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INSTITUTIONAL PERSPECTIVES OF LAND RECLAMATION OPERATIONS IN PUNJAB

A Case Study
of the Lower Chenab Canal (East) Circle Area

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and
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IIMI
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Acronyms

ALRO	Assistant Land Reclamation Officer
AVC	Assistant Vernacular Clerk
CCA	Culturable command area
DLR	Directorate of Land Reclamation; also Director of Land Reclamation
HVC	Head Vernacular Clerk
ID	Irrigation Department
LCC	Lower Chenab Canal
LRO	Land Reclamation Officer
PID	Punjab Irrigation and Power Department (World Bank uses this term to mean Provincial Irrigation Department)
RWS	Relative Water Supply
SCARP II	Salinity Control and Reclamation Project II
SDC	Sub-Divisional Clerk
SDO	Sub-Divisional Officer
SE	Superintending Engineer
VC	Vernacular Clerk
WAPDA	Water and Power Development Authority
XEN	Executive Engineer

Glossary

Chowkidar	-	Literally a watchman, a very versatile village official with multifarious functions - in charge of security, reporter of births and deaths, escort to visiting government or other functionaries, town crier, irrigation schedule keeper, helper in revenue collection.
Kacha	-	Provisional
Khasra Sadmazada	-	Proforma for recording details on salt-affected land
Munshi	-	Clerk
Pacca	-	Permanent
Partals	-	Scrutiny of record, or field investigation
Patwari	-	Revenue official at the field level, keeper of revenue record, surveyor of crops, crop damages, salinity-affected land, etc.
Sem	-	Waterlogged soil condition
Twan	-	Fine
Thur	-	Salinity
Thur Nau	-	Recent salinity
Thur Kohna	-	Old salinity
Thur Punjsala	-	Saline patch/parcel known to be such for the past five years or so
Thur Girdawari	-	Visual salinity survey
Thur Juzvi	-	Partial salinity
Thur Tirk	-	Sodic saline land showing cracks
Tirk	-	Incomplete opening of cotton bolls. When used in connection with salinity, it refers to such saline/sodic land where cotton bolls do not open normally or open prematurely or incompletely.
Zilladar	-	Junior member of Supervisory staff of revenue establishment of Irrigation Department, supervising a number of Patwar circles.

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Abstract

THE **DIRECTORATE OF** Land Reclamation (DLR), which was set up in **1945,** is a special unit of Punjab's Irrigation and Power Department for undertaking research and field operations to combat the problem of salinity. Approaching the end of five decades of existence, the Directorate is yet to demonstrate its effectiveness in its assigned task; its inability to fully cope with the conditions of a fast changing irrigation environment makes this rather an illusive goal.

In the selection of lands for reclamation, the Directorate is heavily dependent on the visual salinity survey *(Thur Girdawari)* carried out every year by the Irrigation Department's field staff. This visual survey appears to be a quick and cost-effective method of assessing surface salinity, but its exclusive use as the criterion for selection of affected land is **a** questionable approach. According to original departmental procedure, reclamation activities were confined to only two of the five classes of soil identified by the visual salinity survey, but the current practice of including all the types of salt-affected soils in reclamation operations has made the selection process more subjective. Surprisingly, **the** DLR is not using its existing laboratory facilities optimally to better identify the salt-affected lands. Soil testing in visually identified lands could also help define the reclamation operations more scientifically in addition to improving the selection methods being used.

While formal procedure requires the Directorate to communicate to farmers the details of planned reclamation schemes, farmer awareness of the reclamation program seems to be poor and only a few farmers in the study area readily acknowledge agency assistance in obtaining relevant information. In practice, the proposals for reclamation schemes are often initiated by some influential farmers.

It is a requirement that the amount of water made available for reclamation be over and above the design supply of a given distributary, and special reclamation outlets can be given from a distributary only on the basis that its tail will not suffer. However, the study shows no evidence to show that extra water was made available during the operation of reclamation outlets; further. tail-end shortages were observed in all the distributaries under the study.

In a context where the tendency is to give scant consideration to irrigation rules and procedures, it is unlikely that the Directorate of Land Reclamation in its present form and status will succeed in implementing an extensive program of reclamation operations. For the Directorate to be effective in its legitimate functions and to make it an operationally viable and socially acceptable organizational unit, adequate policy and institutional support seem to be necessary.

I. Introduction

THE PAPER PRESENTS the results of an institutional study by the International Irrigation Management Institute (IIMI) that focused on land reclamation operations conducted by the Directorate of Land Reclamation (DLR) of Punjab's Irrigation and Power Department. The study was carried out in collaboration with the Directorate, to evaluate the on-going reclamation procedures, processes, practices and their impact in reclaiming saline lands. Most of the of study field work was conducted during the 1992 *kharif* season, but the review of literature and interviews with agency personnel continued until June 1993. The study was limited to selected areas in the Lower Chenab Canal (LCC) East Circle in Punjab.

The DLR's reclamation techniques for saline areas include the process of providing additional canal supplies for leaching by installing extra pipe outlets, and some prescribed farming practices. These supplies are additional in the sense that they are over and above the normal supplies committed for irrigation. Such supplies for reclamation could only be made available during summer when the required water is available in the rivers. According to the DLR practices, the extra water supplies are provided at the rate of one cusec (28.32 l/s) for 45 acres (18.2 ha) in perennial canal commands if the water table is below 10 feet depth, and at half this rate if the water table is from 5 to 10 feet (1.5-3.0 m) in depth. For non-perennial canal commands, the normal rate is one cusec (28.32 l/s) for 60 acres (24.3 ha). A reclamation scheme may contain a "compact block" owned by one farmer, or "scattered plots" sewed by a common watercourse. The reclamation supply, which is made available during the kharif season by installing extra pipe outlets and which is continued for a period of three years, is popularly referred to as "reclamation shoots."

This work by the DLR involves complex social issues in the selection of salinity-affected land, in deciding the quantum of additional water supplies, in the modification of existing water distribution schedules, and in monitoring the application of additional supplies. Given the complexity of the work and the high degree of cooperation needed between water users and agency staff, IIMI's study focused on the institutional dimension of reclamation operations.

The main findings of the study indicate that the Directorate, which was originally started with a clear mandate and with great expectations, has declined in status and objective-orientation. The reasons for this decline are attributable to several institutional factors, foremost among which is its inability to deal with growing indiscipline in the irrigation environment. Another major factor is the DLR's isolation from other related research and extension activities in the irrigated agriculture sector, and even from the main stream of activities within its own parent organization, the Punjab Irrigation and Power Department.

The background to the problem of salinity in Punjab and to the institutional arrangements made to cope with this problem is given in an appendix to this paper. In Section II, is a description of the study including study objectives and the methodology employed. The results of the study and a discussion thereon are presented in Section III, and the conclusions and recommendations are in Sections IV and V, respectively.

II. The Study

RATIONALE

IN 1989, THE International Irrigation Management Institute (IIMI) initiated a five-year research project in Pakistan, "Managing Irrigation Systems to Mitigate Waterlogging and Salinity Problems." In the first phase of this research project, a diagnosis of the problem was carried out to study its scope and main features. IIMI's studies confirmed the existence of a disturbing pattern of increased salinity-related problems in Punjab's irrigated agriculture as location varies within both distributary canal and watercourse commands. The source of salt that accumulates in the crop root zone was found to be the poor quality tubewell water used in increasing quantities by fanners for irrigation. In the first phase of this on-going research activity, Vander Velde and Kijne (1992:17) found:

> Serious and persistent inequity in the distribution of high quality canal water within distributary commands, often mirrored at the watercourse level, has meant that farmers in middle- and tail-reach locations increasingly depend on pumped groundwater to meet the bulk of their crop water requirements. For reasons that are not yet well understood, the quality of groundwater pumped by tubewells generally decreases between head and tail within distributary canal commands. Thus, farmers in tail-end locations face a double handicap: they receive much less than their fair share of canal water compared to farmers upstream, and the groundwater supply they therefore must fall back upon is of poorer quality than elsewhere.

This research effort is expected to feed into a series of management interventions. Several such management interventions that would address the water and salt balance issues and seek to improve irrigation performance in general were considered at a retreat seminar held by IIMI in October 1991 (Kijne and Levine 1991). At this seminar, a number of senior officials of the Punjab Irrigation Department (PID) and the Water and Power Development Authority (WAPDA) participated. One of the proposed management interventions was the promotion of salinity mitigation through leaching, which was designed to improve farmer understanding of leaching for salinity control, and to introduce a more systematic approach for redirection of water at the farm level. Since part of the activities of the Directorate of Land Reclamation (DLR) would have direct links with this management intervention, IIMI launched an institutional study of the reclamation activities carried out by the DLR, as part of IIMI's larger program of work.

OBJECTIVES

The overall objective of the study was to understand and document the organizational and operational issues and constraints related to reclamation activities conducted by the Directorate of Land Reclamation

(DLR), and to identify the potential for realizing the fullest benefits from the additional irrigation supplies sanctioned for the reclamation of saline soils in irrigated areas of the Punjab. The study was also expected to help define management interventions which could be undertaken to address the problems of emerging secondary soil salinization. The specific objectives of the study were:

* To review the organizational arrangements in the DLR and the legal and procedural support to its operations.

* To understand how the "reclamation shoots" (reclamation water supplies) are sanctioned, installed and operated, and to document these processes.

* To examine the relationship between reclamation shoots and the availability of irrigation water supplies in the system.

* To study the effect of additional water supplies for reclamation on farmers' irrigation and farming practices, including the existing cropping patterns and *warabandi* (fixed turns).

METHODOLOGY

The methodology employed in this study was to observe and monitor, in the field, the prevailing actual processes and practices of land reclamation, in addition to the collection of theoretical and performance-related information from a review of various reports and research papers. Primary data collection methods also included interviews of beneficiaries and agency personnel.

The land reclamation program is administered on the basis of Canal Irrigation Circles. For monitoring activities of this study, the Lower Chenab Canal (LCC) East Circle was selected, considering its importance in terms of the DLR's normal reclamation operations. Recognizing that the LCC is one of the largest and most complex of the 43 major canal irrigation systems in Pakistan's Indus Basin, the sites of IIMI's other studies have also been located in this canal command. It was therefore possible to make primary data collection more efficient by drawing from IIMI's own field teams located in the area. The selection of this area for the present study will also enable possible integration of its results into IIMI's overall research program in the Punjab. The LCC System is offlaking from the Khanki headworks on the Chenab River. The location map of the LCC system is shown in Annex **A.**

Additional water supplies through reclamation shoots were provided to 55 distributary canals within the Land Reclamation Division, LCC East Circle, for kharif 1992. The reclamation supplies were sanctioned for 163 outlet commands, but the pipe outlets were not fixed on 6 watercourses because farmers refused to avail themselves of this facility, and the reclamation operations were carried out oniy within **157** watercourse commands. The details are in the Statements of Land Reclamation Operations prepared by the DLR (Annexes B1 to B3).

Study sites were selected from a multi-stage sample, with the main canal system as the primary, distributaries as the secondaty, and the list of operational or recently terminated reclamation shoots as the final sampling frame, In the upper and lower reaches of the Gugera System, altogether 10 distributary commands (18 percent of the total number in the LCC East Circle) were selected from the area falling within the official jurisdiction of the Land Reclamation Officer (LRO), LCC East Circle.

For the monitoring of the DLR's reclamation activities, distributary commands were selected from the head, middle and tail reaches of the LCC system. They were located within three divisions in the Upper

Gugera, Lower Gugera and Burala Branch Canal systems of the LCC East Circle (at RD 282, the Upper Gugera Branch bifurcates into the Burala and the Lower Gugera Branches). Basic data for these three divisions are summarized in Tables 1 and 2.

Table 1. Salient statistics of the LCC East Circle.

Name of division	Length of channel/ canal (miles)	Discharge of channel (cusecs)	No. of outlets	Gross command area (acres)	Cultivable command area (acres)	Annual irrigated area (acres)
Upper Gugera	435	1,653	1,050	701,133	576,233	763,612
Lower Gugera	429	1,834	989	621,524	521,064	696,677
Burala	408	1,542	947	588,220	510,638	704,723
Total	1,271	4,029	3,006	1,910,877	1,607,935	2,165,012

Note: 1 acre = 0.4047 hectare; 1 mile = 1.61 km; 1 cusec = 28.32 l/s.
Source: Bandaragoda and Firdousi 1992:73.

Table 2. Reclamation supply, selected saline areas and rice areas during kharif 1992.

Irrigation division	Reclamation supply (cusecs)	Selected saline area (acres)	Area under rice (acres)
Upper Gugera	48.86	2824	1944
Lower Gugera	75.96	3447	1469
Burala	38.40	2049	1048
Total	163.22	7780	4461

Note: 1 acre = 0.4047 hectare: 1 cusec = 28.32 l/s.
Source: LRO Office, LCC East Circle, Faisalabad.

The Farooqabad Subdivision of the Upper Gugera Division comprises the service area of seven distributaries in the head reach of Upper Gugera Branch; of these, the Mananwala and Lagar distributaries, and the Karkan Minor were the focus of detailed monitoring and assessment during kharif **1992.** Observations of reclamation activities were carried out in 3 of the 6 distributaries in the Bhagat Subdivision of the Lower Gugera Division, and observations were also conducted in **4** distribuataries *of* the Kanyan and Sultan Pur Subdivisions of the Burala Branch. The finally selected sample comprised **20** watercourses **(13** percent of the total number of outlets identified for reclamation operations by the DLR in the LCC East Circle). The sample covered head, middle and tail reaches of each selected distributary. Details of the sample *of* watercourse commands are listed in Table 3.

The reclamation activities in the sample area were monitored from July to October **1992** through field observations, water measurements and farmer interviews. Planned study work could not be fully undertaken in the Burala Division. Of **the** 4 distributary commands in the Burala Division, discharge measurements were undertaken only on the Kot Pathana Minor whereas data were collected on the remaining sample sites to understand the approval process toward securing sanctioned reclamation shoots. Farmers in the two distributaries -- Kamalia and Waghi of the Burala Branch --were not willing to proceed with reclamation shoots as the procedural delays in the sanctioning process during the previous year had significantly delayed the intended rice cultivation. For them, the prospects of a repetition of the unwanted delays was too discomforting. At the Kanyan Distributary of the Burala Branch, the issue of reclamation shoots was still more contentious as the tail enders, already suffering due to scarcity *of* water, had since last year obtained stay orders from the court against the granting *of* reclamation shoots upstream.

Watercourse	Location	Command area		Outlet discharge	Reclamation discharge	Selected area	Cycle
		GCA	CCA	(cusecs)	(cusecs)	(acres)	year
UG-LA 1052-R	Head	862	761	1.44	0.50	22.25	1992-94
UG-LA 17541-R	Head	677	614	1.16	1.00	45.43	1991-93
UG-LA 16330-L	Head	778	646	1.22	0.50	21.79	1992-94
UG-LA 24200-L	Middle	1287	1165	2.21	0.50	22.25	1992-94
UG-LA 26475-L	Middle	650	518	0.98	0.50	22.71	1992-94
UG-MA 49985-R	Middle	356	343	0.65	1.00	45.11	1991-93
UG-MA 82600-R	Middle	416	394	1.12	Un-authorized		
UG-MA 27062-L	Head	598	493	1.23	1.00	42.50	1990-92
UG-KN 31605-L	Middle	180	178	0.51	Un-authorized		
UG-KN 34875-L	Middle	676	641	1.82	1.00	45.42	1992-94
LG-YA 10229-R	Head	680	612	1.75	1.51	68.10	1992-94
LG-BH 5150-L	Head	801	658	1.89	0.77	34.76	1992-94
LG-BH 10164-L	Head	473	355	1.35	0.75	34.38	1992-94
LG-RA 11900-L	Head	513	440	1.37	0.76	34.41	1992-94
LG-RA 13753-L	Middle	540	469	1.43	0.73	32.98	1992-94
EU-KA 7289-L	Head	438	371	0.99	1.01	48.14	1991-93
BU-WA 5940-R	Head	105	539	2.00	1.66	14.77	1991-93
BU-WA 5950-L	Head	461	350	1.33	1.43	64.31	1991-93
BU-KM 8218-L	Head	569	427	1.63	2.00	90.00	1991-93
BU-KP 8920-L	Middle	490	366	1.39	2.00	90.00	1991-93

UG = Upper Gugera
LA = Lagar
MA = Mananwala
KN = Karkan
KP = Kot Pamana

LG = Lower Gugera
YA = Yakkar
BH = Ehun
RA = Rajana
GCA = Gross command area in acres

BU =Burala
KA =Kanyan
WA =Waghi
KM =Kamalia
CCA=Culturable command area in acres

CANALWISE DISTRIBUTI(

Upper Gugera		Lower Gugera	Burala
Lagar Distributary 1052-R 17541-R 16330-L 24200-R 26475-L	Mananwaia Distributary 49985-R 82600-R Karkan Minor 27062-L 31605-L 34875-L	Yakkar Distributary 10229-R Ehun Distributary 5150-L 10164-L Rajana Distributary 11900-L 13753-L	Kanyan Distributary 7289-L Waghi Distributary 5940-R 5950-L Kamalia Distributary 8218-L Kot Palhana Minor 8920-L

Note: 1 cusec = 28.32 l/s, 1 acre = 0.41347 hectare.

III. Results and Discussion

RESULTS OF THE literature review, the interviews with agency personnel and farmers, and the field observations are presented in this section of the paper. The results and the discussions thereon are arranged in terms of specific study objectives mentioned in Section II above, and are presented under four headings:

* Institutional Framework for Reclamation Operations
* Planning and Implementing Reclamation Schemes
* Water Availability for Reclamation Supplies
* Effect of Reclamation Supplies on Farming Practices

INSTITUTIONAL FRAMEWORK FOR RECLAMATION OPERATIONS

A review of various documents on the subject indicated that, historically, institutional development associated with reclamation of salinity affected lands in the Punjab had run parallel to a growing awareness of irrigation-related environmental problems. As far back as **1927,** the Punjab authorities came to learn of the problem of soil salinity in upper regions of the *Rechna Doab* where the water table was very high, almost at the surface in some places. To assess the extent of land affected, the Waterlogging Enquiry Committee started a salinity survey (*Thur Girdawari*) in the area. Initially, the survey was confined to areas with the water table within five feet (1.52 m) from the surface, but by 1937, as further investigations were carried out, salinity was found to be present even in areas where the water table was deeper. With this realization, in 1943, the salinity survey was extended to cover the entire irrigated area in Punjab, and the work was entrusted to the Irrigation Department. As the concern became greater, in 1945, the Directorate of Land Reclamation (DLR) was formed as a separate unit within the Irrigation Department to exclusively undertake salinity surveys and related research work and remedial measures.

Legal Base for the DLR's Work

Study investigations based on official documents and staff interviews did not reach any clear position regarding an exclusive legal framework which is operative for the DLR's current work. In the absence of a separate law for the creation or the functioning of the **DLR,** it was generally acknowledged that the main source of authority for the DLR's work emanated from the Canal and Drainage Act of 1873, a law which had been operative from the inception of institutionalized irrigation in the Punjab. Authority for most of the water-related interventions for the **DLR's** reclamation operations derives from Section **68** of the 1873 Act.

Nasir (1981:131) reckons Section 68 as the most important part of the Act as it deals with the authority of the Canal Officers over water distribution problems. Provisions of this section of the Act can therefore be exercised by the Assistant Land Reclamation Officers of the DLR within their respective areas of jurisdiction, but in respect of additional reclamation supplies only.

Rules for the remodelling of channels and outlets required for the distribution of reclamation supplies, the methods of distribution of reclamation supplies and selection of salinity-affected areas of outlets, the instructions on the survey of salinity-affected areas and waterlogged areas, and the process of reclamation of salinity-affected lands are specifically provided as subsidiary laws (Nasir, 1981: Annexures III, V and VII).

Aiming at the speedy reclamation and improvement of the areas affected by waterlogging and salinity, the Punjab Soil Reclamation Act was passed in 1952. Under this Act, a Soil Reclamation Board was constituted with the Chief Engineer, Irrigation of the Province as its Chairman: the Director, Land Reclamation as a member and Technical Advisor; and Superintending Engineer, Drainage, as a member. The Board was charged with the responsibility for the planning and implementing of reclamation projects by providing adequate additional water supplies through tubewells and canals in the province. This was later renamed the Punjab Land and Water Development Board, which was, in turn, dissolved with effect from 31 January 1973; its functions were merged with the Irrigation and Power Department and the Secretary, Irrigation and Power Department was appointed the Administrator under Section 79 of the Act of 1952. However, since both the Acts are operative now, Nasir (1981: 151) suggests that for speedy action, Section 17 of the Punjab Soil Reclamation Act of 1952 should be preferable to Sections 20 and 68 of the Canal and Drainage Act of 1873.

Structure of the DLR

Administratively, as a part of the Irrigation Research Zone of the Punjab's Irrigation and Power Department, the DLR is headed by a Director, having the status of a Superintending Engineer, who functions under the overall guidance of the Chief Engineer (Research) and the Secretary of the Irrigation and Power Department. The DLR consists of a research laboratory at Lahore, nine experimental research stations located in different parts of the province to monitor different soil and climatic conditions, and seven field Land Reclamation Divisions covering almost all of the canal command areas of the Punjab. The organizational structure of the DLR is given in Annex C1. The organizational structure of the LCC East Circle Field Reclamation Division is given in Annex **C2** and its staffing positions are detailed in Table **4.** These reflect the scope of the DLR's reclamation activities in a field unit, which forms the focus of this study.

Embodied in the PID's static organizational structure, the DLR finds itself isolated from other agencies and institutes working in irrigated agriculture. Interviews with the DLR staff and the PID field staff showed that the DLR's interactions are limited to the PID, and to the process of obtaining extra canal supplies. There was no evidence that the DLR was consulting any agency or groups of personnel involved in agricultural extension or adaptive research in the field. Similarly, there was no indication that the DLR was seeking to approach farmers in established groups, or farmer organizations, or that it was collaborating with any other agency for this purpose.

Table 4. ***Staffing positions in the DLR, LCC*** East *Circle*

Name of position	Provision	Available
Land Reclamation Officer	1	1
Assistant Land Reclamation Officer	2	2
Reclamation Supervisor	2	2
Zilladar	6	6
Patwari	64	52
Head Vernacular Clerk (HVC)	1	1
Vernacular Clerk (VC)	1	1
Munshi or Assistant Vernacular Clerk (AVC)	6	6
Accounts Clerk	2	2
Sub-Divisional Clerk (SDC)	2	2
Junior Clerk	4	4
Peon	10	10
Total	101	89

Source: LRO Office, LCC East Circle, Faisalabad.

Functions of the DLR

The work of the DLR was originally expected to cover a wide range of soil- and water-related problems. In more recent times, however, the focus of the DLR's work has been on the basic problem of salinity as it relates to soil deterioration, water quality, irrigation water management, crop water requirements, and cropping patterns. Reclamation of saline lands through the process of ieaching with additional canal supplies during the high-flow summer season, accompanied by prescribed management practices, is considered to be a pioneering effort of the DLR (Mashhadi **1987:** 28). At present, the broad functions of the DLR (**DLR 1991:** 2) are:

* Conducting soil- and water-related research with the objective of evolving effective ways and means of combating waterlogging and salinity.

* Supervision of the collection of salinity (*Thur*) and waterlogging (Sern) statistics of the province.

* Planning, organizing and exercising technical control of reclamation operations on farmer's fields in coordination with local Canal Circles.

Research connected with saline and waterlogged soils is carried out at the research laboratory located in Lahore and at field experimental stations. The laboratory facility in Lahore, for which a two-acre block of land is available adjacent to the office building, has two segments -- Soil Section and Chemical Section -- to analyze soil and water samples for conducting small-scale experimental studies. Larger-scale studies are undertaken in the nine field experimental stations located in different areas representing the major agro-climatic zones of the province. Some details of these experimental stations are given in Annex D.

The Soil Section, headed by a research officer and with a number of research assistants, is assigned the following work:

- Applied research on soil and water in the laboratory as well as on experimental fields.
* Analytical work on soil and water samples.
* Soil survey and land classification.
* Monitoring studies of Salinity Control and Reclamation Project II (SCARP II).

The Chemical Section, operated by the Physical Chemist and his research staff, works on basic problems relating to soil, water and plant relationships, and is assigned the following work

* Reclamation of saline, saline sodic, and sodic soils by chemical and biological methods.
* Assessment of the effects of toxic elements on crops and soils.

The DLR is expected to play a supervisory role in conducting salinity surveys. This responsibility apart, it is in the DLR's own interest to have reliable salinity data as the reclamation operations are normally based on these salinity appraisals for which the DLR depends on the Irrigation Department field staff. The process of conducting a salinity survey is described below.

For the reclamation of partially affected lands, and those which have gone out of cultivation recently, a reclamation program is drawn up by the land reclamation staff functioning under the administrative control of Superintending Engineers of Irrigation Canal Circles. Technical guidance is provided by the DLR. The land reclamation staff assigned for this purpose include Land Reclamation Officers, Assistant Land Reclamation Officers, Reclamation Supervisors, Reclamation *Zilladars* and Reclamation *Patwaris*, who are jointly responsible for preparing reclamation schemes and arranging for the distribution of the water supply among the cultivators. The physical work involved in the leaching of land is carried out by the respective cultivators of the affected lands.

PLANNING AND IMPLEMENTING RECLAMATION SCHEMES

Salinity Survey - The Basis for Reclamation Schemes

In visual salinity surveys (Thur *Girdawari*), the Canal Patwaris in the Irrigation Department make visual appraisals of soil salinity in the canal command areas. Since salinity (Thur) is generally visible during winter months, Thur Girdawari is carried out during the months of December, January and February. Canal Patwaris are required to survey the entire area within the canal irrigation boundary, and make entries in the Khasra *Sadmazada* (proforma for salt-affected lands) before the end of February. During the month of March, Patwaris have to prepare abstracts of Thur areas by class, by outlet,' by village and by distributary. The Divisional Office records this information in "Thur Abstract Registers," and the information is sent to the DLR office to maintain up-to-date information regarding areas affected by Thur and *Sem* (waterlogging).

Thur is classified into three main types by the DLR (Consolidated Instructions for Recording of Thur and Sem Girdawari, Ref. No. 134-140/16W, dated 19.11.60, issued by Land Reclamation Officer -- Thur and Sem Statistics):

1. Uncultivated ***Thur (Thur Kohna)*** is Thur never broken, meaning a saline area which has never Seen cultivated since the advent of canal irrigation according to recorded evidence,

2. Formerly Cultivated ***Thur*** comprises all areas which have been under cultivation since the advent of canal irrigation but has gone out of cultivation later on account of Thur. It is divided into two subclasses Thur *Punjsala* and Thur *Nau*.

   Thur *Punjsala* is land which has been under the plough but has become uncultivable, owing to the effect of Thur, more than *5* years before the Thur Girdawari.

   Thur *Nau* is land which has been under the plough but has become uncultivable owing to the effect of Thur, within the 5 years before the Thur Girdawari.

3. Cultivated ***Thur*** comprises land which is under cultivation but affected with salts. It is divided into two subclasses, Thur Juzvi and Thur Tirk.

   Thur *Juzvi* is a visually *Thur*-affected area in which Thur exists in 20 percent or more of the area, but it is still under cultivation. The area recorded under any other kind of *Thur* will be excluded for determining the 20 percent limit.

   Thur *Tirk* is land in which Thur is not visible but cotton is affected by *Tirk* (incomplete opening of bolls); it is recorded if the water rate and land revenue have been remitted for this reason.

Thur Girdawari, the visual soil salinity survey conducted annually by the Canal Patwaris, appears to be a quick and cost-effective method for a preliminary inventory of salt-affected lands. However, to rely on its use as the only criterion in selecting lands for reclamation operations is questionable. For instance, when IIMI carried out a soil sampling exercise in the upper and lower reaches of the Gugera Irrigation System, the results showed that more accurate information on soil salinity would tend to counter the validity of the DLR's existing land selection procedure. For the IIMI study, the Mananwala Distributary at the head and Junejwala Minor of Pirmahal Distributary at the tail of the system were selected. The selection of sites in

the watercourse commands was again done keeping in view the head, middle and tail locations. Soil samples were taken from the various representative locations of each watercourse. These samples were given to the DLR's laboratory at Lahore for analysis. The results indicate that on average 66 percent of the samples were non-saline, while 29 percent of the samples were slightly saline causing small yield reductions, and only 5.5 percent of the samples showed a moderately saline composition which ***causes*** substantial yield reductions **(see** Table 5A). Both along the Gugera System and along the secondary channels, Mananwala Distributary and Junejwala Minor, the soil salinity increased from head to tail.

Table *5A. **Results of*** soil sample analysis *for **1992.***

Watercourse command	Percentage of soil sample falling in salinization class				Percentage of soil sample falling in sodication class			
	None	Slight	Sub-stantial	Severe	None	Slight	Sub-stantial	Severe
Manwl 024R	97%	2%	1%	0%	93%	6%	1%	0%
Manwl 071R	87%	12%	1%	0%	38%	50%	11%	1%
Manwl 143R2	44%	50%	6%	0%	15%	21%	31%	33%
Junwl 08L	63%	28%	9%	0%	50%	24%	22%	4%
Junwl 29R	51%	41%	8%	0%	32%	27%	26%	15%
Junwl 46L	53%	40%	8%	0%	39%	31%	21%	9%

CLASSIFICATION CRITERIA

	Degree of salinization	Degree of sodication
None	0 - 2	0 - 8
Slight	2 - 4	8 - 13
Substantial	4 - 8	13 - 20
Severe	> 8	> 20

Notes: [a]ECe = Electrical conductivity of soil extract in dS/m.
[b]SAR = Sodium Adsorption Ratio in $(meq/l)^{1/2}$.
Source: Kuper and Waijjen (1993).

Table 5B gives an indication of the salinity picture as seen in the visual survey conducted under the supervision of the DLR in the same channels for the same year. **A** comparison of the two **sets** of data shows that the visual survey can be very misleading in terms of actual salinity in the soil. Therefore, in-house laboratory facilities available with the DLR can be gainfully used to better categorize the affected lands and define the reclamation operations accordingly. Further, a more scientifically rigorous approach

in selecting blocks of land for additional supplies can improve the quality of the decision making on reclamation activities, and avoid the subjective selection procedure which is so vulnerable to pressure from informal sources.

The continued practice of relying solely on the salinity surveys conducted by Canal Patwaris through visual observation tends to reduce the credibility of the program. The presence of salinity-affected areas in most of the watercourse commands provides an easy justification for this practice, but that itself plaaes the whole procedure of selection entirely under the direction of the agency staff. This laxity provides for influential, resourceful and clever farmers to have a greater chance of being successful in getting their lands selected for reclamation.

Table 5B. *Visual* salinity according *to* the ***survey*** *of* the ***DLR*** for ***1992***

Watercourse command	Saline area
Manawl 024R	2.5%
Manawl 071R	0%
Manawl 143R2	0%
Junwi 08L	37.2%
Junwl 29R	0%
Junwl 46L	48.5%

Time Series Data

Yearly data obtained through *Thur* Girdawariprovide a time series record for establishing how the salinity situation has changed with time. In general, these statistics represent the trend in soil salinity as can be seen in Annex **E** and Figures 1 to 3 derived from consolidated data kept by the DLR (DLR 1992; Appendix 1). The data in Annex E show the position every year, starting from 1944-45, for a period of more than 45 years. While the surveyed area covering the irrigated land has steadily increased over time, reaching the limits of the total culturable command area, the relative proportion of the *Thur*-affected area increased gradually from 17.1 percent in 1944-45 to reach 21.7 percent in 1954-55, but it then declined to 15.0 percent in 1964-65, to 13.2 percent in 1974-75 and to 11.1 in 1984-85. However, since 1985-86, the percentage of affected area has again taken an upward trend to reach 12.8 percent in 1989-90. However, for the year 1991-92, the DLR's report (1992) shows that the salt-affectedarea has again declined to 12.4 percent of the total area surveyed.

Figures 1 and 2 show closer pictures of the time series data of the area surveyed for soil salinity and the saline area detected, respectively, for the period 1968 to 1992. Figure 3 shows, for the same period, the pattern of the saline area as a percentage of the area surveyed. According to these statistics, the surveyed area has reached a maximum possible by 1983 and remained at that level for a decade. Assuming that the total irrigated area was surveyed by the Canal Patwaris during this period, what is

discernible from Figures 2 and 3 is that the area affected by salinity started to steadily increase from 1985, although there is a slow downward movement since 1990.

Annual statements prepared by the Land Reclamation Officer (LRO), Thur and Sem Division, Lahore, present time series data for the last ten years classified into Jhurcategories. These statements also carry the totals of area surveyed and the Thur-affected area for each year. The data in Annex F1 and Figure 4 show that 65 percent of the saline area is Thur *Juzvi* and is cultivated, while the remaining 35 percent is uncultivated. The uncultivated saline area consists of Jhur Kohna (19%), Thur *Punjsala* (10%), and Jhur *Nau* (6%).

A close scrutiny of the two sets of time series data referred to above, Annex E, and Annex F1, read with Annex F2, indicates that their accuracy is suspect. First, the consolidated figures for the last few years in Appendix 1 of the DLR's report of 1992, which is reproduced in Annex E of this paper, do not tally with the total figures in the annual statements prepared by the LRO (Thur and Sem Division). A more disturbing

Figure 1 *Irrigated* area of *Punjab* surveyed for salinity by Canal *Patwaris*.

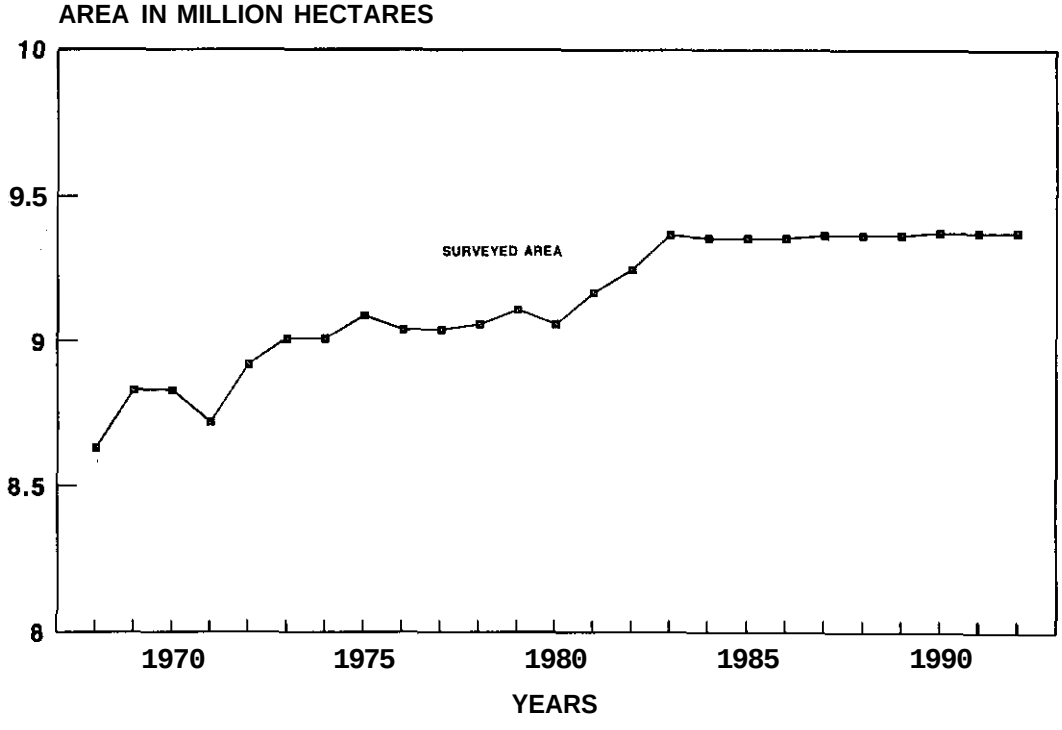


Figure 2. Salinity in irrigated areas of Punjab from 1968 to 1992.

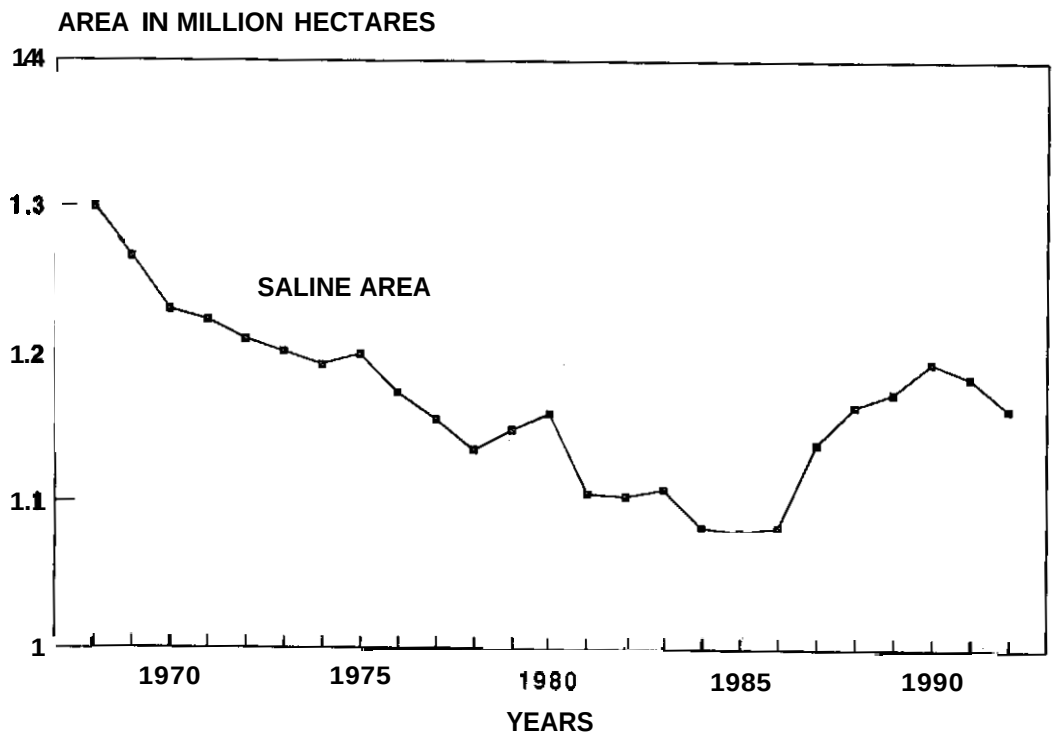


Figure 3. Affected area as percent of area surveyed from 1968 to 1992 (DLR data).

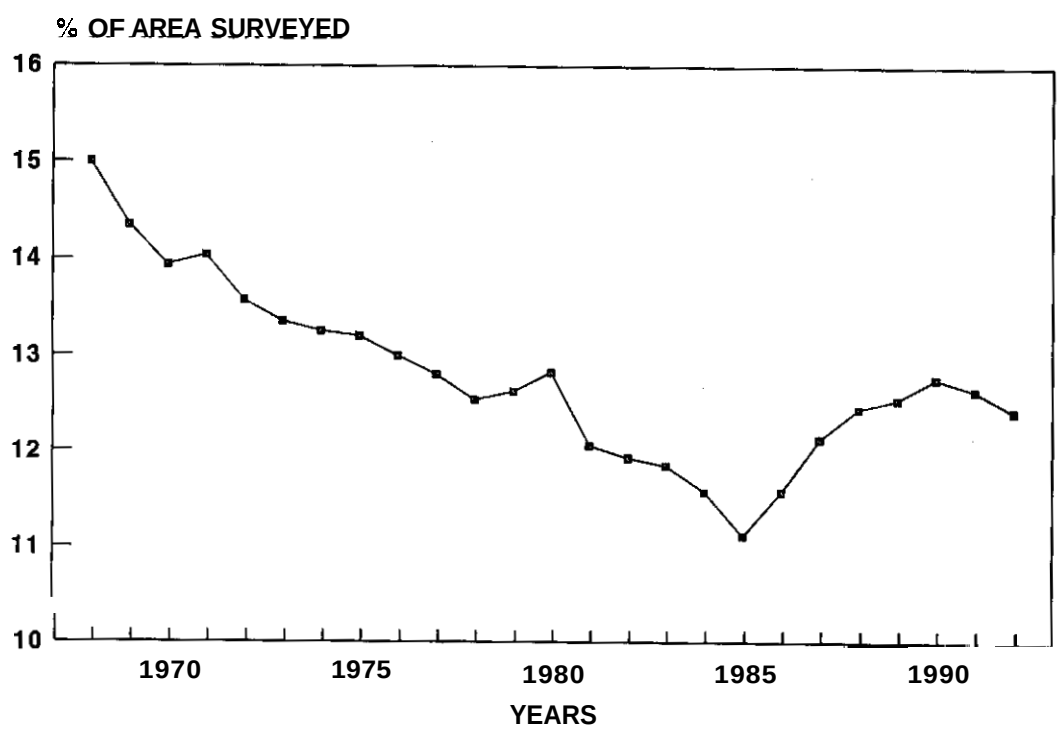
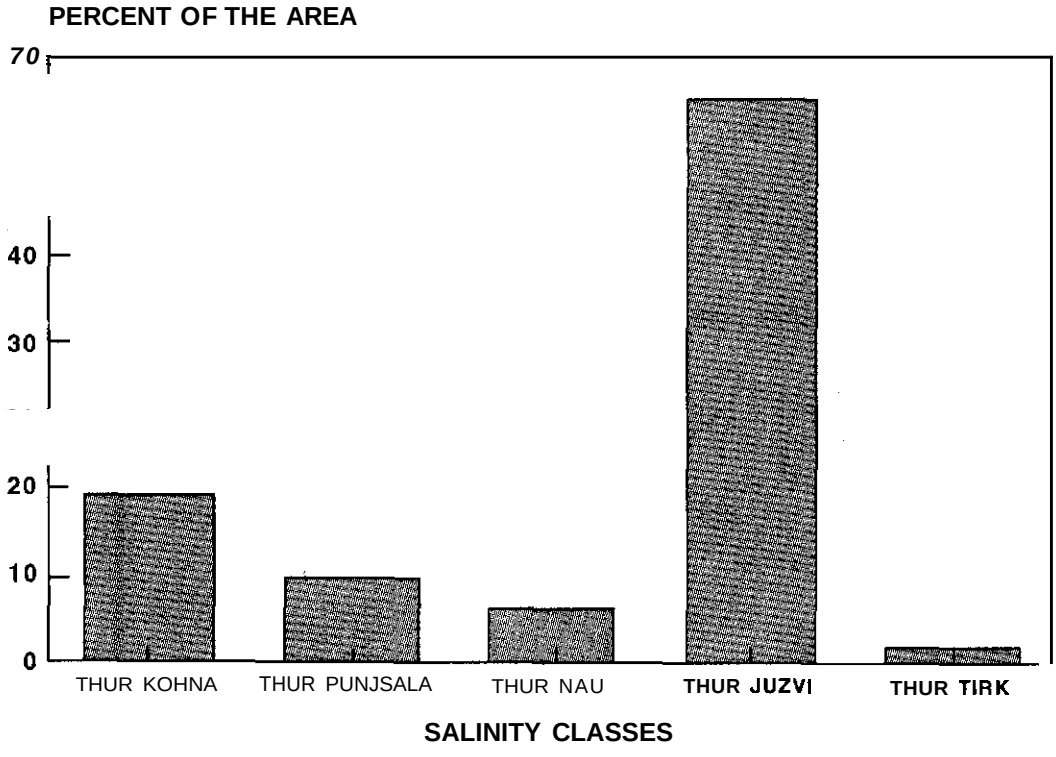


Figure *4.* Distribution of classified Thur in *Punjab (1982-92)*



feature of this discrepancy is that the figure for the total *Thur* area for some divisions, such as the LCC East Circle area, has remained at the same value for several years. Annex F2 gives the information on various items relating to the LCC East Circle, as extracted from the annual statements prepared by the DLR's office.

Planning for a Reclamation Program

According to procedure, the DLR staff have to propose a certain quantum of irrigation supply for reclamation purposes, keeping in view the *Thur* position of various channels on the basis of the visual soil salinity survey conducted each year. Data copied from the "Thur Abstract Registers" for the previous year are used to identify affected land by outlet, by village and by distributary. A tentative program is prepared and submitted to the concerned Executive Engineer (XEN) and Superintending Engineer (SE) for finalization. The XENs, after consulting their staffs on the program, on its maintenance and repair work and water availability in different canals, submit the *results of* their discussions to the SE with a copy to the LRO. After further consultation, the program is finalized by the SE. Annex G gives a copy of a "Tentative Reclamation Program" which has been issued by SE, LCC (East) Circle, for operations in the Upper Gugera Division during the kharif season of 1992.

Preparation of a Reclamation Scheme

Afler obtaining approval from the concerned SE for the tentative reclamation program, the DLR staff start their field work. They are expected to conduct another *Jhur Girdawari* (resurvey to check the salinity) in the reach of the channel where the reclamation supply have been agreed upon. According to original departmental procedure, reclamation activities were confined to only *Thur Juzvi* (cultivated *Thur*) and *Thur Nau* (uncultivated *Thur*) categories. Later in 1970, *Jhur Kohna* and *Thur Punjsala* were also declared eligible to get reclamation supplies (Lahore Irrigation Chief Engineer's Letter No. 1647/W-II/7023768-72/680/56, dated 24/11/70 addressed to SEs and the DLR). At present, all types of salt-affected soils are included in reclamation operations. While visiting the field for the checking of Canal Patwaris' work of *Thur Girdawari,* the Land Reclamation staff are also expected to explain to the farmers the conditions under which reclamation supplies are provided. Wide publicity is to be given in the villages through public address systems, *Chowkidars* or other personal contacts. At the same time, the cultivators are asked to apply for additional water supplies for reclamation purposes on prescribed forms.

Later, the Reclamation *Zilladar,* with the help of his staff, prepares "selection cases," for which selection of fields is done on-site and an agreement is made with the shareholders of the targeted outlets. These cases are submitted to the Sub-Divisional Office. The Assistant Land Reclamation Officer (ALRO) is expected to recheck about 20 percent of the selected area on each outlet. Then, the Zilladar prepares the Reclamation Scheme and submits it to the ALRO, and he, in turn, to the LRO. The LRO, after scrutiny, sends the scheme to the concerned XENs, SE, and Director Land Reclamation with copies to the concerned ALROs. The XENs prepare a "Shoot Statement," which is submitted to the SE for approval. After approval, orders for the fixation of the reclamation shoots are given in writing as well as on wire through a signaler. In the meantime, the Reclamation Patwari and Zilladar proceed to frame amended warabandi case5 and submit them to the ALRO, who sanctions reclamation warabandis before the release of the reclamation supply to ensure its proper utilization. In due course, the Reclamation Patwari goes to the shareholders of the outlets and arranges to prepare their lands which were selected for the purpose. On receipt of installation orders by the SE on a wire message through a signaler or through letter, the concerned Sub-Divisional Officer (SDO) of the Punjab Irrigation Department gives instructions to his Sub-Engineer (Overseer) for the fixation of pipes. Table 6 gives the activities involved in a reclamation scheme, including identification, approval and implementation.

Land Reclamation Operations in LCC (East) Circle

The Land Reclamation Officer (LRO), Lower Chenab Canal East Circle, has responsibility for reclamation activities in three branches: the Upper Gugera, Lower Gugera and Burala. The level of reclamation operations undertaken during kharif 1992 in the three branches is given in Table 2. A comparison of the saline area selected for reclamation activities with the irrigated area reveals that the extent of land reclamation is very meager. The saline area selected for reclamation supplies was only about 0.5 percent of the total culturable command area (CCA). Out of a total of 7,780 acres (3,149 ha) of selected saline area, only 57 percent was under rice which is one of the recommended reclamation crops for this season. This low percentage of area under rice confirms the farmers' comments during field interviews that the

Table 6. Activities involved in the preparation *of a* Reclamation Scheme.

Sr. No.	Activity	Undertaken by:	Scope of activity	Output checking by:	Reporting document
1	Annual Jhur *Girdawari* :salinity survey)	Canal Patwaris	Halqas (few villages)	Canal Ziliadar	Thur Khasras
2	Thur Girdawari Abstract	Canal Zilladar	Irrigation Division *(20 %)*	XEN, SOO, Canal Deputy Collector, Canal Zilladar,	Thur Abstract Registers
3	Checking of *Thur Girdawari* and limits (Kacha and Pacca Rabi Partals)	ID and the DLR Staff	2,000 acres 6,000 acres 6,000 acres 5,000 acres 10,000 acres 15,000 acres	LRO ALRO Reciamation Zilladar LRO T&S ALRO T&S Ziliadar T&S	
4	Use of ID *Thur Girdawari* data by the DLR tor preparing the Tentative Program	Land Reclamation Stan	Land Reclamation Circle	LRO	Tentative Program
5	Survey or the areas or the distributaries by outlets an which land reclamation operations are to be started	Reclamation Patwari	Land Reclamation Circle staff	LRO, ALRO and Zilladar	Selection Case
6	Preparation of "selection cases" of the selected fields to which reclamation supply is to be given. (includes applications from farmers, Sketch of watercourse command, selection list, agreements with farmers and preparation of modified warabandi).	The DLR staff, Patwaris, Ziiiadar and ALRO	Selected watercourse commands in Me whole Circle	LRO, ALRO and Ziliadar	Selection Case
7	Preparation of Reclamation Scheme	ALRO	Land Raciamation Circle	LRO	Reclamation Scheme
8	Certification for no tail-shonage	XEN	Canal Division	SE	Reclamation Shoot Statement
9	Final approval lor the Reclamation Supply for particular cases	SE	Canal Circle	SE	Approval Letter
10	Implementation of the scheme by installing a pipe outlet	Sub-Engineer	Irrigation Sub-Division	SDO	Compliance Letter

LRO = Land Reclamation Officer
ALRO = Assistant Land Reclamation Officer
ID = Irrigation Department
T&S = Thur and Sem
SE = Superintending Engineer
XEN = Executive Engineer
SDO = Sub-Divisional Officer

Note: 1 acre = 0.4047 hectare.

DLR's reclamation operations are not planned and initiated on time for them to start rice cultivation at the proper time in the kharif season.

In Table 7 where details on yearly allocation of reclamation supplies for the period 1986 to 1992 are given, a decreasing trend in the yearly reclamation supplies actually used can be seen until 1991-92. The data also show that during the last seven years the reclamation supply has been low relative to the demand. The decrease in additional water supplies for reclamation is partly attributed to the problems of maintenance of the canal network, and partly to the increase in demand for water for general crop production.

Table 7, Reclamation activities in *LCC* fast Circle ***(1985-86** to 1991-92).*

Year	Total *Thur* area (acres)	Reclamation discharge demanded (cfs)	Reclamation discharge sanctioned (cfs)	Reclamation discharge actually utilized (cfs)	Area operated (acres)	Area declared reclaimed during the year (acres)
1985-86	261,614	319.24	117.55	114.16	5,282	2,595
1986-87	255,102	300.50	162.55	159.34	7,187	1,637
1987-88	263,680	317.04	184.44	174.00	8,118	889
1988-89	263,638	332.17	174.19	159.36	7,213	1,525
1989-90	264,836	319.53	128.04	106.17	4,810	1,397
1990-91	263,638	386.62	124.96	106.14	5,022	580
1991-92		373.93	172.77	163.22	5,434	-

Note: 1 acre = 0.4047 hectare; 1 cusec (cfs) = 28.32 l/s.
Source: LRO Office, LCC East Circle, Faisalabad.

During kharif 1992, reclamation supplies were sanctioned for 163 watercourse commands, 62 of which were in the Upper Gugera Division, 65 in the Lower Gugera Division and 36 in the Burala Division. The data show that 66 percent of the total number of reclamation shoots were installed in the head reaches. 32 percent in the middle reaches and only 1 percent in the tail reaches of various channels **(see** Table ***8).***

As far as the operational details are concerned, only 2 percent of the pipe outlets were fixed in the month of June, 88 percent in July and 10 percent in August. The data show that 91 percent of the pipe outlets were closed in September and the remaining 9 percent in October. On average, reclamation shoots were operational for 79 days during the kharif season in the LCG East Circle. The average operational period for the Upper Gugera was 73 days, while it was 80 days in the Lower Gugera and 89 days in the Burala Division. This shows that the original prescribed period of six months has been restricted to less

than three months, mostly due to the shortage of water, and also due to delays in preparation of reclamation schemes.

Table 8. Operational details of the Reclamation Program of **LCC** East Circle, ***kharif 1992.***

Irrigation division	Sanctioned reclamation shoots		Location on channel			Operational details					
						Number fixed during:			Number closed during:		Number of average operating days
	Fixed	Not fixed	Head	Middle	Tail	June	July	August	September	October	
Upper Gugera	62	-	33	28	1	3	45	14	50	12	73
Lower Gugera	65	1	43	21	1	-	64	-	62	2	80
Burala	36	5	32	4	-	-	29	2	31	-	89
Overall	**163**	***6***	108	53	2	3	138	16	143	14	79

Source: LRO Office, LCC East Circle, Faisalabad.

Theoretically, a procedure as described above and a comprehensive time table exist for initiation, preparation and execution of reclamation schemes. According to the rules, the time required from preparation to approval is approximately one-and-a-half years. Activities to be undertaken during this period range from the checking of *Thur Girdawari*, verification of sufficient irrigation supplies in the distributary, preparation of tentative schemes, and the approval of the reclamation shoots. **The** prescribed time for the installation of the reclamation pipes was in early April. Later on, pressed by the shortage of supplies, it was shifted to early July when peak flows in the rivers are available due to the summer flood season.

However, **48** percent of the farmers in the study-sample area acknowledged that the cases were processed within two months due to the intervention of influentials, and 17 percent of the respondents reported that reclamation shoots were sanctioned on the basis of political considerations. Only 20 percent of the farmers confirmed approval through normal procedure.

The rules for remodelling of the channels and outlets for reclamation operations require that the **DLR** inform the concerned farmers where reclamation schemes will be located, before the distribution of reclamation supplies is effected. A tentative proposal for the scheme should be presented to them, inviting their applications for reclamation supplies, and asking them to prepare the fields before the end of kharif.

In the 20 sites where interviews were conducted with **40** farmers and other resource persons, only **40** percent of the respondents acknowledged that they obtained the relevant information from the **DLR** staff. The major source of information regarding reclamation shoots was, in fact, the farmers in the area, not the agency personnel. In practice, the proposals for reclamation shoots are largely motivated by the influence and the initiative of farmers. About ***50*** percent of the farmers in the study area reported that for acquiring additional water supplies, the initiative was taken by the individual farmers who were the village leaders, whereas **40** percent referred to group action by all the water users. About 10 percent of the farmer respondents reported a "struggle" or "a real effort" for reclamation shoots. The awareness of the farmers

about the final approving authority was checked through interviews; 60 percent identified the **SE** as the real authority, 35 percent the XEN, and 5 percent the LRO. Although this lack of awareness is typical of many state intervention programs in the rural areas, the quality of reclamation operations can be greatly improved with increased awareness among the water users.

The documentation prepared by the DLR staff for the selection of a watercourse command to be included under a reclamation scheme appears to be quite comprehensive, at least in volume, particularly in cases where the reclamation supply is given to scattered plots. In the study sample, 14 (70%) of the reclamation schemes were represented by the scattered plots, while 6 (30%) of them fell under the category of Compact Block. All Compact Block cases were found in the Upper Gugera Division.

WATER AVAILABILITY FOR RECLAMATION SUPPLIES

The details of reclamation supplies utilized during the period from 1948-49 to 1990-91 are shown in Annex H and a graphic presentation of the same data for the period from 1968 to 1992 is shown in Figure 5. Since its establishment in 1945, the DLR claims that it has reclaimed about 0.5 million hectares of the irrigated area of the Punjab (Annex H). However, the data also shows that since around 1979, there has been a steady decrease in additional water supplies available each year for reclamation, resulting in a corresponding decrease in area operated or treated, and reclaimed.

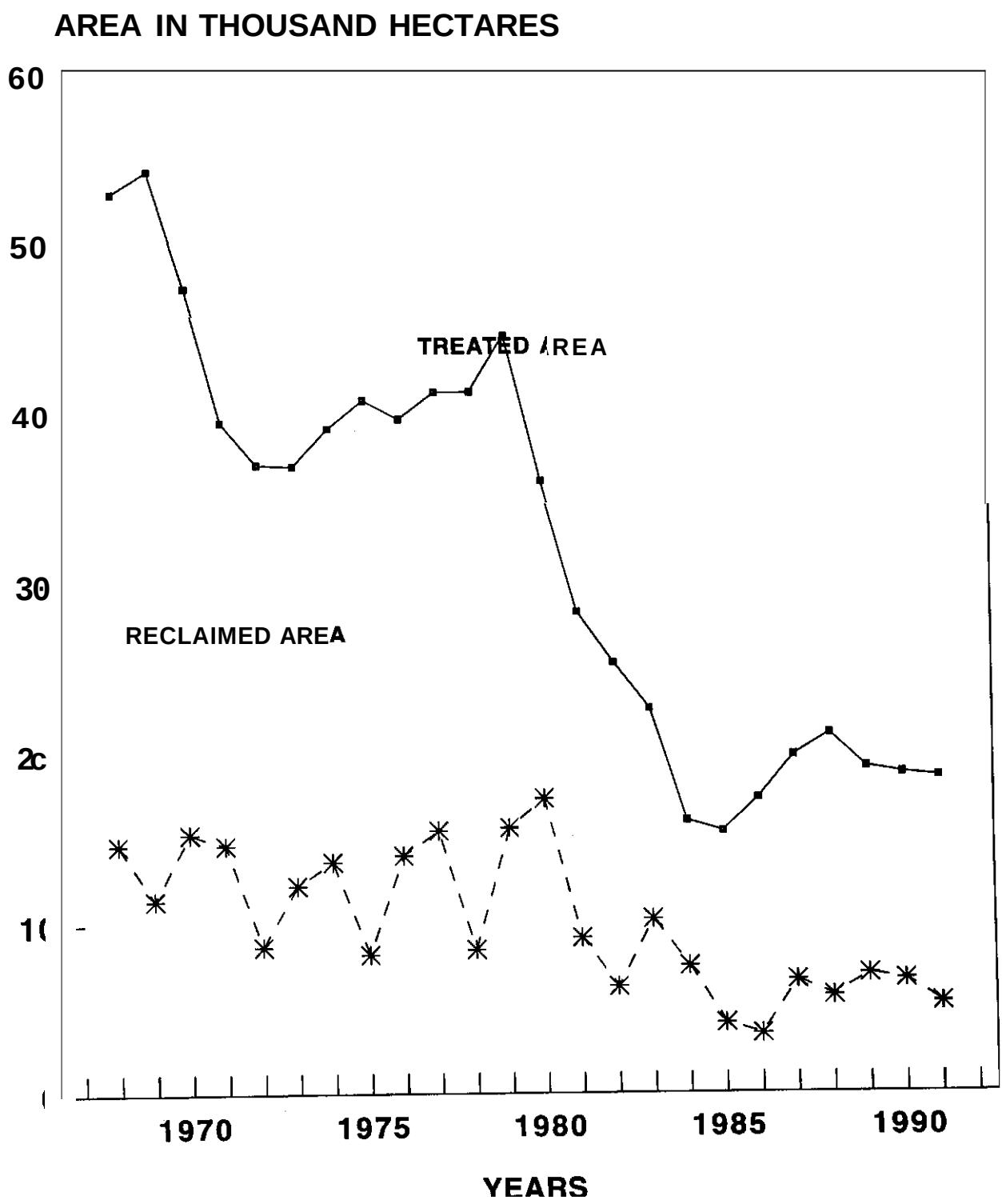
Additional Water Supplies for Reclamation

Figure 6A, which is derived from the DLR's data in Annex H, gives the average reclamation supply actually utilized during recent years, in liters per second per hectare. The wide fluctuations in the per-hectare use of water for this purpose reflect the variability in the supply, or a lack of adherence to the prescribed criteria for operating reclamation shoots.

Using this data, an attempt was made to roughly identify the scope of these reclamation supplies for leaching purposes. Since rice is the most water-consuming crop among the crops recommended during reclamation, the maximum amount of water that rice would require indicates the level of crop water requirement during these operations. Following the observations by Murray-Rust and Vander Velde (1992), it was assumed that the rice crop was normally given sufficient water, about **10** mm/day, to avoid stress, and accordingly the equivalent of this was marked in Figure 6A at the level of **1.15** liters per second per hectare. It is clear from Figure 6A that a macro-level analysis of the DLR's data given in Annex H points to the **use** of a substantial amount of water for leaching purposes during this period. Figure 6B shows the same effect when data is converted into Relative Water Supply (RWS) terms.

Additional canal water is to be provided during the summer season through special outlets according to provisions under the "rules for the remodelling of channels and outlets required for the distribution of reclamation supplies." According to these rules, the distribution of reclamation supplies **must** be based on the distributary as a unit. For any distributary on which reclamation is to be taken up, a hydraulic survey of the channel and its minors is required. However, no such activity was observed during the study in any **of** the selected distributaries.

Figure 5. Area treated and reclaimed, from 1968 to 1991 in Punjab.



Theoretically, the amount of water made available for reclamation should be supplied over and above the design supplies of a given distributary. In addition, a formal prerequisite for the approval of a reclamation scheme is a certificate issued by the **XEN** of **the** Irrigation Division concerned that there will be no shortage of irrigation supply to the tail of the distributary. The study showed that this formality was being observed as a routine, without considering actual hydraulic data or monitoring of the tail supplies.

Although there is a general belief within the Irrigation and Power Department and the **DLR** that additional amounts of irrigation water is made available at the offtakes of the distributaries, the study found no evidence to substantiate this belief. Monitoring of flow gauges, both at the heads and tails of the seven distributaries, indicated that no extra water was made available during the operation of reclamation outlets, A further decline of irrigation supplies was observed at the tails of all the distributaries studied.

Head and tail supplies of all the sample distributaries were monitored during *kharif* 1992. Table 9 gives a comparison between the design head gauge and the monthly average of the head gauge readings of six channels in the study sample. The notion that reclamation shoots are based on additional water supplies provided during kharif is not supported by this data; in each of the six channels, the head discharge is less than the design discharge.

Figure ***6A.*** Canal *supply* allocated *for* reclamation *from 1968 to* ***1991*** in *Punjab.*

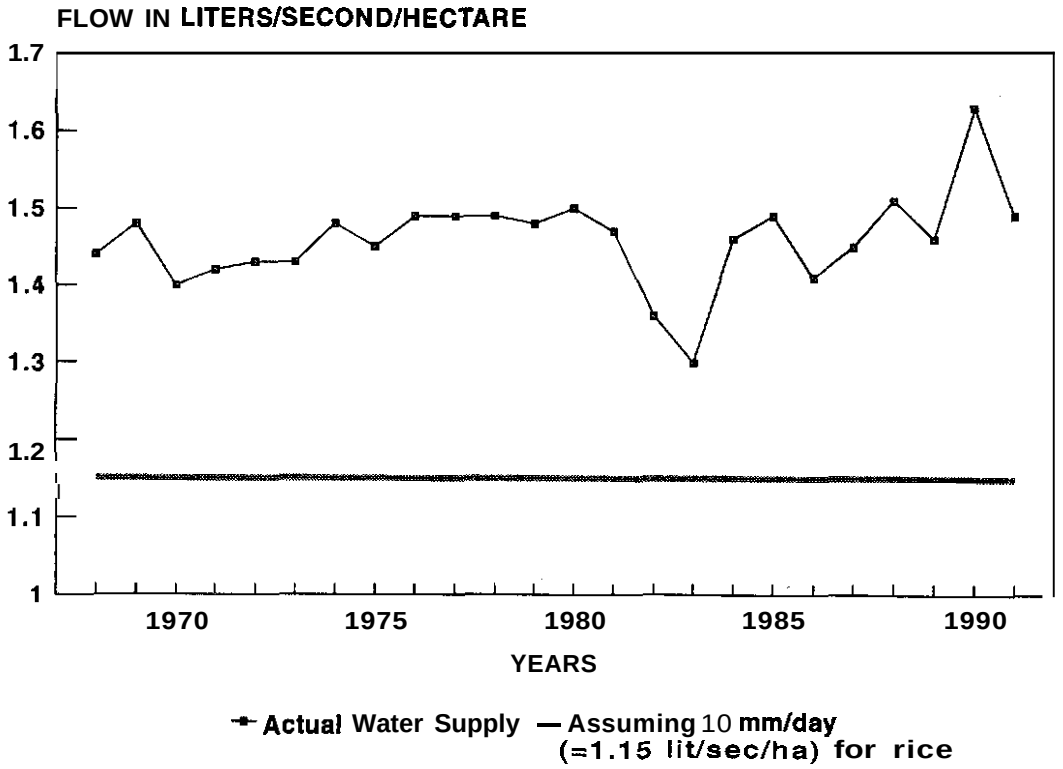


Figure 6B. *Irrigation* water for reclamation *in terms* of RWS *in Punjab (1968 to 1991).*

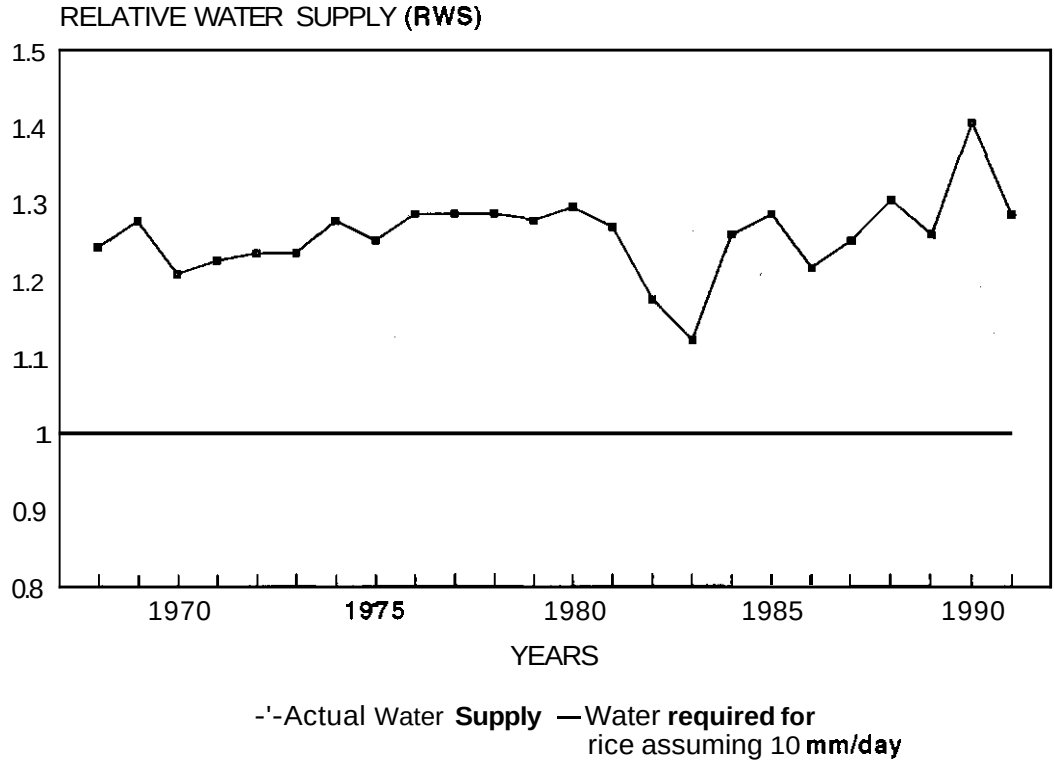


Table *9.* Design head gauge versus observed head gauge of sample channels,

Distributary/ minor	Design head gauge (feet)	Average, observed head gauge, kharif 1992 (feet)							
		March	April	May	June	July	August	September	October
Lagar	1.89	1.45	1.58	1.66	1.65	1.63	1.50	1.41	1.62
Mananwaia	5.20	4.34	5.01	5.07	5.08	5.14	5.10	4.81	4.68
Karkan	3.31	2.51	2.96	3.06	3.09	3.04	3.04	2.58	2.51
Yakkar	1.25	1.18	1.03	1.07	1.21	1.22	1.26	0.99	1.05
Bhun	1.10	1.01	1.08	1.14	1.31	0.94	1.04	1.07	1.08
Rajana	1.20	1.13	1.24	1.19	1.05	1.12	1.05	1.07	1.09

In the case of the Kot Pathana Minor, four discharge measurements were taken during the months of September and October. The average, measured head discharge for Kot Pathana was 9.36 cusecs (265.1 l/s), compared to the design discharge of 13 cusecs (368.2 l/s).

Figures **7** to 13 are derived from this information, and selected tail gauge readings and measurements. These figures present a comparison of actual and design supplies both for the heads and tails of the sample channels. Figures 7 to 13 show that the irrigation supplies to the watercourses at the tail of the distributaries were considerably reduced when reclamation shoots were installed during July to August.

The reclamation shoots installed under these conditions cause a further reduction of canal water supplies at the tails, which are already short of supply, and this leads to increased salinity in the tail-commanded areas contrary to the purpose of reclamation operations.

In the Kot Pathana Minor, it was observed that even when water did not reach the tail, a reclamation shoot was still operating in the middle reach of the minor. During the whole study period, water never reached the tail area in the minor, even though the Executive Engineer had issued the formally required certificate that the tail will not suffer.

Figure 7. Monthly average readings *of* gauge at head and tail, *Lagar* Distributary.

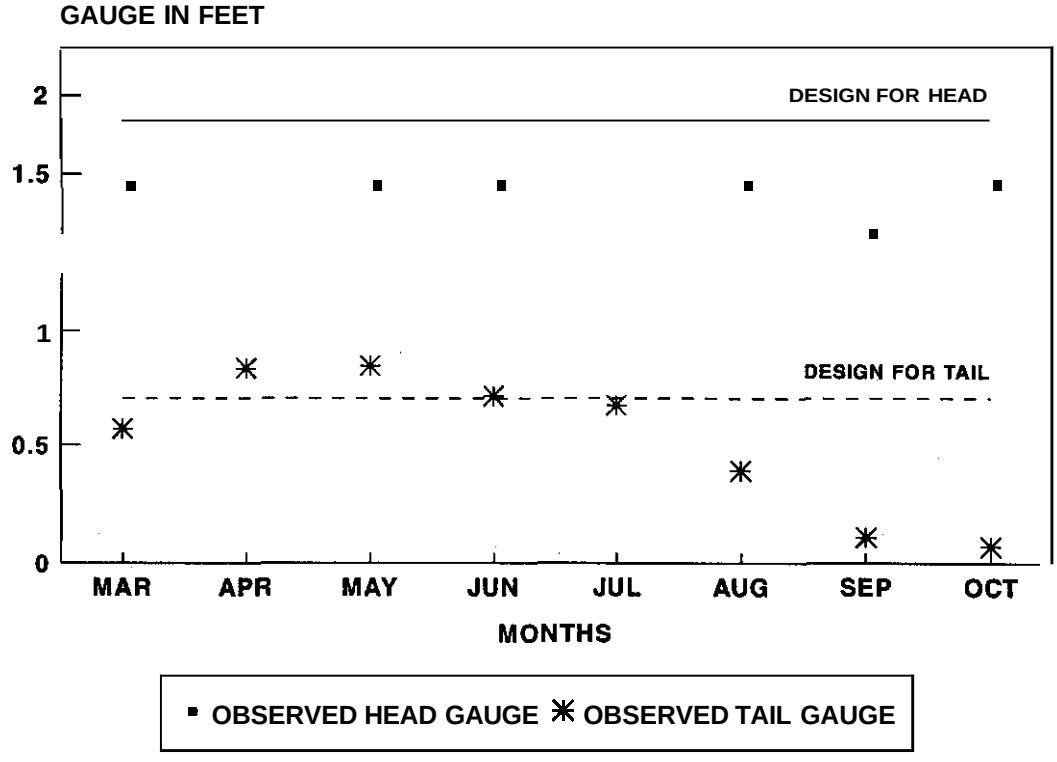


Figure 8. Monthly average readings of gauge at head and tail, Mananwafa Distributary.

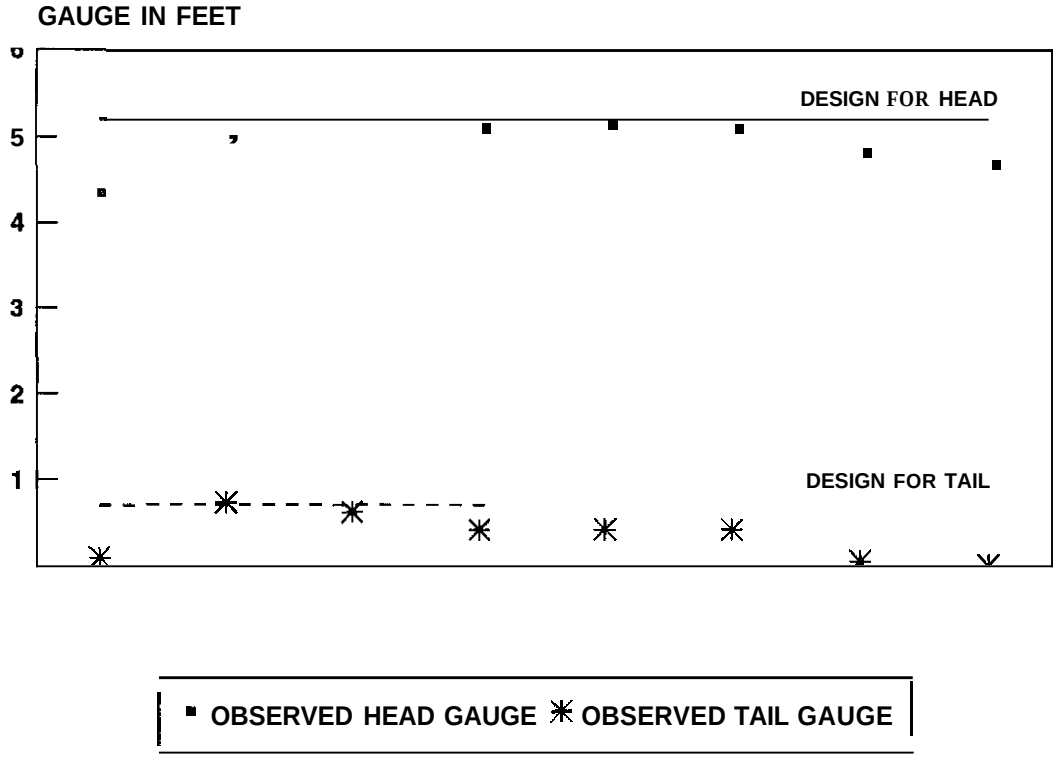


Figure 9. Monthly average readings of gauge at head and tail, Karkan Minor.

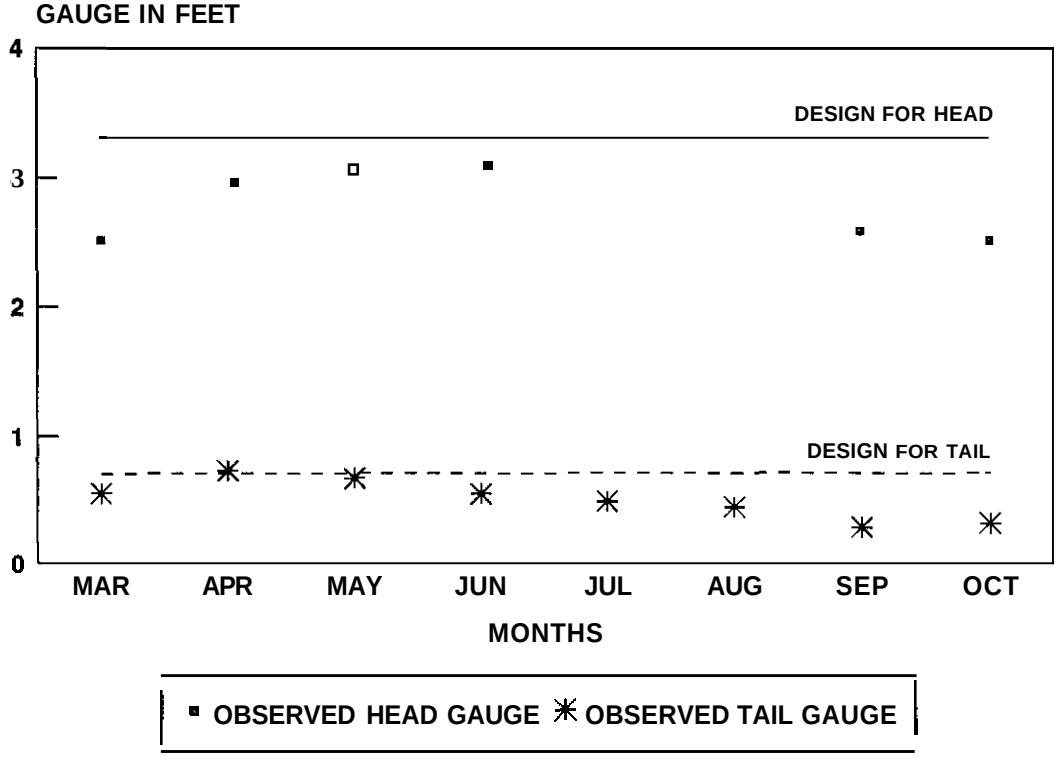


Figure 10. Monthly average readings of gauge at head and tail, Yakkar Distributary.

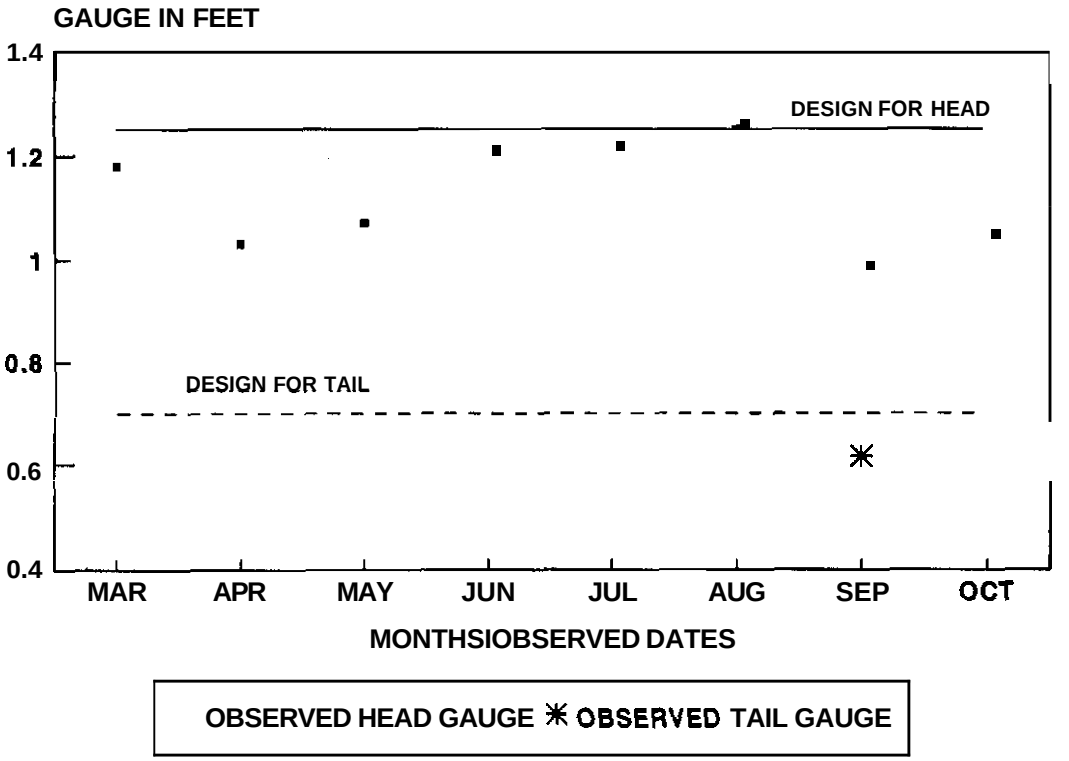


Figure 11. Monthly average readings of gauge at head and fail, Bhun Distributary.

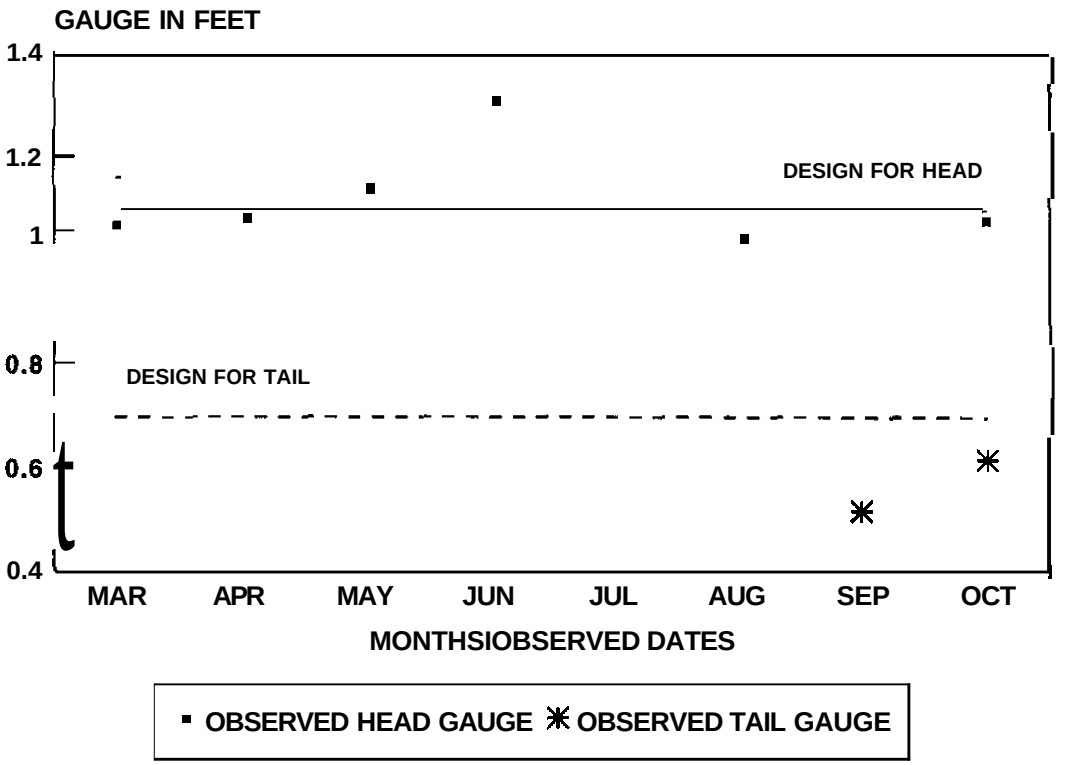


Figure 12. Monthly average readings of gauge at head and tail, Rajana Distributary.

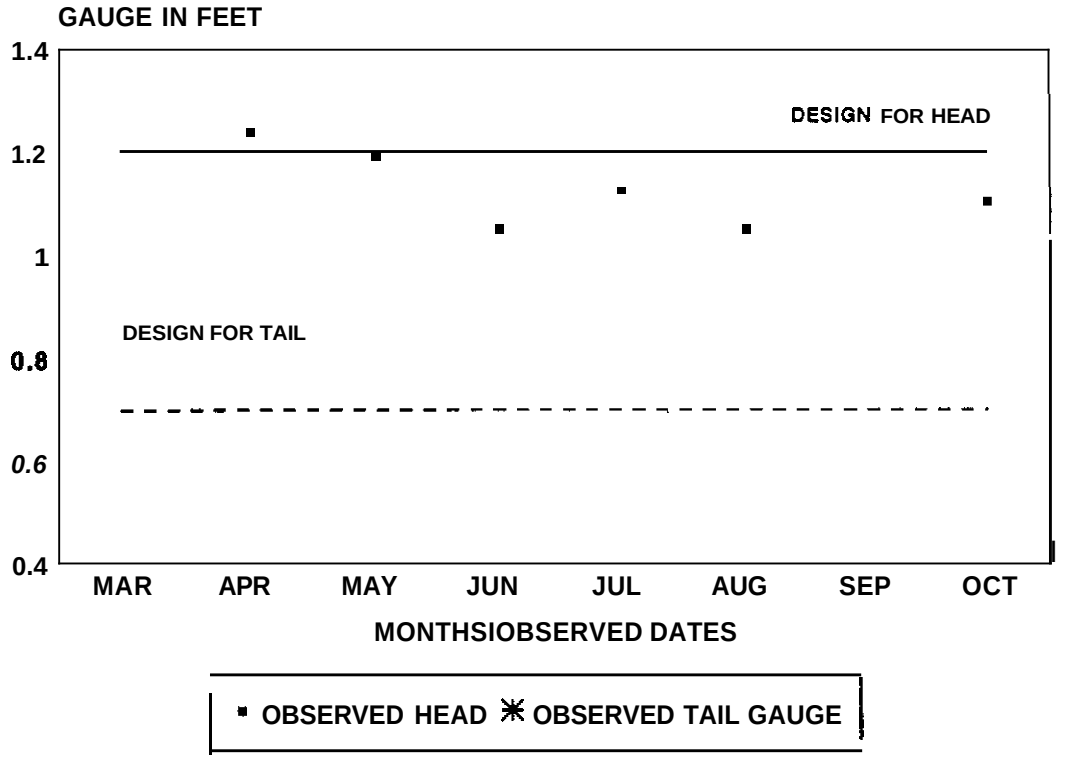
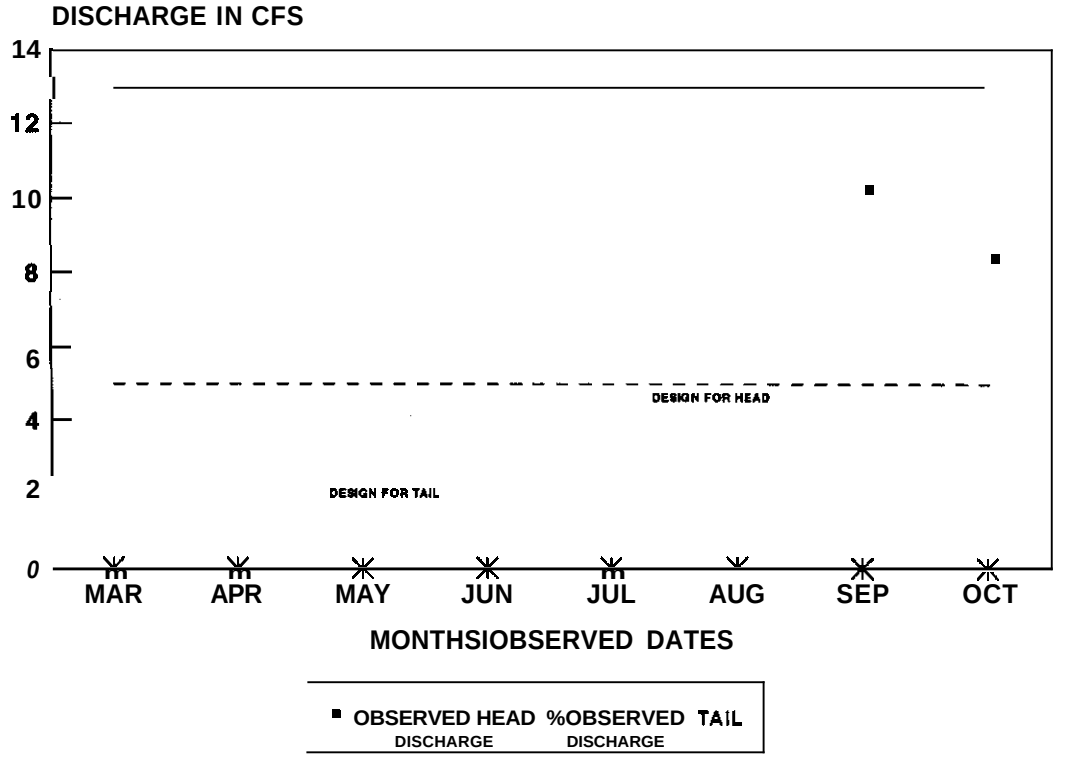


Figure 13. Monthly average flows at head and tail, Kot Pathana Minor.



Location of Reclamation Outlets

Table **3,** given in Section III, shows that of the **20** reclamation shoots monitored in the study sample, **12** were in the head reaches of the distributaries, while **8** were located in the middle reaches and none at all in the tail reaches. Since this appeared to be almost like part of an officially accepted phenomenon **,** the observation was checked with the DCR staff. The reason given was that irrigation supplies at the tails were always considerably less than their due share, and it was not possible to convey additional supplies for a reclamation shoot in the tail area unless substantially increased supplies were delivered to the distributary. However, during the study, an interesting exception to this general pattern was observed, which might even provide an exemplary solution to the problem. The tail outlet **No. 65,000** TL of the Jurian Distributary in the Upper Gugera Division was provided with an additional supply for reclamation from the main canal itself, at RD **30** (L) in the head reach of the Mian Ali Branch.

The conspicuous absence of reclamation outlets in the tail portions of the distributaries draws attention to two interrelated system management issues. One is that the tail command areas are inherently short of water relative to their authorized share, and the other is that as a consequence, reclamation facilities cannot be provided to the tail reaches, which in fact are observed to be the areas most affected by salinity. This is further compounded by the fact that reclamation outlets given a much higher duty of water than the normal outlets become instrumental in further depriving the tail areas of their due share of water (as will be shown below, no regulatory adjustments are made for making extra water available at the offtakes of these distributaries).

Discharge of Reclamation Outlets

While the sanctioned discharge for each watercourse is assumed to comply with the design duty determined by the irrigable extent of land, in practice, gross deviations can be observed. Special reclamation shoots are not exceptions to this behavior. Table **10** shows the deviations observed in **14** sample outlets. They not only vary substantially, the average actual discharges ranging from **64** percent to **400** percent of the sanctioned or the design discharges for the respective "shoots," but also, in many instances, they draw more than the regular outlets (when compared with data in Table **3).** The resultant inequity extends itself to downstream water users who stand to lose even on their regular irrigation supplies. The degree of variability within watercourses can be seen in the measure of the coefficient of variation given in Table **10.**

Lagar Distributary

The Lagar is one of the seven distributaries in Farooqabad Sub-Division, Upper Gugera Division, of the Lower Chenab Canal system. It offtakes from the right bank of Upper Gugera Branch Canal at RD 108000. Lagar has a total length of **62,218** feet **(18,950** meters) and a design discharge of **38** cusecs **(1,076.2** l/s) to supply 29 outlets **(6** of which are directly supplied from Jhinda Minor). These outlets serve a culturable commanded area (CCA) of **16,356** acres **(6,619** hectares) from an average authorized gross command area of **18,408** acres **(7,450** hectares). The average authorized outlet discharge is **1.13** cusecs **(32** l/s) serving a CCA of **585** acres **(229** hectares). Discharge into the Lagar Distributary is not regulated by a gated structure; rather stop logs (*karries*) are used to control the flow into the head of the channel.

Table *10.* Details *of* reclamation shoots under observation

(1) Watercourse command	(2) Selected area (acres)	(3) Sanctioned discharge (cfs)	(4) Average actual discharge (cfs)	(5) Coefficient of variation (%)	(6) Start (days from 1 July)	(7) Termination (days from 1 July)	(8) Duration (% of the theoretical 90 days)
1052-R	22.25	0.50	1.60	11	9	110	112
17541-R	45.43	1.00	1.74	4	1	110	121
16330-L	21.79	0.50	2.00	10	22	110	98
133983-R	22.25	0.50	1.48	5	-4	92	107
26475-L	22.71	0.50	0.73	7	21	110	99
49985-R	45.11	1.00	0.94	4	-6	98	116
27062-L	42.50	1.00	1.20	13	-8	116	138
34875-L	45.42	1.00	1.12	5	6	100	104
10229-R	68.10	1.51	1.44	0	17	108	101
5150-L	34.76	0.77	0.72	12	23	94	79
10164-L	34.38	0.75	0.71	8	23	94	79
11900-L	34.41	0.76	0.49	7	27	110	92
13753-L	32.98	0.73	0.52	11	27	110	92
8920-L	90.00	2.00	1.73	10	65	107	47

Note: 1 acre = **0.4047** hectare; 1 cusec (cfs) = 28.32 l/s).

Five reclamation outlets with a total sanctioned discharge of 3 cusecs (85 l/s) were approved and operated in kharif 1992, despite the fact that the distributary itself never received its sanctioned discharge. Another reclamation outlet has been sanctioned from the Lagar Distributary to a command area outside that of Lagar. in the Main Upper Gugera Canal command. Figure 7 presents a comparison of the design head gauge and tail gauge readings with the observed or measured head gauge and tail gauge values. It can be seen that the tail supplies were minimum during the period *of* reclamation operations. Thus, the reclamation operations were carried out in **the** head and middle reaches of the Largar Distributary at the expense of its tail command areas.

EFFECTS OF RECLAMATION SUPPLIES ON FARMING PRACTICES

The farmer's decisions on cropping and irrigation management are based on his own priorities, knowledge, experience and resource availability, but they are conditioned to a large degree by the availability of irrigation water. His compliance with advice and recommendations from government agencies primarily depends on how such instructions are useful to him in maximizing his farm income.

Prescribed cultural and management practices are an essential accompaniment to the reclamation operations employed by the DLR. In itself, the technique of leaching of salts with additional water supplies is a universally accepted practice, but the accompanying recommended farming practices are restricted by various contextual conditions such as existing cropping patterns and farmer preferences. In this instance, the recommendations include the cultivation of certain specific crops and the way water is to be applied to the field.

Field Preparation

The DLR staff specify certain field preparations for reclamation purposes. The cultivator is required to level the fields, construct levees for holding water in the plots and apply water every seven days to start downward movement of salts, thereby lowering their surface concentration.

Each farmer whose area has been selected for reclamation is required to lay *Thur*-affected fields roughly in quarter-acre plots with a watercourse in the middle. However, no such practice was seen in the study area. Farmers could not specify anything different than what they would routinely do for normal irrigation and crop production.

Reclamation Crops

The cropping rotation during reclamation includes the growing of rice in the summer followed by berseem fodder or gram during the winter. Berseem is grown using the normal water supply as the additional water supply is cut off during the winter. In non-perennial areas, gram is cultivated on residual moisture *(wadh wattar)* of the preceding rice crop. Provision of crop cover during the winter is very essential to control the upward movement of salts. Green manuring with Jantar (*Sesbania Aculeata*) preceded by the growing of rice is considered a very desirable practice to add organic matter and to improve the fertility of the soil,

The majority of soils having soluble salts is expected to be easily leached within a cycle of operations for three years. However, if a field still shows patchiness and the farmer needs the additional supplies for a longer period, he can apply to the DLR for an extension of operations. In response to an application for extension of the period of reclamation operations, soil samples are supposed to be collected and analyzed by the DLR staff. In the light of the results, reclamation operations may be carried out beyond the three-year period.

Selected crops are those which can withstand the increased quantity of water applied during leaching operations. To ensure proper leaching, the cultivation of any crop other than those recommended as reclamation crops is prohibited. Violation of this requirement is liable to be dealt with *tawan* (fine), but the enforcement of this restriction seems to be difficult. During kharif 1992, in 14 sample watercourses, about 36 percent of the area selected for reclamation did not use the water for recommended reclamation crops (see Table 11). In the whole study area, no instance was reported where *tawan* was levied on defaulters.

Table *11. Cropping patterns* observed *in* the *study* area.

Watercourse	Total (acres)	Area planted with recommended crops (acres)		Area planted with other crops (acres)	Area for reclamation only (acres)
		Rice	Jantar		
UG-MA 49985-R	45.11	30.06		7.04	8.01
UG-LA 1052-R	22.25	22.25			
UG-LA 16330-L	21.79	21.79	-	-	
UG-LA 24200-L	22.25	22.25			
UG-LA 25100-L	29.69	29.69			
UG-LA 17545-R	45.43	40.23			5.20
UG-KN 25150-L	42.51	23.10		8.20	11.21
UG-KN 34875-L	45.50	26.20	-	10.18	9.12
LG-YA 10229-R	68.00	15.92	8.52	0.75	42.81 †
LG-BH 5150-L	34.90	8.38	6.31	2.50	17.17
LG-BH 10164-L	34.63	0.75	8.38		25.50
LG-RA 11900-L	34.41	2.10	1.15	17.98	13.00
LG-RA 13753-L	32.98	2.25	4.96	19.30	6.45
BU-KP 8920-L	89.38	89.38			
Overall	568.09	334.35	29.32	65.95	138.47
Percentage		59%	5%	12%	24%

† A large proportion of land in this watercourse command had been affected by poor quality groundwater and, therefore, required relatively larger allocations for reclamation purposes.

Note: 1 **acre** = 0.4047 **hectare.**

No significant difference was observed between the cropping patterns of areas under the reclamation schemes and patterns of other areas. The Upper Gugera Division comes under the rice-wheat zone while the Lower Gugera Division and Burala Division fall under the mixed cropping zone. The cropping pattern in case of reclamation shoots follows almost the same degree of difference.

Of the interviewed farmers, 20 percent supported the general observation that additional water supplies were in fact being used for ordinary crop production rather than for reclamation purposes. These farmers acknowledged that the reclamation shoots were installed to get the additional supplies of good quality water for general crop production rather than for the reclamation of soil. Of the sample, 38 percent of the farmers acknowledged that reclamation supplies were being used to increase the extent under rice. One farmer who succeeded in obtaining a reclamation shoot for a block on account of his "informal pressure" was even found selling extra water to other farmers in the area. In fact, farmers have started to call these additional supplies as "grow-more-rice shoots."

Revision of Warabandis

Rules specify that when the reclamation program has been approved by the competent authority, the Land Reclamation Officer will have to prepare modified warabandis taking into account the additional water allocations. In cases where reclamation supplies have been sanctioned for Compact Blocks, to an individual farmer or to a few farmers, this was not required. The study found that the DLR staff did prepare revised warabandis where they were required, but farmers never adopted them. No effective modified warabandi was found in the study area, and it was observed that the farmers whose lands had not been identified for reclamation were also sharing reclamation supplies. This practice further confirmed the absence of a modified warabandi schedule.

Use of Groundwater

Usually farmers have to meet the water requirements of their crops with supplemental irrigation through groundwater development. The increased availability of irrigation water from private tubewells has helped farmers to sustain already high cropping intensities in the study area. During the study period, a survey was conducted with private tubewell users in 14 sample outlet commands where reclamation shoots were operational (Table 12). According to user perceptions, the proportion of tubewells with good quality water is 39 percent in the Upper Gugera Division as compared to 65 percent in the Lower Gugera Division. The average quality of water in the former case was 61 percent as against only 8 percent in the latter. The poor quality of tubewell water was reported only in the Lower Gugera area which was in 27 percent of its total number of tubewells. The greater use of poor quality water in the Lower Gugera is due to reduced supply of canal water for irrigation purposes. Wherever good quality groundwater is available in the sweet water zone, it can also be used for reclamation purposes. Some consideration should be given to this aspect.

Table *12.* **Farmers' perception** *of* **groundwater** ***quality*** **in reclamation command areas during** ***kharif 1992.***

Reclamation command	Total No. of tubewells	Perceived quality of water		
		Good	Averaqe	Poor
LGR 1052-R	12	12		
LGR 17541-R	13	13		
LGR 16330-L	17	-	17	
LGR 133983-R	21		21	
LGR 26475-L	15		15	
MNW 49985-R	*8*		8	
KRN 30079-L	7	7		
KRN 34875-L	14	10	4	
Upper Gugera	107	42 (39%)	65 (61%)	
YKR 10229-R	8	2	6	
BHN 5150-L	14	12		2
BHN 10164-L	11	9		2
RJN 11900-L	11			1:
RJN 13753-L	4			4
KPM 8920-L	23	23		
Lower Gugera	71	46 (65%)	6 (8%)	19 (27%)
Total	178	88 (49%)	71 (40%)	19 (11 %)

IV. Conclusions

DESPITE THE **FACT** that the results reported and discussed in this paper relate only to a small percentage of the overall number of reclamation schemes in the Punjab, they represent the field situation, in general, and provide adequate support for a number of important conclusions.

The DLR's time series data on the extent of salinity show very little variation over the years. The practice of collecting salinity data through annual visual surveys conducted by field staff appears to have become a mere routine and to have deteriorated in accuracy.

The present method of selecting saline-affected lands for reclamation operations is highly vulnerable to undue influences. In the absence of a well-supervised and technically supported selection process, the field staff of the agencies are easy targets of these influences. The reclamation operations were originally intended for lands with salinity classed as *Thur Juzvi* (land salt-affected to the extent of ***20%)*** and *Thur Nau* (land deprived of cultivation during the preceding five years), both based on annually conducted visual surveys. However, the operations can now be sanctioned for any class of saline-affected land as visually assessed. This liberalization has increased the subjectivity in the selection process.

Primarily, the sanctioned reclamation shoot has virtually become an unfair means of obtaining extra canal irrigation supplies for agricultural production, particularly for rice cultivation during kharif; its **use** as an additional supply for the leaching of salts has become a secondary concern.

A major reason for the misuse of these extra supplies is the poor level of information related to reclamation programs reaching the farmers as a common group. The initiative for establishing reclamation shoots seems to be mostly from individual farmers, after which the prescribed procedure usually follows as a routine. For the approval of a reclamation scheme, a great deal of follow-up at each stage is required, from the Reclamation Patwari who does the initial assessment, to the Superintending Engineer who has the final authority. The original officially prescribed period of six months from 16 April to **15** October for reclamation schemes has now been reduced to a period of only three to three-and-a-half months from **1** July to 15 October. Within this restriction, there are many variations in their actual periods of operation. As the time becomes limited, even where farmers are generally informed of approved reclamation programs, they face many difficulties in having reclamation outlets installed in time; those who have prior knowledge and means to get things done have a greater chance of benefitting from the system.

No additional water is being made available to compensate for reclamation supplies. Since reclamation shoots are generally given in the head and middle reaches of a distributary, the water-short tail reaches tend to suffer more. This means that, in general, the additional supplies for reclamation purposes can contribute to increased inequity in water distribution. Further, this has an effect of exacerbating the salinity problem in the command areas located at the tail of the distributaries.

There is little evidence of any significant improvement having been made on the standard rules established half a century ago. The procedure adopted at present does not include any monitoring activity to find out whether the reclamation of a block of affected land has been successful, or whether the effort can produce long-term effects. If increased water supplies are to be maintained for a period longer than the stipulated three years, or if the water allowance has to be increased substantially, then the method is

nonviable under the prevailing conditions of irrigation water scarcity which, in fact, has resulted in a reduction of the reclamation supplies by more than ***50*** percent during the last **45** years. Additionally, the lack of follow-up by the **DLR** to advise cultivators on improved cultural practices, coupled with **the** lack of concern and awareness among the cultivators, creates such an environmentthat the fundamental objective of improving and sustaining yields is rarely realized.

Finally, the status of the Directorateof Land Reclamationwithin the family of agencies in the sector does not seem to **be** adequate for it to **be** able to play an effective role vis-a-vis the other agencies, as well as the farmers.

V. Recommendations

1. THE PRESENT METHOD of visual appraisal of saline areas should be improved by supplementing it with more scientific soil testing methods. Greater supervision is needed to improve the quality of this appraisal and the related data collection. The selection of blocks of land for reclamation should be systematized to make the selection process more objective.

2. Information on planned reclamation programs should be made freely available to all the farmers in the affected area, and their participation be obtained in the decision-making process.

3. Planning for reclamation should be undertaken on a system-wide basis so that the availability of additional water could be assessed and taken into account in deciding reclamation operations in areas where they are mostly needed.

4. Suitable tubewell water should also be considered in the assessment of overall water availability for reclamation shoots.

5. In a more scientific and comprehensive planning process for reclamation operations, consideration should be given to the location of reclamation shoots in tail areas of canal commands.

6. The DLR should be given the necessary resources to monitor and evaluate its reclamation operations both during and after their implementation. Several federal and provincial institutes and organizations with a mandate for salinity research are operating in the Punjab. Some of them even have facilities for their field operations. There should be some mechanism for linking the **DLR** with these institutes and organizations formally or informally to integrate their activities. For the program to be effective, the **DLR** should be given due legal and social recognition to provide it with the necessary authority for independent action.

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Appendix

IRRIGATED AGRICULTURE AND SALINITY IN PUNJAB

THE **IMPORTANCE OF** agriculture in Pakistan's socioeconomic environment cannot be overstated. The country's fertile culturable land serves as the mainstay of sustenance for its 120 million people, nearly 75 percent of whom live in rural areas and are mostly involved in agricultural pursuits. Agriculture employs a little over half the total labor force and accounts for more than a quarter of the country's export earnings. Although agriculture's share of the GDP has been declining, its present level remains at 26 percent compared to its share of 53 percent in 1950. Pakistan also has a long tradition of agriculture, which is closely woven into its social fabric, and to date, particularly irrigated agriculture plays a very significant role in the country's political economy. Any problem relating to irrigated agriculture, therefore, is a matter of concern to many in Pakistan.

The climate and the substantial water resources endowment of Pakistan have made its culturable land resources suitable for year-round agricultural production. The country's persistent efforts in developing extensive infrastructure has enabled nearly 80 percent of its cultivated land to be served by irrigation. However, this dependence on irrigation for agriculture has tended to make the country easily vulnerable to environmental degradation problems associated with irrigation, which, in turn, have started to impose limitations on production. Of these problems, salinity is considered a serious threat to irrigated agriculture in Pakistan. Grossly estimated, salinity is supposed to affect about 25 percent of the total irrigation canal command area in Pakistan, and about 9.7 percent of its Class I and Class II soils (Pakistan National Conservation Strategy 1991:29).

Of Pakistan's four provinces, the Punjab, meaning the land of five rivers, accounts for the largest share (almost 70 percent) of the country's cropped area. Punjab also produces the major part of the export commodities, 95 percent of Basmati rice and 88 percent of cotton, and accounts for about 72 percent of Pakistan's wheat produce and ***55*** percent of sugarcane (Punjab Bureau of Statistics 1992:7). The province owes its fertile lands located in the northeastern plains of the country to the alluvial deposits of the river Indus and its tributaries, Jehlum, Chenab, Ravi and Sutlej, the five main waterways which also deliver water from the perennial sources in the mountains and glaciers in northern Pakistan to the province's extensive irrigation system running through the plains.

The Punjab has a total geographical area of 20.6 million hectares, about one-fourth of the country's size. Of the province's 14.8 million hectares of cropped land in the 1990-91 cropping year, 12.6 million hectares were irrigated by various means; 8.3 million hectares by canal irrigation, 3.9 million hectares by tubewells, and the balance by other means (Agricultural Statistics of Pakistan 1991-92: 111 and 117). The irrigation network comprising 28 canals delivers 62 billion cubic meters of water annually. With the introduction of extensive canal irrigation facilities in the late nineteenth and early twentieth centuries, the problems of salinity, sodicity and waterlogging started to affect the soils of the Punjab. At present, about 1.6 million hectares (12.6 percent of the irrigated area) are affected by salinity (Agricultural Statistics of Pakistan 1991-92: 126). The 1977-79 soil salinity survey carried out by Water and Power Development Authority (WAPDA) reported that 14 percent of the canal command area of Punjab has surface salinity. A feature

of Punjab's irrigated agriculture, which is not so clearly identified or articulated, is the important role played by groundwater as a supplement to canal irrigation. The Water Sector Investment Plan of 1990 estimated that in 1986, Punjab had almost 88 percent of the total number of private tubewells in Pakistan, and according to current estimates the number in the Punjab is about 300,000. The area irrigated by tubeweli water is about 3.9 million hectares in the Punjab as against a total of 4.3 million hectares in the country. The extensive use of groundwater and its inferior quality as compared to canal water are both significant factors affecting surface salinity.

Thus, the dominance of the Punjab province in Pakistan's irrigated agriculture is also accompanied by its correspondingly large share of irrigation-related environmental problems. Consequently, there has been a justifiable concern about these problems in the Punjab. Early attempts to arrest these problems included important institutional development strategies to evolve a more permanent organizational arrangement with adequate legal support.

At the initial stages of irrigation development during the last century, waterlogging was identified as the major and primary environmental problem. To address this issue, the pre-partition Punjab authorities established a "Drainage Board" in 1917. The Board was later replaced by the "Waterlogging Enquiry Committee" with a mandate to investigate more scientifically the causes of the infertility of waterlogged lands and evolve methods by which such soils could be restored to normal productivity, and subsequently the Committee was renamed the "Waterlogging Board." In 1925, the Irrigation Research Institute was established, having a separate section dealing with the problems of land reclamation, and until about 1940, this section had conducted preliminary work on diagnosis and reclamation of saline and waterlogged areas. By the year 1940, the problem of salinity had emerged as a serious concern when salts were visible on the surface of land, and it was felt necessary to strengthen the institutional support to provide advice on reclamation operations based on the research conducted up to that time. To reach small farmers whose land had been damaged, land reclamation centers were established in selected areas, and later in 1942, the strategy was extended to cover reclamation on all the distributaries (Hussain and Nishat 1963:11; Mashhadi 1987:27).

With the rapid expansion of soil-related problems in the fertile canal irrigated areas, the need to set up a separate Organizational unit to deal with land reclamation problems became imperative. The Directorate of Land Reclamation (DLR) was thus established in 1945 with its headquarters at Lahore under the control of the Punjab Irrigation Department. Basically, this was meant to be a research-oriented organization to identify and deal with the problems of salinity and sodicity in the irrigated areas of the Punjab, but later on the DLR has undertaken field operations in various canal circles in the Punjab, focusing on the reclamation of salt-affected lands.'

'The Directorate of Land Reclamation in its presentation, 'Land Reclamation Strategy of Irrigation and Power Department, Punjab. 1992" provides a good description of its scope of work and a brief review of its achievements.

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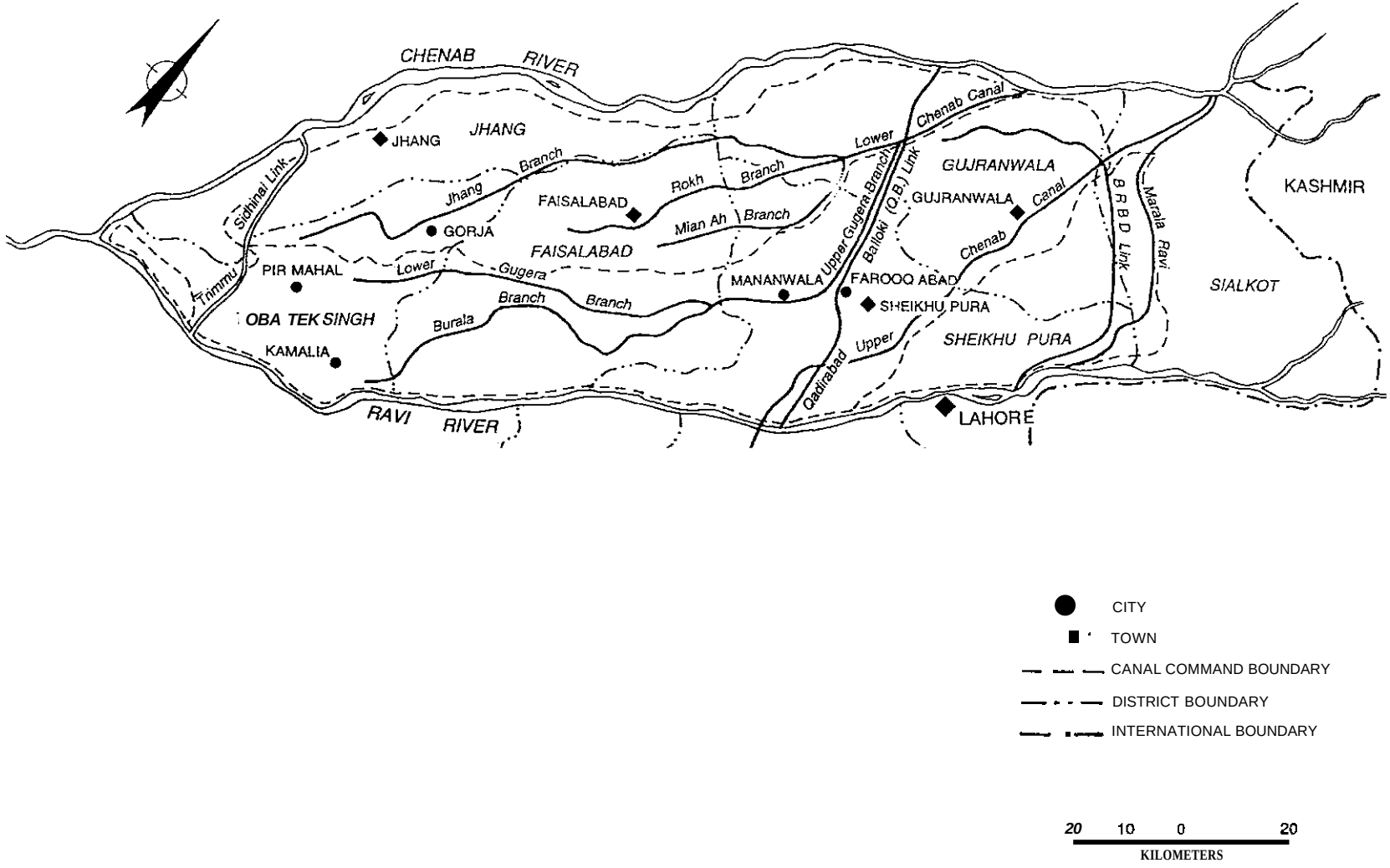
Annex A

LOCATION MAP OF LOWER CHENAB CANAL



Annex B1

STATEMENT OF LAND RECLAMATION OPERATIONS LOWER CHENAB CANAL EAST FAISALABAD FOR KHARIF 1992 (Prepared by LRO *Office*)

Upper Gugera Division

S.No.		Sanctioned (cfs)	Tail R.D. (ft)	Reclamation Outlet R.D. (ft)	Reclamation Discharge	Date of fixation (day/mth/yr)	Date of closure (day/mth/yr)
1	Karkan Minor		84300	25150-L 34875-L	0.94 1.00	6-7-92 6-7-92	30-9-92 30-9-92
2	Khureranwala Disty	207	123790	38629-R 37525-L 41920-R	1.50 1.50 0.91	28-7-92 28-7-92 18-7-92	30-9-92 30-9-92 30-9-92
3	Jangali Disty	45	85631	47055-L 36202-L	1.50 0.96	13-7-92 27-7-92	30-9-92 30-9-92
4	Mananwala Disty	191	148600	24932-L 49985-R 56334-L 91600-L 550-L 68955-L 35360-R	0.75 1.00 0.50 0.53 0.94 0.50 0.50	27-7-92 27-7-92 27-7-92 27-7-92 27-7-92 27-7-92 27-7-92	30-9-92 30-9-92 30-9-92 30-9-92 30-9-92 30-9-92 30-9-92
5	Nankana Minor	54	71881	26920-R 36290-R 36000-R	1.00 1.00 0.50	14-7-92 10-8-92 14-7-92	30-9-92 30-9-92 30-9-92
6	Mian Ali Branch	665	100000	4000-R 9500-L 58815-L	1.00 1.00 1.50	17-8-92 17-8-92 17-8-92	30-9-92 30-9-92 30-9-92
	Jhodkey Minor	42	73858	5450-L 6300-R1 6300-L 6300-R2	0.50 0.50 0.50 0.65	17-8-92 8-8-92 8-8-92 8-8-92	30-9-92 30-9-92 30-9-92 30-9-92
8	Jurrian Disty	49	46946	1484-R 65000-TL 10924-L	0.43 1.00 0.50	13-7-92 13-7-92 10-8-92	30-9-92 30-9-92 30-9-92
9	Gujiana Disty	98	131164	27438-L 56033-R1 56033-R2 19450-R 21348-R 24703-L 30010-R1 71047-R 30010-R2 56033-R1 56033-R2 34475-R 74634-R	1.00 1.00 1.00 0.50 0.75 0.50 0.75 0.50 0.50 1.00 1.00 0.50 1.00	13-7-92 3-8-92 3-8-92 6-7-92 6-7-92 6-7-92 6-7-92 13-7-92 13-7-92 13-7-92 13-7-92 13-7-92 13-7-92	30-9-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92
10	Mangat Minor	56	58310	30110-L 8280-L	0.50 1.00	13-7-92 13-7-92	30-9-92 30-9-92
11	Sharqpur Disty	244	172726	62594-R	0.50	8-8-92	30-9-92

Continued

Annex B1 (Continued)

12	Nahra Disty	124	113193	14375-L 99095-R 21500-I	1.00 1.00 1.00	2-1-92 13-7-92 7-1-92	30-9-92 30-9-92 30-9-92
13	Ghourdour Disty	50	67919	26680-R	0.50	14-1-92	30-9-92
14	Rodi Disty	23	24642	13880-L	0.50	28-7-92	30-9-92
15	Martonpur Disty	9	7080	4580-L	2.00	20-7-92	30-9-92
16	Manianwala Disty	9	6960	270-L	0.50	17-8-92	30-9-92
17	Mallah Disty	94	54150	1450-R 1450-L	0.50 1.00	13-1-92 28-8-92	30-9-92 30-9-92
18	Lagar Disty	38	62218	17545-R 16330-L 1052-R 25100-L 24-25-R	1.00 0.50 0.50 4.50 0.50	13-7-92 13-1-92 13-1-92 13-1-92 13-7-92	30-9-92 30-9-92 30-9-92 30-9-92 30-9-92
19	Bath Disty	1	15914	4752-L 6511-R 07-08-R	0.15 1.00 0.50	6-1-92 6-1-92 6-7-92	30-9-92 30-9-92 30-9-92
20	Jhinda Minor	9	11309	6008-L	0.50	14-1-92	30-9-92
21	Salar Minor/ Mian Ali Br.	9	11134	58815-L (Mian Ali)	1.50	6-1-92	30-9-92

Annex B2

STATEMENT OF LAND RECLAMATION OPERATIONS
LOWER CHENAB CANAL EAST FAISALABAD FOR KHARIF 1992
(Prepared by LRO Office)

Lower Gugera Division

S.No.	Name of Channel	Sanctioned Discharge (cfs)	Tail R.D. (ft)	Reclamation Outlet R.D. (ft)	Recla-mation discharge	Date of fixation (day/mth/yr)	Date of closure (day/mth/yr)
1	Pauliani-Minor NO. I	10	10135 10135	7185-TLD	1.02	2-1-92	30-9-92
2	Pauliani-Minor No. II	14	18000	50-R	0.50	23-7-92	30-9-92
3	Chanuana Disty	96	98449	14650-R 14687-R 16060-R 19136-R 19146-R 47938-R 59360-L 62801-L	1.33 1.00 1.23 1.01 1.25 2.01 2.00 1.00	15-1-92 15-1-92 21-7-92 15-7-92 15-1-92 8-1-92 14-1-92 14-1-92	1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92
		49	32016	63930-L 55852-R	1.00 1.96	14-1-92 19-7-92	1-10-92 1-10-92
4	Jassuana Disty		32016	42283-L 24354-L 32016-L 32717-L 44498-L 36895-L 38845-L 40053-L	1.41 0.96 1.02 0.92 1.50 0.95 0.87 0.90	13-7-92 17-7-92 17-7-92 17-7-92 13-7-92 13-7-92 13-7-92 13-7-92	1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92
5	Phadiara Disty	11	31059	175-R 2499-R	1.27 1.21	8-7-92 8-1-92	1-10-92 1-10-92
6	Talyara Disty	11.50	21700	7720-L	1.51	NOT FIXED	
7	Satiana Disty	37	33350	10609-L 2205-L 7306-L 9524-L	1.00 1.50 1.50	14-7-92 14-1-92 14-1-92 14-7-92	1-10-92 1-10-92 1-10-92 1-10-92
8	Bhartiana Disty		25458	15607-L 11978-L 13627-L	1.03 1.46 1.35	16-1-92 16-7-92 16-7-92	1-10-92 1-10-92 1-10-92
9	Bhartiana Minor		14378	471-R	1.00	8-1-92	1-10-92
10	Koru Disty		11500	75-L	1.02	15-7-92	8-10-92
11	Khatwan Disty	7.76	17000	212-R 2752-R	1.64 2.35	23-1-92 23-1-92	8-10-92 8-10-92
12	Rassiana Disty		43200	265-L 2710-L 4575-L	0.14 0.73 1.55	5-7-92 5-7-92 5-1-92	1-10-92 1-10-92 1-10-92
13	Bhail Disty	35.30	23862	990-R 3492-L 4678-L 9500-L 1050-L	1.03 1.93 1.46 1.60 1.04	13-7-92 13-1-92 13-7-92 13-7-92 13-1-92	1-10-92 1-10-92 1-10-92 1-10-92 1-10-92

(Continued)

Annex B2 (Continued)

14	Tarkhani Disty	235	153033	16159-R 34942-L 35007-L 38490-L 38810-L 67827-R	1.00 1.01 1.00 1.01 1.00 1.50	21-7-92 18-7-92 18-7-92 18-7-92 18-7-92 30-7-92	1-10-92 1-10-92 1-10-92 1-10-92 1-10-92 1-10-92
15	Tarkhani Minor	31.50	33600	12914-L 20200-L	1.33 0.67	20-7-92 20-7-92	1-10-92 1-10-92
16	Janiwala Disty	44	40643	32243-R 2950-R 6475-R	1.03 1.03 1.03	13-7-92 13-7-92 13-7-92	1-10-92 1-10-92 1-10-92
17	Amirwala Minor	16	25064	7270-L 12960-R 15900-L	1.36 1.00 1.08	13-7-92 13-7-92 13-7-92	1-10-92 1-10-92 1-10-92
18	Moongi Disty	164	121278	1000-L 12500-L 15125-L 17942-L	1.50 1.00 1.00 1.00	13-7-92 13-7-92 13-7-92 13-7-92	2-10-92 15-10-92 15-10-92 15-10-92
19	Yakkar Disty	43	60312	10229-R	1.51	23-7-92	2-10-92
20	Bhun Disty	36	54197	5150-L 10164-L	0.77 0.76	23-7-92 27-7-92	2-10-92 2-10-92
21	Rajana Disty	53	37400	11900-L 13753-L	0.76 0.73	25-7-92 25-7-92	17-10-92 17-10-92

Annex B3

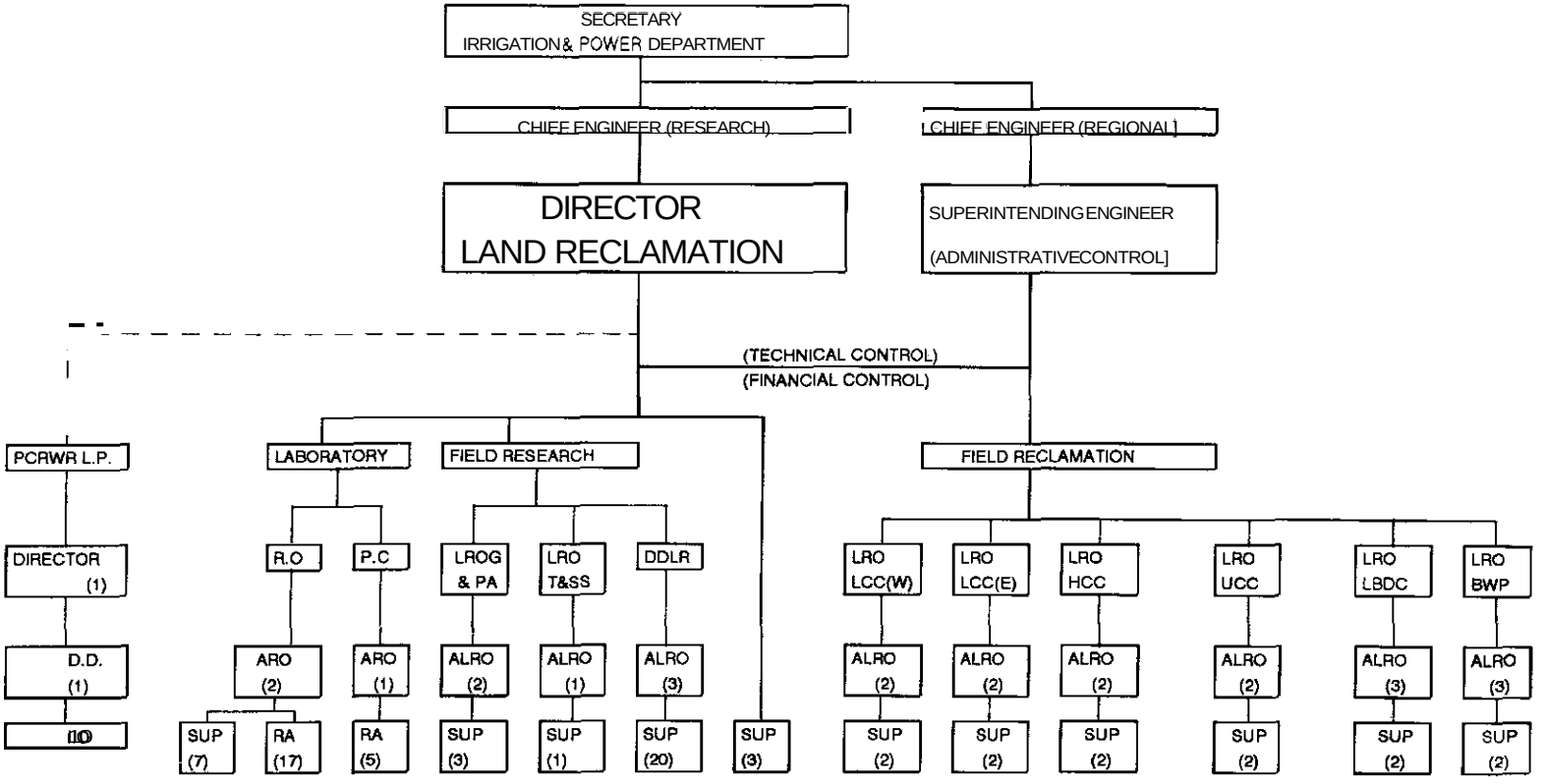
STATEMENT OF LAND RECLAMATION OPERATIONS LOWER CHENAB CANAL EAST FAISALABAD FOR KHARIF 1992 (Prepared by LRO Office)

Burala Division

S.No.	Name of Channel	Sanctioned Discharge (cfs)	Tail R.D. (ft)	Reclamation Outlet R.D. (ft)	Reclamation discharge	Date of fixation (day/mth/yr)	Date of closure (day/mth/yr)
1	Arif Disty	20	55300	3453-R 5351-L	1.00 0.90	9-7-92 16-7-92	10-10-92 10-10-92
2	Jhoke No. 1	14.50	16150	1225-L 4790-L	1.50 1.50	20-7-92 19-8-92	7-10-92 7-10-92
3	Tandlianwala Disty	385	119873	226-R 240-R	0.90 1.11	NOT FIXED NOT FIXED	
4	Kanyan Disty	21	33256	1190-L 3668-L 10896-R 7289-L	1.01 1.05 1.02 1.07	15-7-92 15-7-92 15-7-92 15-7-92	15-10-92 15-10-92 15-10-92 15-10-92
5	Killianwala Disty	212.13	151086	12500-L 15000-L 19625-L 30145-R 30162-R 33484-R 35763-R 23370-L 27867-R	0.75 0.75 1.50 1.31 1.20 1.03 1.29 1.00 2.00	15-7-92 15-7-92 15-7-92 15-7-92 15-7-92 15-7-92 15-7-92 15-7-92 15-7-92	15-10-92 15-10-92 15-10-92 15-10-92 15-10-92 15-10-92 15-10-92 15-10-92 15-10-92
6	Girja Disty	13	20061	402-L 6202-L	1.51 1.56	15-7-92 15-7-92	1-10-92 1-10-92
7	Samundari Disty	42	62288	39318-L 42724-R 43165-L	1.00 2.02 2.00	15-7-92 27-7-92 15-7-92	1-10-92 1-10-92 1-10-92
8	Munianwala Minor	5	5422	100-R 150-R	0.55 1.60	15-7-92 15-7-92	1-10-92 1-10-92
9	Direct Burala Branch	2385	485755	239180-L	2.00	15-7-92	15-10-92
10	Waghi Disty	74	85000	5940-R 5950-R	1.66 1.43	NOT FIXED NOT FIXED	
11	Kamalia Disty	43	58000	8218-L	2.00	NOT FIXED	
12	Kot Pathana Minor	13	21980	8920-L	1.99	3-8-92	15-10-92
13	Hotar Minor	51	54000	3050-L 7462-R 8600-L 6912-R 11890-L	0.70 0.52 1.00 1.00 1.00	10-7-92 10-7-92 10-7-92 10-7-92 10-7-92	15-10-92 15-10-92 15-10-92 15-10-92 15-10-92

ORGANIZATIONAL CHART OF DIRECTORATE OF LAND RECLAMATION

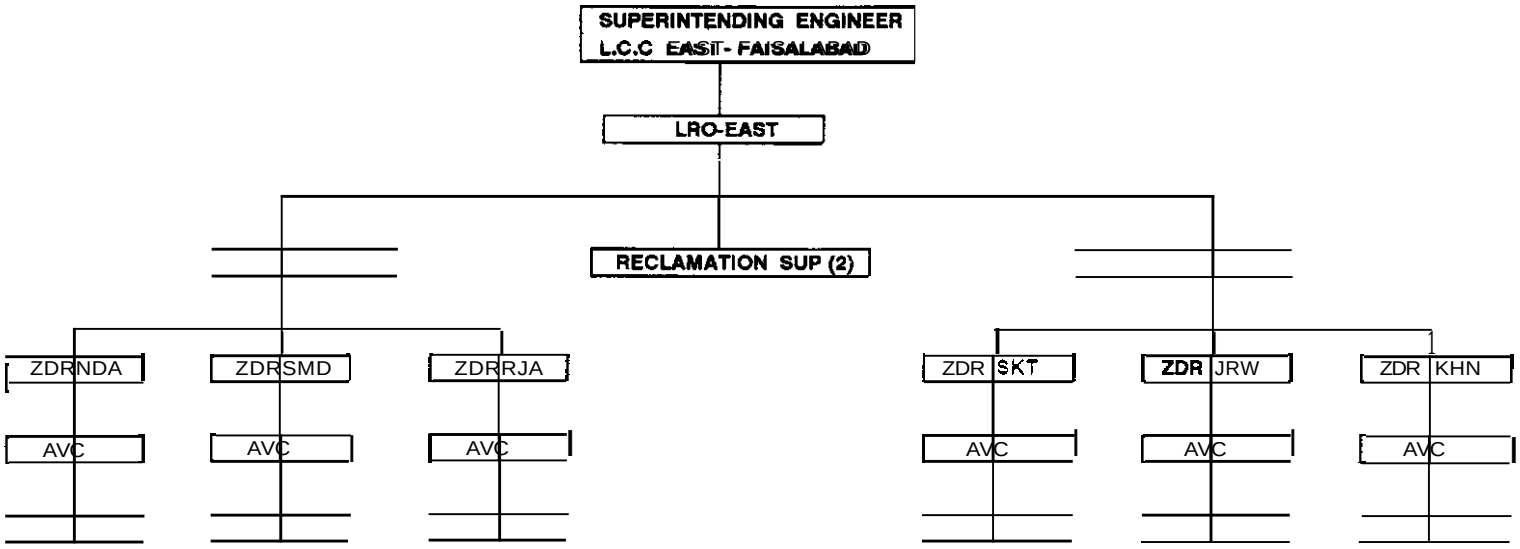
Annex C1



RO	RESEARCH OFFICER	PCRWR	PAKISTAN COUNCIL OF RESEARCH IN WATER RESOURCES
PC	PHYSICAL CHEMIST	D.D	DEPUTY DIRECTOR
DOLR	DEPUTY DIRECTOR LAND RECLAMATION	LCC(E)	LOWER CHENAB CANAL (EAST)
LRO	LAND RECLAMATION OFFICER	LCC(W)	LOWER CHENAB CANAL (WEST)
ALRO	ASSISTANT LAND RECL. OFFICER	LBDC	LOWER BARI DOAB CANAL
ARO	ASSISTANT RESEARCH OFFICER	UCC	UPPER CHENAB CANAL
RA	RESEARCH ASSISTANT	IO	INSTRUMENTATION OFFICER
SUP	RECLAMATION SUPERVISOR/ SOIL SUPERVISOR	T&SS	THUR AND SEM STATISTICS
		LP.	LYSIMETER PROJECT

ORGANIZATIONAL CHART OF LCC EAST FIELD RECLAMATION DIVISION

Annex C2



L.C.C	LOWER CHENAB CANAL
FSD	FAISALABAD
LRO	LAND RECLAMATIONOFFICER
ALRO	ASSISSTANT LAND RECLAMATION OFFICER
SUP	SUPERVISOR
NKA	NANKANA SAHIB
ZDR	ZILLADAR
AVC	ASSISSTANT VERNACULAR CLERK
NDA	NARADADA SECTION
SMD	SMUNDRI SECTION
RJA	RWANA SECTION
SKT	SHAHKOT SECTION
JRW	JARANWALA SECTION
KHN	KHANUANA SECTION

Annex D

EXPERIMENTAL RESEARCH STATIONS

S. No.	Name of research station	Location	Area in acres	Year of start	Description
1.	Chakanwali	Near Hafizabad District Gujranwala	3645	1926	Represents high watertable conditions. Field drainage of different types have been tried.
2.	Mohranwala	Near Jaranwala District Faisalabad	50.62	1939	Represents the rising watertable area. Method of reclaiming saline soils have been tried.
3.	Jagattan	Near Jaranwala District Faisalabad	59.79	1952	Represents deteriorated land in respect of salinity and waterlogging.
4.	Haveli	Near Shorkot Cantt:Dist.Jhang	323.37	1945	Represents saline sodic conditions of Ghag Darkhana Blocks of Haveli Canal.
5.	Chak 1121 15L Mianchannu	District Khanewal	500	1965	Represents the saline sodic conditions of Khanewal.
6.	Chak 7/3L Ahmadpur Sial	Near Ahmadpur Sial Dist Jhang	306.37	1947	Represents non-perennial saline sodic soil of Rangpur canal in lower Thal.
7.	Kundian	Neal Kundian District Mianwali	35	1941	Represents sandy soil in upper Thal. Movement of salts and water was studied.
8.	Main Line Lower	Near Bhakkar	35	1941	Represents clay loam soils in Central Thal.
9.	Layyah	Near Chowk Azam Diet. Jhang	35	1941	Represents sodic soils of lower Thal.

Annex E

STATEMENT SHOWING VARIATION IN SALINITY DURING THE YEARS FROM 1944-45 TO 1991-92

Year	Total area surveyed (acres)	Total salinity (thur) in acres	Percentage of (thur) saline area over total
1944-45	11990782	2051500	17.11
1945-46	11959455	2248381	18.80
1946-47	11955691	2269670	18.98
1947-48	11956605	2251185	16.83
1948-49	12017458	2193327	18.25
1949-50	12042337	2278411	16.92
1950-51	12697327	2348284	16.49
1951-52	12947486	2413961	18.64
1952-53	13055999	2467012	18.89
1953-54	12936965	2509626	19.39
1954-55	13475680	2921175	21.88
1955-56	14734875	3041850	20.64
1956-57	15277059	3089765	20.09
1957-58	15417670	3030343	19.65
1958-59	15624493	3053093	19.54
1959-60	16762419	2985390	17.78
1960-61	16862808	2942349	17.45
1961-62	21069363	3349888	15.88
1962-63	21004335	3434805	18.35
1963-64	20913887	3349978	16.01
1964-65	21139145	3186054	15.00
1965-66	21173163	3180964	15.00
1966-67	21547753	3214676	14.92
1967-68	21320924	3210418	15.00
1968-69	21808755	3131351	14.35
1969-70	21621727	3042863	13.94
1970-71	21540938	3023689	14.04
1971-72	22046012	2993242	13.57
1972-73	22268326	2972690	13.35
1973-74	22262300	2949739	13.25
1974-75	22457083	2966680	13.20
1975-76	22330310	2902403	12.99
1976-77	22343900	2860173	12.80
1977-78	22395905	2806916	12.53
1978-79	22504434	2840878	12.62
1979-80	22378970	2869087	12.82
1980-81	22670911	2731867	12.05
1981-82	22666381	2726617	11.92
1982-83	23142447	2739978	11.84
1983-84	23125196	2676607	11.57
1984-85	23132051	2669314	11.11
1985-86	23134054	2676616	11.57
1986-87	23154177	2816868	12.12
1987-88	23155581	2880540	12.44
1988-89	23154580	2904080	12.54
1989-90	23172194	2956432	12.76
1990-91	23168509	2929549	12.63
1991-92	23169811	2875374	12.41

Source: Directorate of Land Reclamation, Punjab Irrigation and Power Department Lahore.

Annex F1

CLASSIFIED THUR STATISTICS OF PUNJAB (1982-92)

Yeay	Total	Thur Kohna		Thur Pt ıala			Thur Nau		Thur Juzvi		Thur Tirk	
	(acres)	Area	%	Area					Area	%	Area	%
1982-83	2739978	556928	20.33	240346					1723301	62.89	3677	0.13
1983-84	2676607	533389	19.93	238970	8.93		151214	5.65	1695436	63.34	3599	0.13
1984-85	2669314	533513	19.99	239111					1695482	63.52	3587	0.13
1985-86	2676616	533083	19.92	239095	8.93		152563	5.70	1695914	63.36	3632	0.14
1986-87	2816888	538398	19.11	253093	8.98		152962	5.43	1819417	64.59	3824	0.14
1987-88	2880540	538178	18.68	269086	9.34		150379	5.22	1865529	64.76	4092	0.14
1988-89	2904080	538576	18.55	270562	9.32		152524	525	1881139	64.78	4095	0.14
1989-90	2886776	533250	18.47	270817	9.38		152578	5.29	1877424	65.04	4209	0.15
1990-91	2879021	533203	18.52	270801	9.41		152721	5.30	1857921	64.53	1386	0.48
1991-92	2852149	537488	18.85	270336	9.48		154109	5.40	1836270	64.38	8	0.14
											3923	
Overall	27981969	5376006	19.00	2562217	9.86		152493		17947833	65	4850	0.14
											3	

Source: LRO (Thur & Sem Division),
Directorate of Land Reclamation, Lahore.

Annex F2

THUR STATISTICS OF LCC EAST RECLAMATION DIVISION FAISALABAD

YEAR	AREA SURVEYED	THUR KOHNA	THUR PUNJSALA	THUR NAU	THUR JUZVI	THUR TIRK	THUR RECL.	TOTAL THUR	%AGE THUR
1982-83	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1983-84	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1984-85	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1985-86	1854568	28313	36452	18859	171795	710	7430	263568	14.21
1986-87	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1987-88	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1980-89	1854568	28313	36452	18859	171795	719	7430	263568	14.21
1989-90	1854568	22254	36416	18803	171915	719	7401	257508	13.89
1990-91	1854568	22254	36416	18803	171915	719	7401	257508	13.89
1991-92	1856568	28332	36452	21460	181578	718	7380	275920	14.86

Source : Annual Data Statements by LRO (Thur & Sem)
Directorate of Land Reclamation Punjab, Lahore.

Annex G

A TYPICAL "TENTATIVE" RECLAMATION PROGRAM

From

The Superintending Engineer,
Lower Chenab Canal East Circle,
Faisalabad.

To The Executive Engineer,
Upper Gugera Division,
Sheikhupura.

No. 3658 / 59 Dated: 18-5-92

Subject: Tentative Reclamation Programme for Kharif 1992
Lower Chenab Canal East Circle, Faisalabad.

The Tentative Reclamation Programme of Upper Gugera Division has been discussed and finalized for Kharif 1992 in my office today dated 17-5-1992. The detail of discharges pproved are given as under.

Name of Disty	Repeated Supply		Balanc Supply		New S ıply		Total
	Reach	Disch.	Reach	Disch.	Reach	Disch	
Karkan	25150-L	0.94					0.94
Mananwala	91600-L	2.78			250-L	1.00	3.76
	24932-L						
	49985-R						
	56334-L						
Nankana	26920-R	1.00	36290-R	1.00			2.00
Gujiana	27438-L	4.00					4.00
	74634-R						
Mian Ali Br.	58815-L	1.50					1.50
Mangat	8280-L	1.00					1.00
Mullah	1450-R	1.00					1.00
Nahra	14375-L	2.00			99095-R	1.00	3.00
	23500-L						
Martonpur	4580-L	2.00					2.00
Jurian	1484-R	1.43					1.43
	65000-L						0.50
Lagar	17545-R	1.00					1.00
Jhodke	5450-L	0.50					0.50
Bath	4752-L	2.25					2.25
	6511-R						
Jhinda	6008-L	0.50					0.50
Dangali					47055-L	1.50	1.50
	Total	21.90		1.00		3.50	26.40

sd/
Superintending Engineer
LCC East Circle Faisalabad

Annex H

RECLAMATION OPERATIONS AND AREA RECLAIMED IN PUNJAB

Year	Reclamation supply actually utilized (cusecs)	Area operated in acres	Area reclaimed during the year (acres)	Area reclaimed upto date in acres
				143046
1948-49	2254.48	102347	25164	168210
1949-50	2345.79	107921	19437	187647
1950-51	2107.55	96897	20195	207842
1951-52	2161.35	103113	17644	225486
1952-53	2624.14	128979	14798	240284
1953-54	4142.97	179172	26827	267111
1954-55	4004.77	169066	27841	294952
1955-56	3498.92	153148	34383	329335
1956-57	3156.44	150766	23901	353236
1957-58	3040.59	140903	27843	381079
1958-59	3090.25	152807	37067	418146
1959-60	2547.90	127355	27251	445397
1960-61	2407.84	121258	38507	483904
1961-62	2106.88	99872	21912	505816
1962-63	2019.38	96788	21801	527617
1963-64	2239.84	106143	31468	559085
1964-65	2350.05	113018	27621	586706
1965-66	2704.22	128840	29230	615936
1966-67	2561.00	125592	34596	650532
1967-68	2679.81	130399	36144	686676
1968-69	2825.05	133636	28206	714882
1969-70	2329.93	116794	37738	752620
1970-71	1979.75	97319	36087	788707
1971-72	1862.29	91090	21387	810094
1972-73	1853.51	90838	30249	840343
1973-74	2040.41	96313	33689	874032
1974-75	2088.13	100418	20247	894279
1975-76	2082.20	97689	34563	928842
1976-77	2159.45	101529	38132	966974
1977-78	2161.74	101618	20931	987905
1978-79	2320.05	109828	38515	1026420
1979-80	1902.08	88552	42739	1069159
1980-81	1465.89	69806	22575	1091734
1981-82	1216.36	62383	15465	1107199
1982-83	1037.82	55682	25284	1132483
1983-84	823.40	39505	18451	1150934
1984-85	805.80	37944	10092	1161026
1985-86	860.12	42738	8514	1169540
1986-87	1015.16	48866	16362	1185902
1987-88	1118.62	51992	14007	1199409
1988-89	984.96	47170	17219	1217128
1989-90	1074.63	46270	16426	1233552
1990-91	973.96	45774	12998	1246550

Source : Directorate of Land Reclamation.
Punjab Irrigation and Power Department, Lahore.