROHI	RASOOL BUX BROHI	WARAH
OM 105-B	AMIR BUX BROHI	RASOOL BUX BROHI	WARAH
OM 106-A	GHULAM NABI GAHECHO	DRIBH SHARIF	WARAH
OM 106-B	RUSTAM GAHECHO	DRIBH SHARIF	WARAH
OM 108-A	ABDUL RAHEEM LASHARI	JANDAHI	GARHI MAKORO
OM 108-B	ABDUL BAQI	JANDAHI	GARHI MAKORO
OM 109-A	BAJHI CHOOLIANI	ADIAL CHOLIANI	GUL BURIRO
OM 109-B	HUB ALI CHOOLIANI	ADIAL CHOLIANI	GUL BURIRO
OM 110-A	MOULA BUX CHANDIO	GUL M. CHANDIO	HAMID
OM 110-B	SAEED AHMED	GUL M. CHANDIO	HAMID
OM 112-A	ALI MURAD GADHI	ALI GOHAR GADHI	JOONANI
OM 112-B	HIDAYATULLAH GADHI	ALI GOHAR GADHI	JOONANI
OM 113-A	NISAR AHMED	GUL BURIRO-1	GUL BURIRO
OM 113-B	ABDUL SATTAR BURIRO	GUL BURIRO-1	GUL BURIRO
OM 114-A	AMIR ALI LASHARI	GUL BURIRO-2	GUL BURIRO
OM 114-B	HAKIM KORI	GUL BURIRO-2	NAWAB KALHORO
OM 115-A	KHAN AREEJO	SHER M. AREEJA	SAFAR TUNIO
OM 115-B	ALI GOHAR MUGHERI	SHER M. AREEJA	SAFAR TUNIO
OM 116-A	ARBAB ALI SHABRANI	ALI SHER SHABRANI	PUNA
OM 116-B	MUHAMMAD SALIM CHANDIO	ALI SHER SHABRANI	PUNA
OM 117-A	MUHAMMAD WARIAL MIRJAT	SADIQABAD	PANWHARO
OM 117-B	AJAZ AHMAD SHAIKH	SADIQABAD	PANWHARO
OM 118-A	JAMALUDDIN CHANDIO	PANWHARO	PANWHARO
OM 118-B	ABDUL RAHIM MIRJAT	PANWHARO	PANWHARO
OM 119-A	ABDUL MAJEED CHANDIO	BUTHI LASHKAR KHAN	BAGH JAGEER
OM 119-B	ABDUL HADI CHANDIO	BUTHI LASHKAR KHAN	BAGH JAGEER
OM 120-A	NIAZ HUSSAIN CHANDIO	AMANULLAH CHANDIO	BAGH JAGEER
OM 120-B	ABDUL RAHEEM CHANDIO	AMANULLAH CHANDIO	BAGH JAGEER
OM 121-A	HAJI SAHAB GADHI	MIR GADHI	KHANDOO
OM 121-B	ALI AKBAR GADHI	MIR GADHI	KHANDOO
OM 122-A	ALI HYDER CHANDIO	ABDUL QADIR	BAGH JAGEER
OM 122-B	ABDUL QADIR CHANDIO	ABDUL QADIR	BAGH JAGEER
OM 123-A	GHULAM ALI SHBRANI	HOT KHAN CHANDIO	JAGEER NO. 5

OM 123-B	SAFAR ALI SHBRANI	HOT KHAN CHANDIO	JAGEER NO. 5
OM 124-A	MUHAMMAD KHAN	MIAT SHAHEED	KALAR
OM 124-B	MUHAMMAD BUX LASHARI	MIAT SHAHEED	KALAR
OM 125-A	AHMED ALI BROHI	NOORABAD	JAKHRO
OM 125-B	GHULAM MUSTAFA BROHI	NOORABAD	JAKHRO
OM 126-A	ALI AKBAR BHANGAR	PIRAL KHAN MUGHERI	BUKEJA
OM 126-B	MUHAMMAD SALAH MUGHERI	PIRAL KHAN MUGHERI	BUKEJA
OM 127-A	BAGHAL CHANNA	VAKEEL	VAKEEL
OM 127-B	MOULA BUX MUGHERI	VAKEEL	VAKEEL
OM 128-A	QAMARUDDIN BURIRO	SABOO BURIRO	BAGH JAGEER
OM 128-B	ABDUL HAYEE BURIRO	SABOO BURIRO	BAGH JAGEER
OM 129-A	JALALUDDIN CHANDIO	MISRI KHAN CHANDIO	BAGH JAGEER
OM 129-B	SIKANDAR ALI CHANDIO	MISRI KHAN CHANDIO	BAGH JAGEER
OM 130-A	HUBDAR AHMED	KHAIR M. KARTIO	KUNWAR
OM 130-B	SAIFULLAH KHAN KARTIO	KHAIR M. KARTIO	KUNWAR
OM 131-A	NEK MUHAMMAD BROHI	ZAFARABAD	KALAR
OM 131-B	KARIM BUX BROHI	ZAFARABAD	KALAR
OM 135-A	MASHOOQ CHANDIO	DAHAIR CHANDIO	WAKRO
OM 135-B	MUKHTIAR CHANDIO	DAHAIR CHANDIO	WAKRO
OM 136-A	DUR MUHAMMAD BROHI	KHAMISO BROHI	MUHABAT BULEDI
OM 136-B	MUHAMMAD MURAD BROHI	KHAMISO BROHI	MUHABAT BULEDI
OM 137-A	HAJI KHAN CHANDIO	ABDUL RAOOF	KUNWAR
OM 137-B	KHADIM HUSSAIN CHANDIO	ABDUL RAOOF	KUNWAR

ANNEXURE VI. WHEAT-RICE FARMING IN THE WARAH BRANCH COMMAND

Table VI-1. Depth of Standing Water in the Rice Fields (in inches).

Sub-division Depth	Madeji	Miro Khan	Warah	Average
Average	4.3	4.4	3.5	4.1
Minimum	2.0	1.0	1.0	1.0
Maximum	9.0	12.0	12.0	12.0

Table VI-2. Date of Last Watering to the Rice before Harvesting.

Date	Madeji	Miro Khan	Warah
Average	October 13	October 20	October 31
Earliest	Sept. 07	July 07	August 31
Latest	December 07	December 10	Sept. 27

Table VI-3. Harvesting Dates for Rice.

Sub-division Harvesting Date	Madeji	Miro Khan	Warah	Average
Average	Nov. 09	Nov. 16	Nov. 22	Nov. 16
Early	Sept. 30	Sept. 30	Oct. 01	Sept. 30
Late	Jan. 07	Jan. 15	Jan. 31	Jan. 07

Table VI-4. Rice Yields (in kg/ha).

Sub-division Yields	Madeji	Miro Khan	Warah	Warah Division
Minimum	800	600	400	400
Maximum	2800	2400	2000	2800
Potential/Gap	2000	1800	1600	2400

Table VI-5. Status of Rice Yields (percent farmers).

Sub-division	Madeji	Miro Khan	Warah	Average
Satisfactory	37	21	2	20
Low	52	63	80	65
Very Low	11	16	18	15

Table VI-6. Area under Wheat Crop on Sample Farms (hectares).

Sub-division Areas	Madeji	Miro Khan	Warah	Average
Farm Area	1590	2205	2588	6383
Cultivated Area (Rabi)				
Wheat Area	612	667	253	1532

Table VI-7. Wheat Varieties Sown in the Warah Branch Commmand.

Sub-division Variety	Madeji	Miro Khan	Warah	Average
Sindhi	55.6	18.0	2.00	25.2
Maxi	23.6	16.9	51.0	30.5
711	4.2	32.6	5.90	14.2
T J 83	1.4	7.9	15.7	8.3
Sar Sabz	1.4	10.1	0.0	3.8
Sona Leeka	4.2	2.2	13.7	6.7
Combination	8.3	5.6	0.0	4.7
Other	1.4	6.7	11.8	6.6

Table VI-8. Wheat Sowing Dates.

Sub-division	Madeji	Miro Khan	Warah	Average
Sowing Date				
Average	18th Dec	20th Dec	14th Dec	18th Dec
Earliest	7th Nov	11th Sep	1st Nov	11th Sep
Late	1st March	7th Feb	28th Feb	1st March

Table VI-9. Number of Irrigation Turns Applied to Wheat.

Sub-division Number	Madeji %	Miro Khan %	Warah %	Warah Division %
Zero (0)	1.4	2.2	2.0	1.9
One (1)	28.8	27.0	35.3	30.3
Two (2)	53.4	66.3	49.0	56.2
Three (3)	16.4	4.50	13.7	11.6

Table VI-10. Wheat Harvesting Dates.

Sub-division Dates	Madeji	Miro Khan	Warah	Average
Average	Apr 21	Apr 20	Apr 10	Apr 17
Earliest	March 31	March 31	Feb 20	Feb 20
Late	May 14	May 10	May 07	May 14

Table VI-11. Wheat Yields (in kg/ha).

Sub-division	Madeji	Miro Khan	Warah	Warah Division
Yields				
Minimum	160	120	80	80
Maximum	1280	1000	1280	1280
Potential/Gap	1020	880	1200	1200

Table VI-12. Status of Wheat Yields (percent farmers).

Sub-division	Madeji	Miro Khan	Warah	Average
Satisfactory	26	17	4	16
Low	22	46	57	41
Very Low	52	37	39	43

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
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