Report No. C-12

Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan

CASE STUDY OF THE PUNJAB IRRIGATION DEPARTMENT

Consultancy Report

ASRAR-UL-HAQ

September 1998
PAKISTAN NATIONAL PROGRAM
INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE
LAHORE

TABLE OF CONTENTS

ANNEXES

TABLES

FIGURES AND PHOTOGRAPHS

Photographs

FOREWORD

This case study is part of the activities undertaken by IIMI under its action research project, "Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan" with financial support from the Royal Netherlands Government. The project includes three main components:

I) Operational Management, which covers the improvement of Main System Management through the introduction of Decision Support Packages, supplemented with Watercourse Management aspects including improved surface irrigation practices;

II) Institutional Development, which largely focuses on water users, farmer-agency and inter-agency coordination, and other institutional arrangements for irrigated agriculture; and

III) Salinity Management, which aims at the development of a predictive capability of the salinity conditions over large areas.

Of these, the Component II on institutional development forms the most significant part of this effort as it serves the essential purpose of institutionalizing the technical solutions. The activities of this component are further divided into the following three sub-components:

(IIa) Sub-Component on Water Users Organizations (WUOs)

Develop feasible irrigation management strategies regarding water users organizations that will alleviate trends in soil salinity and groundwater quality that threaten the sustainability of irrigated agriculture in Pakistan.

(IIb) Sub-Component on Institutional Support for WUOs

Create institutional support for water users associations at both the watercourse and distributary levels, along with strengthening the interactions between farmers and government agencies.

(IIc) Sub-Component on Coordinated Irrigation and Agriculture Services

Explore institutional arrangements for coordinated services by the provincial agriculture and irrigation services.

The case studies of Provincial Irrigation and Agriculture Departments, are related to the two sub-components IIb and IIc mentioned above.

The methodology adopted for this purpose included the involvement of some "insiders", those

who have served or are serving in these agencies, to write the case studies on their respective agencies on an agreed common format. This unusual approach is based on the following main reasons: (1) the time and other resources available for this activity are limited, and the best possible method of obtaining information has to be deployed; (2) an appropriately enlightened and knowledgeable insider can provide valuable and authentic information of the organization in a short duration of time; (3) the bias that many people associate with an insider's study of an organization depends on the objective for which information is collected and the format used, and in most instances cannot be more than the bias of a less involved outsider; and (4) the quality of the case study report can be improved by subjecting it to an appropriate review process.

In the form of an agreed common format, the case studies were to encompass five essential components:

1. Historical Development of the Agency: The origin of the agency needs to be traced with references to source material. It is likely that the agency underwent many changes, additions and deletions since its inception, and these changes might have been caused by specific policy needs and changed objectives. A brief description of this development will be useful to place the agency's present status in the correct perspective.

2. Objectives and Functions of the Agency: This component of the case study report should describe the present objectives and functions of the agency in detail. The discussion should include any performance indicators that may have been developed and used to internally assess whether and to what extent the objectives are realized.

3. Human and Financial Resource Base of the Agency: Usually, the reference to the human resource base in an organization is limited to providing an Organizational Structure. Apart from this essential item, the report should analyze the compatibility between the agency's objectives and its manpower resources and their distribution. The levels of funding, allocation and budgetary planning procedure, and the matching between available funds and expenditure, along with the measures taken to ensure financial discipline will form part of this component.

4. Present Performance Problems of the Agency and Analysis of the Causes of the Performance Problems: This is an area which an "insider" usually finds most difficult to deal with. However, an insider has the necessary information about how the agency performs in terms of its expected objectives, and how the agency is evaluated by its customers, and by its environment in general. An objective view of these aspects will help the author to provide a constructive critique with a view to improve the situation.

5. Recommendations for Improvement, including Specific Recommendations for Coordinated Irrigation and Agriculture Services to Farmers: The main objective of this whole exercise of writing case studies is to develop some mechanisms for providing coordinated irrigation and agriculture services to farmers. An insider's contribution

ACKNOWLEDGEMENTS

The author is indebted to the Punjab Irrigation Department and IIMI Pakistan for providing the opportunity to conduct an in-depth review of the department's past performance, current issues and optimization strategies. The assignment had been quite challenging, as well as interesting and professionally rewarding.

The author gratefully acknowledges the encouragement and support received from Mr. Jayatissa Bandaragoda, Senior Management Specialist of IIMI-Pakistan. The interest, commitment, patience and valuable advice given by him remained a source of inspiration throughout the process of writing the Case Study. The author recalls with gratitude the discussions that he had with Dr. Prachanda Pradhan, Institutional Specialist/Consultant, and appreciates his thoughtful comments on the first draft of the Report. Thanks are also due to Ms. Zaigham Habib, Senior Systems Analyst of IIMI, for providing some of the needed literature, and to Mr. Mehmood-ul-Hassan of IIMI for coordinating the finalization of the Case Study Report.

The author wishes to record his deep appreciation for the assistance offered by Mr. Muhammad Hasnain Khan, Deputy Director of the Punjab Irrigation Department. He offered useful comments and helped with some of the data analysis and graphics. The author also acknowledges the suggestions and information that he received from various senior managers and colleagues of the Punjab Irrigation Department. Mr. M.H. Siddiqui, Consultant, Mr. Tayyab Hassan, Canal Collector and Mr. Khalid Faruq, Ex-Chief Engineer, need particular mention in this regard.

Special thanks go to Mr. Mushtaq Ahmad, Stenographer of the Punjab Irrigation Department for his tireless efforts in typing the manuscript and incorporating the changes in the initial drafts. The long hours that he spent after the routine office timings are gratefully acknowledged. The efforts of Mr. Manzoor Hussain, Secretary of IIMI Pakistan in formatting and printing of the final draft also merit special mention and thanks. Finally the author wishes to record his appreciation and gratitude for the very useful editorial comments provided by Ms. Verenia Duke.

While acknowledging the valuable suggestions and comments in the context of the Case Study, the author retains the responsibility for the views and opinions expressed in the report and these views do not in any way constitute the official / agency stand.

towards this objective is anticipated from this component.

The case study on the Punjab Irrigation Department was prepared by Mr. Asrar-ul-Haq. His effort shows a high degree of his professionalism and awareness on the current issues related institutional development in this sector. We hope that this report would serve as a significant step towards an internal evaluation that is needed in pursuing current policy plans for institutional reforms in Pakistan.

D. J. Bandaragoda
Senior Management Specialist

CHAPTER 1

HISTORICAL DEVELOPMENT OF IRRIGATION AND IRRIGATION AGENCY IN THE PUNJAB PROVINCE

The development of Irrigation Agencies has strong linkages, and interfaces with the physical infrastructure as well as system design and management principles. In order to appreciate the historical perspective of irrigation and agency development better, factors contributing to its development need to be determined. Section 1 of the Case Study comprises three parts: an outline of the history of irrigation development in the Indus Basin, the irrigation technology and principles of system management, and a description of the historical development of irrigation agency..

1.1 History of Irrigation Development in the Indus Basin

1.1.1 The Ancient History

Irrigation in the Indus Basin has a long history dating back to the Indus Civilization. The remains of Moenjodoro and Harappa remind us that the inhabitants of this fertile valley were acquainted with the practice of irrigating the lands using wells and river spills during the flood season. The ancient civilizations that flourished along the river banks were mainly dependent on irrigated agriculture.

The decline of the Indus Civilization has been attributed to the character of culture that had become static, probably as a result of complacency impeding further effort. Some historians believe that the deterioration of the irrigation system, which had set in during this decline, might have been due to flogging energy and discipline. This led to inadequate maintenance of irrigation channels and *bunds* that resulted in total system collapse (WAPDA, 1987).

During the period dating between the 8th and the middle of the 19th centuries, a large number of inundation canals were built by various emperors and minor rulers. The recorded history of irrigation as an established practice can be traced as far back as the 8th century, when Arab conquerors of the Sindh Province differentiated between the irrigated and non-irrigated lands to levy land taxes. The Moghul emperors also constructed a number of canals that included the Western Jamna Canal, Hasli Canal, Shah Nehr, and a series of other inundation canals. The available evidence indicates that some of the canals built by Moghul rulers were not primarily for irrigation, but to provide water to the parks and gardens of the Moghul royalty.

1.1.2 Irrigation Development under Colonial Rule (1850 - 1947)

Development in the irrigation field, on a scale unknown in history, started about the middle of 19th century under British rule. Soon after annexation of the territories of the Punjab and Sindh Provinces, the British rulers embarked upon a massive canal construction program. Inundation canals were first improved, and then gradually converted to properly-regulated perennial systems by means of weirs and barrages constructed across the rivers. The works undertaken then were

destined to develop into the world's largest integrated canal network to provide irrigation facilities to 33 million acres of land in the Indus Basin. The main reasons for the urge behind this colossal development included: protection against famine, political compulsion to provide livelihood to disbanded soldiery, the development of area with high agricultural potential and to increase the revenue generation capacity of the state. The chronological sequence of canal construction in the Punjab Province under Colonial Rule is given in Table 1.1.

Table 1.1 Development of Canal System in Punjab Under Colonial Rule.

Year	Major Events / Canal Construction
1854	Beginning of the modern era of irrigation practice with the establishment of a Directorate of Canals under the supervision of the Chief Engineer, Irrigation Works.
1846-1872	Construction of the first weir-controlled perennial irrigation channel; the Upper Bari Doab Canal, off-taking from the river Ravi at Madhopur (1859), and the Sirhand Canal from the river Sutlej at Rupar (1872).
1872-1901	Severe famine prompted construction of Sidhnai Canal from the river Ravi at Sidhnai H/Works (1872), Lower Chenab Canal from Khanki H/Works (1892), and Lower Jhelum Canal from Rasul H/Works (1901).
1901-1928	The Sutlej Valley Project, comprising Depalpur, Bikaner and Eastern Canals off-taking from Ferozepur H/Works, Eastern Sadiqia, Fordwah and Pakpattan Canals from Sulemanki H/Works and Bahawal, Qaim and Mailsi Canals from Islam H/Works were completed.
1932	Punjnad and Abbasia Canals were commissioned from the river Chenab at Punjnad H/Works.
1939	To improve the Sidhnai Canal system, the Trimmu Barrage project, comprising Haveli and Rangpur Canals, was put into operation.
1947-48	Thal Canal off-taking from the river Indus at Kalabagh was constructed to provide irrigation facilities to Sindh Sagar Doab (area between river Indus and Jhelum).

Source: Shahid, et al (1994).

The development of irrigation in the Punjab during British rule transformed socio-economic conditions in the province. Large tracts of land, which used to be uninhabited, and uninhabitable, were soon converted into wide expanses of cultivation dotted with villages that started to bristle with agricultural activity. Virgin lands began to produce rich harvests, and a network of industry and infrastructure came up to replace the wilderness. The continued development of irrigation has introduced development features that have progressively contributed to improving the socio-economic conditions and prosperity of the people. Recurrent famines, which visited the basin in the 18th and 19th centuries, are events of the past (WAPDA, 1987). The ripple effects of irrigation development in the Punjab Province include improved law and order, general improved welfare of the people, better living standards and improved education facilities, as well as the development of industry, infrastructure and communication networks.

1.1.3 Post-Independence Developments (1947 - 60)

After the Independence of Pakistan, the international border between Pakistan and India divided the irrigation system. With this division, the source of supply of all the rivers were located in India. Similarly, some of the headworks along the eastern rivers also fell in Indian territory, while parts of these canal systems irrigated areas in Pakistan. Disputes over the river water, particularly that of managing truncated canal systems, arose between the upper and lower riparians. The dispute could not be resolved and Pakistan had to undertake emergency measures to provide irrigation supplies to affected canal commands. In addition, new projects, as described below in Table 1.2, were also undertaken. The chronological sequence and salient features of Punjab Canal systems are presented in Annex I.

Table 1.2. Irrigation Development 1947-60.

Year	Canal Construction
1952	Construction of Shahpur Branch off-taking from LJC to irrigate 2,15,000 acres of CCA.
1953	Construction of BS Link Canal to connect the Ravi and Sutlej rivers to feed channels off-taking from Sulemanki.
1956	Construction of MR Link to transfer surplus water from the river Chenab to the river Ravi.
1956	Construction of BRBD Link from the Upper Chenab Canal to feed the truncated system of the eastern rivers.
1954-58	Construction of Taunsa Project with two off-taking canals; Muzaffargarh Canal and Dera Ghazi Khan Canal.

Source: Shafi (1994).

1.1.4 Indus Waters Treaty (1960)

The dispute between the two countries over sharing common river water could not be settled through bilateral negotiations and international mediation had to be sought. The dispute was finally resolved with the signing of the Indus Waters Treaty in 1960 after protracted negotiations through the good offices of the World Bank.

Under the treaty, India was entitled to the exclusive use of three eastern rivers (Ravi, Beas and Sutlej), while the western rivers (Chenab, Jhelum and Indus) were earmarked for use by Pakistan. A system of 2 storage dams, 8 inter-river link canals and 6 barrages were constructed as replacement works under the treaty to transfer water from western rivers to the eastern river canal systems. The works constructed under the Indus Basin Project are listed in Annex 2.

The construction of storage and link canals allow the operation of the Indus irrigation system in an integrated and improved manner, with greater control and enhanced river water utilization. As a result, the canal head withdrawals in the Indus Basin have increased considerably. The average annual withdrawals increased from 67 MAF in 1949-52 to 85 MAF by 1959-60, and 95 MAF just after the construction of the Mangla Dam in 1967-68. The withdrawals further increased to 101 MAF just after the Tarbela Dam completed and reached the peak of 108 MAF in 1979. The

canal withdrawals then stagnated at this level up to 1989-90 and are now declining to around 105 MAF due to reduction in reservoir capacities caused by progressive sedimentation.

1.1.5 Water Accord 1991

Development of water resources has remained frozen since 1976 and no new storage or irrigation project could be constructed after the completion of the Tarbela Dam. This stalemate has been due to the continuation of age-old disputes between the provinces over sharing Indus waters. Signing the Water Accord between the four provinces and the Federal Government in 1991 was a major step towards resolving the longstanding water apportionment disputes, thereby promising to open a gateway for irrigation development in the country. The salient features of the accord include clear definition of provincial shares in the existing river diversions, as well as for future development projects, the establishment of an authority for regulation and distribution of river water to the provinces, the recognition of the need to construct storage for planned future agricultural development, and an agreement between provinces to undertake new projects. The main features of the Water Accord are presented in Annex 3.

The perceived benefits of the accord, however have not materialized so far because of the delay in constructing of a new storage. The existing river supplies are totally committed to the existing projects. Therefore, in order for the accord to be really meaningful and for it to play an enabling role in irrigation development, there is a need to initiate immediate steps to store surplus river water available for 90-100 days during the high-flow summer season, which is currently running as waste into sea.

1.1.6 Anti-waterlogging Measures and Groundwater Development

Before the construction of the extensive canal network, the groundwater was in a state of natural equilibrium. After the construction of canals, the groundwater started to rise due to seepage losses from unlined canals and watercourses and field application losses. The annual rate of water table rises varied from 0.5 ft to more than 2.0 ft, depending upon the local environment. With rising water tables the menace of salinity also developed. Various measures were undertaken up to 1950s to arrest the alarming spread of waterlogging and salinity, but these measures proved inadequate.

In 1961 the matter was discussed at the level of the Presidents of Pakistan and the United States. As a result of this initiative at the highest level, various teams of US experts visited Pakistan to help to plan anti-waterlogging measures. After investigations and discussions, the expatriate experts proposed a new strategy, now well known as the Salinity Control and Reclamation Project (SCARP) approach. This approach envisaged the vertical drainage of land by pumping water through deep and large capacity tubewells. In useable groundwater areas, the pumped water was planned for use to supplement canal supplies. In addition, surface drainage systems were augmented to address surface run-off problems. Soil reclamation was envisaged through the drainage provided, and also by farmers' own efforts supplemented by agricultural extension services.

With this concept, a large number of project units were planned and implemented. A total of 10,196 tubewells, 8,260 in fresh groundwater and 1,936 in saline groundwater areas, were installed. The number of operable tubewells, however, decreased to around 9000 by 1994, with annual pumpage of about 6 MAF. SCARP tubewells, by and large, have succeeded in curbing waterlogging problems in most of areas. The government's budget, however, has been taxed heavily on account of high operation and maintenance (O&M) costs for tubewells, which is constantly increasing due to rising electric tariffs. The overall performance of SCARPs is also on the decline due to frequent power shut-downs and mechanical failures, fall in groundwater levels and reduction in the specific capacity of the tubewells (Shahid et al, 1994)

1.1.7 Private Tubewell Development

Concurrent with the development of public-funded SCARPs, there have been great advances in private groundwater development in the Punjab Province. The demand for additional irrigation water arising from increased cropping intensities and changes in cropping patterns triggered a rapid growth in private tubewells. The number of private tubewells, as such, increased from a mere 28,746 in 1965, to 147,995 in 1979, to 213,408 in 1986, and to 386,526 in 1994. Fairly generous credit facilities have provided the initial impetus and development of the local industry, and indigenous methods have made it possible to continue and sustain private tubewell development. The total pumpage from private tubewells has gradually increased from 3.27 MAF in 1965 to 32.10 MAF in 1985-87. Currently, it is estimated that public and private tubewells are contributing over a third of the total irrigation water input in agriculture (WSIPS, 1990; Bandaragoda, 1993; Bureau of Statistics, 1995).

1.1.8 SCARP Transitioning

In view of the success of private tubewells and to avoid rapidly escalating expenditure on O&M and replacement of fresh water SCARP tubewells, the government has adopted a policy to dis-invest fresh groundwater (FGW) SCARP tubewells. Under the SCARP transition pilot project, 213 FGW tubewells were replaced by 2100 small capacity tubewells in the private sector. The pilot effort has been replicated, through second scarp transition project, in the entire SCARP I area, resulting in transitioning of the balance 1471 FGW tubewells. A Project to dis-invest the remaining SCARP tubewells in the FGW area has also been planned and is currently under implementation.

1.2 Historical Perspective of Irrigation Technology and Irrigation Management

1.2.1 Historic Water Rights and System Design

The traditional distribution of uncontrolled flows of hill torrents in tribal areas was based on "*Saroba-Paina*", a system in which the farmers at the head reach had the right to divert water up to their full requirements, and then passing the water on to the lower riparian (WSIPS, 1990).

The earlier inundation canals were almost always constructed through the joint action of rulers and farmers, and were thus recognized as the joint property of the state and the irrigators. The

state left the irrigators to manage the maintenance of works and the distribution of water for themselves as much as possible. The state management was generally exercised through village headmen and village revenue officials. In 1873, the Government of India enacted "The Northern India Canal and Drainage Act" applicable to the Punjab and NWFP provinces, and the "Sindh Irrigation Act" in 1879 for the Sindh region. Through these acts, the Government assumed the powers to regulate the use of water from rivers in the interest of the public (Jahania, 1986).

The Indus Basin, as a whole, is located in a water-scarce environment, where water is a limiting resource for agricultural development. The water rights and system designs have been historically evolved against this backdrop. The primary purpose of the canal systems was protection against droughts and famines by bringing as large areas under cultivation as possible, with thin water application. The historic irrigation withdrawals were considered as legal water rights. With the construction of new barrages and headworks, the canal withdrawals improved and their commands acquired new water rights. To resolve regional water disputes, various commissions also based their awards on historic withdrawals, rather than on crop water requirements. The rules that serve the irrigation water allocation at a watercourse/distributary level on canal commands were developed during British rule over a century ago. Under these rules, water is delivered based on a predetermined water allowance and size of the culturable commanded area. The canal outlets are ungated structures and are designed to enable all the watercourses drawing its allocated shares of water simultaneously under continuous flow conditions.

There has always been a demand for water in different provinces, states and regions, particularly during critical periods of river supply shortages. The history of water disputes date back to 1919, when some doubts were expressed about the availability of water for the Sutlej Valley Project Canals. In order to examine the position of water availability and allocation to various provinces / states, a number of commissions were set up between 1920 and 1977. The reports of the commissions were either shelved, or its recommendations were selectively implemented, with the result that disputes over the apportionment of river waters between the four provinces of Pakistan could not be resolved until 1991. In the absence of a decision on water apportionment, adhoc arrangements were followed for sharing of Indus Waters (WSIPS, 1990).

1.2.2 Evaluation of Water Distribution at Farm Level: The Warabandi System

Warabandi is a rotational method for the equitable distribution of available water in an irrigation system by turns fixed according to a predetermined schedule specifying the day, time and duration of supply to each irrigator in proportion to the size of his landholding in the outlet command (Singh 1981, Malhotra 1982). Since the beginning of Pakistan's canal irrigation, *warabandi* has been traditionally practiced as a tertiary level water distribution method based on a rotation of water turns among individual water users. The term *warabandi* means `turns' *(wari)* that are fixed (*bandi*).

The origin of *warabandi* is somewhat obscure and has to be placed somewhere in the pre-colonial period (Bandaragoda and Rehman, 1995). In older inundation canals, each individual cultivator used to bring a watercourse from somewhere upstream of his holding to lead the water on to his

field. This system of individual watercourses grew in the village system under which the control was exercised by village headman, or the local land owner. The marked inefficiency of such a system must have been to use joint watercourses serving a number of shareholders (WAPDA, 1987). The *warabandi* concept might have evolved during this period. The *warabandi* on the older inundation canal used to be decided by the farmers themselves, or through village *Panchayats*, while for the turn duration, timings were not fixed, thereby allowing flexible operation. In these old practices, *warabandi* used to operate only during channel flow periods following 10-day schedule. Another feature of the old system used to adjust the flow times in view of water availability. This system was considered to be more appropriate and responsive in view of the flow fluctuations in the supply channel (Hassan et al, 1998).

When the British started building the canal irrigation network, *warabandi* was adopted from an existing practice as a water distribution method. An allocation schedule was locally determined and mutually agreed upon by the farmers along the watercourse command. However, social changes led to intermittent conflicts among farmers, especially pertaining to increased official intervention in this original farmer-managed *kachcha* (unofficial) *warabandi* tradition, resulting in the widespread conversion of *kachcha warabandi* practices into more rigid *pucca* (official) *warabandi* schedules (Bandaragoda and Rehman, 1995).

The *warabandi* system of canal water distribution has been in progress for more than one hundred years. The system has been found quite practicable and appropriate to ensure equitable distribution of scarce resources. Some drawbacks, however, have been identified in the system, which include progressively increasing water losses along the watercourse not accounted for in *warabandi* schedules, flow variability at the distributary and outlet heads, and deviations from the *warabandi* culture due to changing socio-political settings (Nazir and Chaudhry, 1988).

1.2.3 History of Water Rates

Water rates, known as *abiana* are charged by the Provincial Government for canal water supplied to irrigators. This is not a tax, but a service charge recovered from the farmers in respect of matured crops only. The history of the modern water rates structure dates back to 1873, when the Canal and Drainage Act was enacted. Section 36 of this act prescribed that "The rates to be charged for canal water supplied for the purposes of irrigation to the occupiers of land shall be determined by the rules to be made by the Provincial Government and such occupiers as accept the water shall pay for it accordingly". The first schedule for irrigation water charges was prepared for the Upper Bari Doab Canal (UBDC) in 1891. Similar schedules were prepared for other projects upon its completion (Akhtar, 1989).

The water rate structure in Pakistan has the following main characteristics (Nazar, 1986) :

- Different for different canal systems.
- Differs with reference to the pattern of supply, i.e., perennial or non-perennial.
- Charged on the basis of cropped area, and not on volumetric basis.
- Keeps the requirements of reclamation of soil and the need of fodder for animals in view.

- Double in SCARP areas due to additional supply of groundwater when compared to non-SCARP areas.

Generally, there are three basic approaches to determine water charges. Rates can be related to the cost of providing irrigation water, to the benefits derived from irrigation, or some value judgement on the beneficiaries' abilities to pay water rates. While fixing the water rates for irrigation from various canals in Pakistan, the following specific criteria were historically kept in view (Muzamil, 1986) :

- Interest on the capital cost of a canal and its working expenses.
- The amount of water required to mature a particular crop.
- Paying capacity of the cultivators.
- Availability of namely the Kharif crop only, or similarly intermittent from the escapes, etc., for the whole year.
- Value of produce.
- Incentive, or its absence, for certain crops.
- Soil conditions and the need for reclamation.

The declaration of the pre-independence government of the Punjab was that it was the government's duty to see that the burden on canal water users is no heavier than they could bear. Irrigation water has always remained a critical, but low-priced input in the agriculture sector. Only in the interest of irrigation welfare have water rates not been increased commensurate with rises in rates of other commodities. After the imposition of the earliest schedule of water rates in UBDC in 1891, the first revision of rates was effected in 1924, when increased by 25 percent. The rates were reduced in 1934 due to a slump in the prices of agricultural produce.

The reduced rates remained in force for quite a long time, despite the fact that the prices of agricultural commodities displayed an increasing trend. In 1955, the Punjab Government revised the schedule of the occupier's rates to the pre-1934 level. In 1959, during the one unit period, the Government of West Pakistan decided to increase water charges on a uniform basis throughout the province. After 1959, there have been successive increases in water charges for major crops, as presented in Table 1.3 (Usman, 1995; PID Files).

The enactment notification of 1993 contemplated an annual 10 percent increase up to 1998, mainly to match the increased O&M costs of the system. For the first time, a surcharge of 10 percent was prescribed in 1993 for delays when depositing *abiana*. Another increase of 25 percent was made by the government during 1996, in addition to the 10 percent increase notified during 1993.

Table 1.3. Successive increases in Water Charges of Major Crops in the Punjab.

Year	Increases in *Abiana*
1977-78	25 %
1980-81	25 %
1981-82	25 %
1993	25 %
1994	10 %
1995	10 %
1996	37.5 %
1997	10 %
1998	10 %

1.3 Historical Development of Irrigation Agency

1.3.1 The Early History

Prior to 1849, the general control of roads in Bengal and Northern India was responsibility of the Military Board at Calcutta. In that year, an organization headed by Robert Napier was created to execute all the public works in the area of the Punjab, the North-West Frontier Province and adjoining territories. The engineering works used to be financed by the Local Government, and were carried out by a Board of Administration. This organization successfully pioneered work in the sub-continent.

The control of the Military Board continued until 1854 when the entire engineering works in the Punjab and the NWFP (civil, military and public works) were placed under one department, with Napier as Chief Engineer. A directorate of canals was also created in September 1854, and the designation of its head was changed to Chief Engineer, Irrigation Works. A Public Works Department in the Govt. of India was created during the period of Lord Dalhousie, and that was followed by the creation of Public Works Departments in all the provinces under central control. In order to meet the increasing demand for public works, the following three separate branches were created in 1866:

1. The Military Works Branch;
2. The Civil Works Branch, including Irrigation; and
3. The Railway Branch.

Until 1892, the practice was that the senior Chief Engineer used to be the Secretary to the Local Government, and the junior one the Joint Secretary. Later the Government of India agreed to designate the Chief Engineers as Secretaries to the Local Government.

In accordance with the recommendations of the Aitchison Commission on the Indian Public Services in 1893, a Provincial Service was created for more extensive employment of non-British staff. By 1895, the Public Works Department had become a purely civil department responsible only for civil works, including irrigation works (PWD, 1963).

By the turn of the century, engineering organizations originating as single units in the middle of the previous century had grown in size and stature, and were functioning as separate organizations. The chronological sequence of the development of Irrigation Agency up to independence (1947), is presented in Table 1.4.

Table 1.4. Chronological Sequence of Development of Irrigation Agency up to 1947.

Year	Development
By 1905	The setup of the Irrigation Department comprised one Chief Engineer/ Secretary, and seven circles.
1905	The post of Second Chief Engineer/Joint Secretary to the Government was sanctioned. The post was later raised to the status of Secretary to the Government.
1906	Creation of another three circles for implementation of the Triple Canal Project.
1915	Swat Canal Circle transferred to the NWFP Government.
1921	A post of a third Chief Engineer Irrigation Works, and Secretary to the Government was sanctioned, for construction of a series of works along the Sutlej River at Ferozepur, Sulemanki and Islam Headworks.
1933	Completion of the Sutlej Valley Project, along with the construction of the fourth weir at Panjnad.
1945	The Irrigation Department had expanded to the extent of 20 circles. In order to cope with the increased work load, a post of a fourth Chief Engineer / Secretary to the Government was created.
1946	The post of Fifth Chief Engineer/Secretary to the Government was created.

Source: PWD (1963)

1.3.2 Post-independence Set-up (1947-55)

In the wake of independence came the division of the Punjab Province, entailing extensive dislocation in the department. The set-up of the department at the time of independence is given in Table 1.5.

Consideration of the vastness of the span of responsibility and the crucial importance of the work had led to the unique administrative arrangement of concurrently having three secretaries to the government, who were also vested with the powers of Chief Engineer, and were all located at Lahore to work as a team.

Table 1.5. Set-up of the Irrigation Department in 1947.

Description	C.Es	S.Es	XENs	SDOs
Total Strength of Engineering Staff (during 1947)	5	27	98	245
Number of posts that came to the share of Punjab (Pakistan)	3	17	63	154

Source : Khalid Farooq (1987).

1.3.3 Post-integration Set-up (1955-62)

During October 1955, all four provinces and some of the princely states were integrated as one unit, named West Pakistan. Government departments were re-organized, and so was the Irrigation Department. In the set-up envisaged for the engineering departments, there was a departure from the long practice of appointing an engineer as the Administrative Secretary of the Department. The post of Chief Engineer (Irrigation) was separated from that of Secretary, to which a non-technical bureaucrat was appointed. There was one Chief Engineer, Irrigation, West Pakistan, who was assisted by four Additional Chief Engineers. The entire West Pakistan was divided into nine regions and Punjab was divided into four. Each region was under the charge of a Deputy Chief Engineer.

1.3.4 Creation of WAPDA (1958)

In late fifties, planning, design and construction activities connected with development of Water and Power resources underwent a major change. All resources in material and manpower were diverted to the timely completion of the gigantic replacement works under the Indus Basin Plan (IBP). WAPDA was created in 1958 as an autonomous organization to control waterlogging and to execute the IBP, mostly with the help of foreign consultants and contractors, in keeping with obligations under foreign assistance for IBP work.

Due to pressure of work of the Replacement Plan, a large number of experienced engineers from the Irrigation Department during the period 1960-70, as the entire emphasis was on the timely execution of the IBP were assigned to WAPDA. No major canal irrigation project outside the Replacement Plan was undertaken works. WAPDA was a young, expanding and powerful organization entirely responsible for the Power Sector and the execution of all Replacement Works. Major new projects in the Water Sector (along with anti-waterlogging and salinity measures) were also assigned to WAPDA. The transfer of principal responsibilities from the Irrigation Department to WAPDA reflected on the morale and performance of the Irrigation Department.

1.3.5 May 1962 Reorganization

The post-integration set-up did not prove to be effective and efficient. Therefore, it was decided to restore the original practice of appointing engineers as the head of engineering departments in

1962. The province was divided into six regions, and each one was put under the charge of a Chief Engineer. Three of these regions comprised areas of the former Punjab Province. There were also two posts of Chief Engineers in the Secretariat; one for Water Treaty Implementation Organization, and the other for Floods.

1.3.6 Exclusive Specialized Units

The successful operation and maintenance of a large irrigation system essentially requires certain supporting units to perform specific functions. These exclusive units have evolved over time and include a Design Directorate, Drainage Divisions / Circles, Research Institute, Mechanical Circle and Land Reclamation Directorate. Historical development of these units is presented in the following paragraphs.

Design Directorate: During the construction of the Haveli Project in 1939, the need was felt to standardize and centralize the design of irrigation structures. A Central Design Office in the Secretariat was consequently created, initially on a temporary basis, which was made permanent on January 01, 1945. The post of Director Central Design was of the rank of Executive Engineer up to October 1955. At the time of the integration of West Pakistan, the post was upgraded to that of Superintending Engineer and designated as the Director of Design and Research. The Central Design Office continued functioning up to October 1955 in the Irrigation Secretariat, and up to May 1962 in the office of the Chief Engineer, Irrigation, West Pakistan. Consequently, it was abolished upon the reorganization of the department and a post of Design Engineer was created in the office of each Regional Chief Engineer. The Design Directorate was re-organized at the departmental level in 1973 under the administrative control of the Chief Engineer of the Central Zone. After the re-organization of the department in 1984, the Design Directorate was attached with the Chief Engineer Planning & Review Zone.

Irrigation Research Institute: The development of irrigation brought, in its wake, problems necessitating scientific research. As early as 1915, It was recommended to appoint a specialist officer trained in the field of physics, but the financial stringency created by the First World War stood in the way of such an appointment. In August 1924 a Scientific Research Officer was appointed in the Irrigation Department. He had to work in the Punjab University Chemical Laboratory. In 1928 a separate building for the Research Institute was erected at the present site, and in 1931-32, the activities of the institute expanded to cover Land Reclamation, Hydraulics Statistics, Chemistry and Physics. A Hydraulic Research Station was established at Malikpur on the Upper Bari Doab Canal in 1925 to carry out model experiments. This station went over to India after independence, and a new Hydraulic Station was established at Nandipur on the Upper Chenab Canal. Another new station for the physics section was initiated in 1959 at Niazbeg, near Lahore, where studies of canal lining, tubewell performance, evapo-transpiration and some other subjects are carried out.

Drainage and Reclamation: The need for systematic drainage investigations was realized for the first time in 1918 when a Drainage Board was formed in the province. A drainage division was constituted in the Upper Bari Doab Canal in 1920, resulting in the post of the Drainage Engineer. In 1925, a Waterlogging Enquiry Committee was constituted to advise the government on the

issue. At the same time, a post of a Superintending Engineer, Waterlogging Investigation, was formed. In 1928, the Waterlogging Enquiry Committee was replaced by the Waterlogging Board to deal with waterlogging problems in the irrigated areas.

The Superintending Engineer in charge of the work was designated as the Superintending Engineer, Drainage Circle, in 1932. During this year, the Drainage Circle was re-organized and two Divisions, namely the Chaj and Rachna, were created to independently tackle the drainage construction in these doabs. In 1939, the drainage of these two divisions was again amalgamated with the Upper Jhelum Canal and Lower Chenab Canal Circle. In 1944, it was again realized that an independent Drainage Circle was better suited for the construction and maintenance of drains and a new circle called, the Northern Drainage Circle, was created with jurisdiction over the Chaj and Rachna Doabs.

After independence, the Drainage Circle was closed once more, and the drainage divisions were attached to the circles in charge of maintaining the canals in respective areas. The conditions of drains deteriorated rapidly, and in 1951, two separate Drainage Circles were again created. An attempt to economize in expenditures resulted in the abolition of separate circles, but these were revived again in 1958, along with the post of a Director of Drainage in the office of the Chief Engineer, Irrigation, West Pakistan.

Currently, there are three Drainage Circles in the Lahore, Faisalabad and Sargodha Zones. In the other three field zones, drainage divisions and/or sub-divisions look after the local drainage network.

Mechanical Set-up: The need for a mechanical outfit as a complementary unit of the largely civil engineering administration of the irrigation system was felt quite early. A Central Workshop was accordingly opened in 1901 at Amritsar, which was modernized and extended in 1905. For several years, this workshop engaged itself in the manufacture of small sluice gates and maintenance of irrigation machinery and structural steel works.

The workshop was taken over by the Government of India for ammunition production during the Second World War. Another workshop was accordingly set-up at Moghalpura (Lahore) to carry out repairs to machinery, pumps, gates and gearing, etc.. The post-independence division of irrigation assets left only the Moghalpura workshop to share of the PID.

With the gradual replacement of manual and donkey labour for earthwork by units of earthmoving machinery to attain speed and quality, the mechanical units had to be expanded, both in scope and size, for the procurement, operation, and maintenance of such machinery. The expansion took place gradually as the needs arose. A Mechanical Circle was established in 1944 to meet the larger work load of workshop and machinery. The mechanical fleet of the Irrigation Department was enlarged and modernized through the USAID-assisted Irrigation Systems Management Project during the 1980s. To further improve the operation and management of machinery units, an exclusive Machinery Circle was created in 1984 as part of the reorganization of the Irrigation Department.

1.3.7 Administrative Changes

The administrative changes in the organizational set-up of the department after 1965 are summarized below (Farooq, 1987).

Creation of the Multan Zone (1968): After the creation of the Agricultural Development Corporation, (ADC) some irrigated areas were transferred to that authority on the concept of a unified development of irrigation, agriculture, and all other agricultural inputs. In the Punjab Province, the Thal Canal and Muzaffargarh Canal systems (excluding the respective headworks) were transferred to the ADC in January 1965. These canal systems were reverted to the Irrigation Department in March 1968 and the ADC was later dissolved. Consequently, a new zone with headquarters at Multan was opened in June 1968 and the boundaries of the existing zones were suitably readjusted.

Creation of the Post of Chief Engineer Floods and Chief Engineer Central (1973): The post of Chief Engineer, Drainage and Floods, was created in March 1973 to plan and implement the flood works in the province, and to coordinate processing of flood schemes with the Federal Flood Commission and Federal Government for the approval and allocation of funds.

A new post of Chief Engineer, Central, was created in June 1973 with administrative control over the Mechanical Circle, Directorate of Land Reclamation, Design Directorate and Small Dams Organization.

Creation of the Faisalabad Zone (1974): In June 1974 another readjustment took place when the Faisalabad Zone under a Chief Engineer was created by splitting the jurisdiction of the previously existent Sargodha Zone. This was done with a view to respond to the increased work load better, and to have separate Chief Engineers at the Civil Division level.

Creation of the Post of Chief Engineer, Research (1975): In April 1975, the post of Director Irrigation, Research Institute, was upgraded to the rank of Chief Engineer Research.

Creation of SCARP Circles: The completed SCARPs were transferred from WAPDA to the Irrigation Department in the mid 70s. Four SCARP circles were accordingly set up in the department for O&M of public tubewells.

Chief Engineer, Co-ordination (1983): A post of Chief Engineer, Coordination, was created in 1983 to coordinate and monitor the implementation of Irrigation Systems Rehabilitation/ Management Projects. These projects were financed by the World Bank and USAID. The projects aimed at rehabilitating the irrigation and drainage network of the province, which had deteriorated due to inadequate maintenance funding in the past two to three decades. The first phase of the project was completed in 1988, with simultaneous launching of the second phase of the ISR Project in 1989 to cover balance rehabilitation needs. The second phase of the project (ISRP) was completed in 1996. The post of Chief Engineer Coordination has been re-designated as Provincial Program Coordinator for the National Drainage Program (NDP I).

Next >>

Chief Engineer, D.G.Khan (1993): A post of Chief Engineer, D.G. Khan, was created in July 1993 by re-adjusting the canal circles in the Multan and Bahawalpur zones. This was considered necessary because of the increased work load of the Multan zone, which had to supervise irrigation activities in 11 districts and 4 civil divisions. In addition, a large number of irrigation and drainage development activities were being planned and implemented in the D.G.Khan Civil Division, which included the management of hill torrents, construction of surface drainage systems, Chashma Right Bank Irrigation Project and other development projects. With the creation of the D.G.Khan zone and re-adjustment of canal circles, the jurisdictions of irrigation zones were redefined to correspond to respective civil divisions better.

1.3.8 1984 Reorganization

In the wake of administrative changes in rapid succession and almost a complete blockade of expansion after the inception of the Indus Basin Project works, there was a general feeling of frustration and despondency prevailing in the department. This started reflecting on the morale, confidence and competence of the staff. As a result of the awareness of this state of affairs, a high level committee, comprising senior echelons of the department and two senior professors of the University of Engineering and Technology was constituted in July 1981 to propose organizational changes to improve the performance of the Irrigation Department.

The committee had, *inter-alia*, noted that there had been a considerable increase in the work load in the field, in respect of revenue and engineering matters. The irrigation intensity had reached an average figure of 110 percent when compared to the designed value of 70 percent. This had resulted in a very keen demand for canal water and a more than 50 percent rise in booking irrigated areas. There were more cases of tampering with outlets and trespassing along the canal banks had increased, especially with the increasing use of tractors / trolleys by the farming community. The cultivators were now more conscious of their rights and required expeditious disposal of their grievances. They had free access to senior officers. Modern means of communications had made them quite mobile. With growing emphasis on development and more powers for local bodies, there was a constant demand for co-ordination and meetings at various levels. However there had been no increase in the original strength of the field staff in the field division, and sub-divisions, since 1937.

In view of the above perspective, the committee made a number of recommendations to improve the working of the Punjab Irrigation Department. The main organizational changes recommended by the committee included 50 percent increase in the revenue staff up to *Ziladar*, 50 percent increase in the engineering staff and 25 percent increase in the canal divisions. This was proposed to be achieved in 2 stages. In the first stage, 25 percent increase in the revenue and engineering subordinate staff as well as 25 percent increase in the sub-divisions, was recommended. Subsequently in the 2nd stage, other changes recommended by the committee were proposed for implementation (Mazhar Ali et al, 1981).

Some of the recommendations were accepted in 1984, with the over-riding condition that no additional funds would be provided. Therefore, it basically meant departmental re-organization; creating some new positions with matching surrenders of some existing positions. A new post of

Additional Secretary and Chief Engineer (Power) were created. The Electrical Inspectors organization was strengthened. A Planning and Review Organization under a Chief Engineer (Planning) was set up. There were adjustments in the functions of Chief Engineers at Lahore and the post of Chief Engineer Central was renamed as Chief Engineer Development, with jurisdiction over the Central Design Office, Project Organization and the mechanical outfit of the Department. The Zonal Chief Engineers and the O&M field staff remained almost unchanged. Recommended expansion of field divisions and sub-divisions was not carried out as an economy measure. Setting up a Board of Chief Engineers at Lahore also did not meet with approval.

1.3.9 Canal O&M Staff

Ever since the creation of the department, there have been substantial and significant social and administrative changes; from empires to the colonial system and then to independence; from separate provincial administration to one-unit administration and back to a federal system; from shared water sources to an independent and integrated irrigation network; from feudal culture to a more democratic system and from large holdings, the extensive fallow lands to intensive agriculture with emerging problems of fragmentation due to immense pressures of a rapidly growing population (Bandaragoda and Firdousi, 1992). Despite these developments, the basic organizational structure of canal O&M and revenue units has remained unchanged, except for the creation of the posts of Chief Engineers and the establishment of new disciplinary wings, such as Drainage, SCARPs and Mechanical, etc.. The jurisdiction, functions and staff strength has not been updated despite tremendous increase in work load caused by the rapidly escalating demand for scarce canal water, rising disputes among the irrigators and sharp decline in the discipline of society.

Table 1.6 presents a summary of the approved positions of the canal O&M and revenue staff since 1980. That there have been few changes in the organizational structure and staff positions in these important disciplines is clearly demonstrated.

Table 1.6. Canal O&M and Revenue Staff Positions.

Staff Positions	No. of Posts			
	1995	1990	1985	1980
A. Engineering Staff				
C.E's	6	5	5	5
S.E's	18	18	18	18
XEN's	56	55	55	55
SDO's	171	171	173	173
Sub Engineers	765	758	768	760
B. Revenue Staff				
Collectors	6	5	5	5
Dy. Collectors	45	45	46	45
Zilladars	421	425	436	435
Patwaris	4495	4469	4485	4480

Source: Punjab Budget Books.

1.3.10 Historical Review of Stature and Agency Performance

The Irrigation Departments have played key roles in developing the world's largest contiguous irrigation network that converted desert wastes into lush green fields. These also have long traditions of performing key roles in the economic and social development of the country.

This grand irrigation system, while providing a livelihood to the millions, also proved to be a massive and lucrative source of revenue earnings for the government during colonial rule. Therefore, it was government's the utmost effort, at that time, to devise a befittingly efficient administrative set-up to manage, operate and develop the irrigation infrastructure. Highlighting the importance and performance of the Irrigation Department, Farooq (1996) has observed:

> *"....The Irrigation Department was accorded a unique and privileged position among all the departments of the province. It was realized that the constant, close and highly technical attention that this Department warranted, was beyond the span of control of one single person. So quite contrary to the normal concept of one secretary as the head of one Department, a unique arrangement of providing four secretaries-cum-chief engineers to head the Irrigation Department concurrently was adopted.....*
>
> *The imperatives of quick processing of financial matters and issuance of timely finances for the Irrigation Department were also fully realized. In pursuance of this requirement, another innovation of bringing the Finance Department to the door-steps of the Irrigation Department was adopted. A Deputy Secretary of Finance Department along with the allied staff was housed in the Irrigation Secretariat. This in-house arrangement resulted in very expeditious disposal of important and urgent cases.....*
>
> *Notwithstanding strict instructions prohibiting incurring of expenditure on works without a budget provision and approval of estimate, a Divisional Officer of the Irrigation Department on grounds of emergency or urgency could take up works for which no financial provisions exist".*

The history of the Irrigation Department's performance has been traced in an exclusive report regarding the reorganization of the Punjab Irrigation Department that was edited by Mazhar Ali (1981). The report brings the factors that have been influencing the working of the Department into sharp focus. Some selected reflections from the above report are reproduced below:

> *".....In the past, the Irrigation Department of the Punjab occupied a top position in the Government's power hierarchy and in national development. Young engineers entering the department had a sense of pride and senior engineers had a feeling of deep professionalism and achievement. They worked with dedication under harsh and difficult environments and made the deserts bloom. The outlook then was progressive and forward looking.....*

During the One Unit period, the department successfully planned, designed, executed and operated two major irrigation projects, viz; the Guddu Barrage Project and the Taunsa Barrage Project. The department had a strong Central Design Office to conceive, plan, design and oversee major projects and to undertake major changes and improvements in operating works. It had also a large construction team to execute major projects expeditiously and economically. It carried out all the complex and difficult studies which subsequently became the basis of the Indus Basin Replacement Plan. Tripartite negotiations on the Indo-Pakistan water dispute among India, Pakistan and the World Bank were successfully handled.....

In 1960, planning, design and construction activities connected with the development of water and power resources underwent a major change. All resources in materials and manpower were diverted to timely completion of the Replacement Works under the Indus Basin Plan. WAPDA was created in 1958 as an autonomous organization to execute the Indus Basin Plan, mostly with the help of foreign consultants and foreign contractors due to Pakistan's obligations under the foreign assistance for the Indus Basin plan. Policy decisions for the execution of the Indus Basin Plan were based on advice of foreign consultants with Pakistani engineers playing only a secondary role.....

Due to pressure of work of the Replacement Plan, a large number of experienced engineers of the Irrigation Department were assigned to WAPDA. No major canal irrigation project outside the Replacement Plan was undertaken during the period 1960-70 as the entire emphasis was on the timely execution of the plan works. The engineers in the Department found themselves at a disadvantage as compared to their colleagues in WAPDA, where they had much better career and professional opportunities. WAPDA was a young, expanding and powerful organization for the Power Sector and execution of all replacement works. Major new projects in the water sector were also assigned to this organization. The transfer of responsibilities for irrigation development to WAPDA adversely affected the professional competence of the Irrigation Department. The engineers in the department were forced into an environment of the inactivity with little chances of professional growth. An organization can blossom only in the face of challenges; inactivity can destroy even the best organizations.

Slowly, but steadily, the Punjab Irrigation Department, which was once the pride of engineers in the field of development and enjoyed a high status in the government hierarchy, went sliding down into near inactivity and stagnation. There were no major projects where the personnel could get important field experience and professional maturity. Departmental promotions became slow as new jobs were not forthcoming. The whole climate became rather stale as there were fewer chances for exposure to modern knowledge and experience. As such, the engineers greatly lost their initiative and confidence."

Commenting on the relevance of the present role structures of the Punjab Irrigation Department in the changed socio-political environments of the society, Bandaragoda and Firdousi (1992) have observed :

".....Organizational structures, distribution of responsibilities and even the size of organizations basically remain in the same form as left by the colonial administration. Minor sporadic changes have resulted only in some appendages, and consequent administrative anomalies...

For instance, the PID, which was created about a hundred years ago, despite its expansion with some new disciplinary wings such as Drainage, SCARP, Mechanical, etc., has not changed in its basic structure of the Open Canal Circles since its creation. Since then, the demand for water has increased manifold due to fragmentation of lands, changes in cropping patterns and expanded irrigable areas, all leading to increased problems concerning distribution of water and disputes among the irrigators.....

Among the institutional factors that affect Pakistan's irrigation performance are the problems of complex and outdated formal rules and procedures compounded by the over riding effect of several socially evolved information institutions, and the associated management deficiencies of a static administrative structure.....

It is recommended to review the present organizational structure of the Punjab Irrigation Department with a view to removing present administrative anomalies and making them more effective in supporting and monitoring irrigation management at divisional level where greater farmer participation can be achieved in decision making."

1.3.11 Foreign Assistance for Water Resources Development and Institutional Reforms

External assistance has played a dominant role in water resource development in Pakistan. Both, the World Bank and the US Agency for International Development (USAID), have provided facilities and finances for development and management of the irrigation infrastructure since the early 1950s. More recently, assistance for the water sector has been provided by the Asian Development Bank, JICA, ODA, and several other bilateral donors. The major foreign-aided projects in Pakistan have included the Indus Basin Replacement Works and Salinity Control and Reclamation Projects (SCARPs) during the 1960s and 1970s; Irrigation Systems Rehabilitation (ISR-I&II) Projects, On-Farm Water Management (OFWM-I, II & III) Projects, Left Bank Outfall Drain (LBOD), and Flood Damages Restoration Projects during the 1980s and 1990s. Some of these projects are still on-going. In addition, two major projects, one for dis-investment of public tubewells and the other to address the overall drainage needs (National Drainage Program), have been launched recently.

Foreign-aided projects have had specific objectives and also carried certain conditions as part of the loan covenants. While these project have contributed significantly towards water resource development and in improving irrigation management in the country, the implementation experience has also brought to focus certain weaknesses and concerns related to optimal utilization of the allocated resources. The major concerns include persistence of waterlogging and salinity as a long-term threat to agricultural development, general lack of financial sustainability, serious issues with regard to adequacy of planning and design of the projects, heavy dependence on technical assistance provided by expatriates, and exorbitantly expensive projects.

The main thrust of investments in the water sector during the 1980s and early 1990s focused on the rehabilitation of the irrigation network to cover the deferred maintenance, and to improve the efficiency of water use at the farm level. The agenda of loans conditionalities, generally, aimed at increasing the O&M funding for the proper upkeep of the irrigation network, raising water charges to bridge the gap between O&M expenditures and system revenues, and phased dis-investment of public tubewells in FGW areas. A review by the World Bank in 1993, however, pointed out the need for major institutional changes in the irrigation management. The major recommendations included treating irrigation water as private goods, re-defining water rights, introducing market incentives for improvements, and establishing public utilities around canal commands to manage irrigation functions with the help of farmer organizations (World Bank, 1994). The proposed reforms have since been extensively debated at the highest policy and public levels. Now the resolution is to pursue a much milder approach to irrigation management reforms that does not contemplate any changes in the existing water discipline, and proposes introducing participatory management concepts by transforming the existing Irrigation Department into an autonomous authority and establishing an Area Water Board in one canal command on a pilot basis.

CHAPTER 2

OBJECTIVES AND FUNCTIONS OF THE PUNJAB IRRIGATION AND POWER DEPARTMENT

2.1 Goals and Objectives of Irrigation Agency

2.1.1 General

Irrigation management deals with the planning, organization, motivation and control of activities to achieve the purpose of irrigation. The activities in irrigation system management can be divided into three main categories: those focused on water, structures and organization.

Goals and objectives are the starting point of the most modern planning and management methods. These provide endpoints, which make it possible to determine the level of the success of an effort. Setting and clear definition of goals and objectives, therefore, is central to the performance assessment of any institution or business enterprise.

The final goal of irrigation schemes should be to improve farmers' welfare through increased agricultural production. This can be achieved if the irrigation schemes are managed according to specific goals and objectives. These goals in ascending order of importance, include appropriate use of water, appropriate use of other agricultural inputs, remunerative selling of agricultural produce and improvement in social facilities (FAO 1982).

The first step in irrigation management is to identify the interest groups with their respective objectives in irrigation. The main interest groups are the farmers, the irrigation agency and the government. Their common aim is to increase agricultural production, but the objectives might sometimes conflict. For example, individual farmers want enough water for optimal crop yield, but in the case of water scarcity, the government or the agency wants the water to be divided among all farmers equitably. The key objective in managing an irrigation and drainage system is to provide levels of service as agreed with the government, irrigation agency and farmers at the minimum achievable cost.

2.1.2 Institutional Set-up for Irrigated Agriculture in Pakistan

A multitude of state agencies and departments share responsibilities for the management of irrigated agriculture in Pakistan. The broad division of responsibilities between irrigation and agriculture starts at the federal level, with two separate ministries, and runs through the sector's whole structure up to the farm level. Irrigation management in Pakistan, thus, follows a segregated organizational structure.

The Water and Power Development Authority (WAPDA), linked with the Federal Ministry of Water and Power, is an autonomous agency responsible for the development of water resources in the country. WAPDA manages the storage dams and operates these in consultation with the Indus River System Authority (IRSA) and Provincial Irrigation Departments (PIDs) according to

the water rights and seasonal allocations of the provinces. WAPDA has also been responsible for the construction of the Indus Basin Project Replacement Works, installation of tubewells in various SCARPs, and installation of drainage projects throughout the country. After the construction of barrages, link canals, tubewells and other drainage schemes by WAPDA, the responsibility for their operation and maintenance is transferred to the PIDs.

The major responsibility for irrigation system management rests with the PIDs, and some of its elements are with Provincial Agriculture Departments (PADs). PIDs undertake some construction works, but primarily attend to the O&M of irrigation facilities, extending from barrages and main canals to outlets, upkeep and maintenance of drainage and flood works, assessment of water charges, and resolution of conflicts among water users. On-Farm Water Management (OFWM) Directorates carry out watercourse lining and on-farm water management, while PADs are responsible for agricultural research, extension and productivity enhancement. On the other end, farm level decisions regarding application of water and non-water inputs are made by the individual farmers. A host of complex factors and the external environment impinge farmers' performance and decision-making processes.

2.1.3 Objectives of the Punjab Irrigation Department

Goals and objectives of irrigation management in Pakistan have not been explicitly set out in any single document. The objectives given below have been extracted from various documents and interviews with irrigation engineers. Objectives directly concerning the Punjab Irrigation Department have been listed. The broader objectives, like `increasing the agricultural production' or farm level objectives of `improving the application efficiency', although quite relevant in the context of overall irrigation management, have not been included because these objectives extend beyond the functional jurisdiction of the department. While irrigation water definitely helps to increase the agricultural production, it is only one of the inputs. Other non-water inputs, as well as farming and marketing policies, impact the productivity of the system. Similarly, the jurisdiction of the Irrigation Department extends up to the outlet level and beyond this, farmers are responsible for managing their watercourses and field applications. Therefore, downstream outlet activities have not been included, except for those specifically included in the purview of the irrigation department, e.g. assessment of water charges, etc..

A. Planning Stage Goals

- To overcome recurring famines.
- To develop vast tracts of barren land.
- To provide livelihood to local inhabitants.
- To improve the well-being of the rural population by stabilizing and increasing agricultural production.
- To generate revenue earnings for the state.

B. Design Stage Objectives

- Improved control and command for the acquisition and distribution of irrigation water.
- Optimal allocation and utilization of scarce water resources.
- Bringing maximum area under cultivation to benefit the maximum population with available irrigation water.
- Partial irrigation with restricted cropping intensities.
- Operation of the system with minimum human intervention.
- Equitable and proportional distribution of available irrigation supplies.

C. Operational Objectives

- Effective and efficient management of irrigation and drainage infrastructure.
- Equitable distribution of available canal supplies.
- Control of illegal water abstractions.
- Water resources development.
- Control of waterlogging and salinity.
- Flood protection of population centers, agricultural land and communication network, as well as the industrial and irrigation infrastructure.
- Revenue generation through efficient assessment of water rates.
- Resolution of conflicts related to the mutual water rights of the share-holders.
- Control of environmental degradation of land and water resources.

D. Objectives of the Water Scheduling

The irrigation system of the Punjab Province is mainly a run-of-river system with a limited storage capacity upstream in the system. Therefore, variability and shortage of surface water supplies are expected. The main objective of the canal operations is to achieve as much equity as possible, and to ensure supplies to tail-end farmers. The objectives of the water scheduling can be categorized as global and operational objectives.

These objectives, for various system levels, are described in Table 2.1 (Shafi and Zaigham, 1996).

Table 2.1. Global and Operational Objectives of Water Scheduling.

System Level	Global Objective	Operational Objectives	Decision-making Authority
Reservoirs and Inter-provincial Canals	• Providing maximum water for agriculture and power generation • Flood and drainage control • Sustainability of the network	• Matching the water demand of different systems • Implementing the Water Apportionment Accord among the provinces	Water & Power Development Authority (WAPDA) and Indus Rivers System Authority (IRSA)
Main Canals	• Deliver water to the secondary system according to the design discharge • Maintenance of the main canals • Satisfy the demand of the secondary system	• Distributing the water shortages or excesses equitably • Minimize the operational cost	Punjab Irrigation Department (PID)
Secondary Canals	• Deliver water to the tertiary canal system according to the design rights • Take care of the environmental impacts • Increase productivity	• Distributing the water shortages or excesses equitably • Minimize the operational cost	PID
Tertiary System	• Providing Water to all cultivators on an equitable basis	• Following the authorized scheduling	Frequently the farmers, occasionally the PID

2.1.4 Review of Department's Goals and Objectives

Vander Velde and Svendsen (1993) have reviewed the goals and objectives of irrigation in Pakistan by conducting review of official published reports and documents, and the interpretation given to the stated goals by irrigation system managers.

The study indicated that a listing of goals for an irrigation projects often presents a picture of bewildering diversity. That the majority of the irrigation staff interviewed defined the equitable distribution of the irrigation supplies to farmers as a system operation objective has been reported. In most cases, the design discharge, or gauge level, was recognized as a target. Increased agricultural production was also identified as a national goal in all the documents reviewed, except the Manual of Irrigation Practice (MIP) and Revenue Manual (RM). The MIP and RM make no mention of any explicit agricultural goals at the irrigation system level. This is understandable because the Irrigation Department's activities do not extend to crop production at the field level. Another irrigation goal mentioned at all organizational levels in all the documents was the need to control water-logging and salinity. Preventing the un-authorized use and theft of water was also mentioned as a system operational objective. The study concluded that articulating clear and specific goals/objectives has not received the attention it warrants. The need to clearly define the goals and objectives of irrigation management in Pakistan, therefore, was proposed. The study also identified inconsistencies in the goals and objectives that have been mentioned in major reports and the actual capacity on the ground, at the operational level, to achieve them.

Two most striking facts need re-emphasis. One is the lack of clear objectives and specific targets for irrigation management in Pakistan and the second is that as a consequence of agricultural development over time, the current water requirements are far in excess of the system capacity during peak demand periods, but the organizational goals have remained unchanged. This means that the existing infrastructure is just not capable to deliver water `on demand' basis or to meet crop water requirements. This gives rise to conflicts between the Irrigation Agency and Farmers and also reflects on the performance and image of the Irrigation Agency. Therefore, there is an urgent need for redefining the objectives of irrigation management through national debate. The objectives have to be compatible with local setting and also achievable given the system constraints. In this context, the observation of Murray-Rust and Snellen (1993) is quite relevant whereby they have postulated that when irrigation managers do not state their objectives clearly, they run the risk of having objectives imposed on them by others.

2.2 Functions of the Punjab Irrigation Department

2.2.1 Irrigation and Drainage: A Provincial Subject

Irrigation and Drainage is a provincial subject in accordance with the provisions of the Constitution of Pakistan (1973). Article 142 of the constitution provides guidelines concerning subject matter of the Federal and Provincial Laws. This article prescribes that the Provincial Assembly shall have the power to make laws with respect to any matter not enumerated in either, the Federal Legislative List or the Concurrent Legislative List. The Federal Legislative List and the Concurrent Legislative List have been notified under the Fourth Schedule [Article 70(4)] of the constitution. Irrigation and drainage have not been included in either of these two lists, and therefore, it becomes a provincial subject.

2.2.2 Official Functions

The functions of the Irrigation and Power Department, as enunciated in the Punjab Government Rules of Business, are given below:

A Irrigation and Drainage

a) Rivers and riverain Surveys.
b) Barrages: construction work and all matters connected therewith.
c) Construction and maintenance of canals.
d) Tubewells and other water utilization schemes.
e) Flood control and flood protection schemes.
f) Drainage schemes.
g) Land reclamation schemes.
h) Storage of water and construction of reservoirs.
i) Basic and applied research in irrigation, hydraulics, groundwater and land reclamation.
j) Administration of the Canal and Drainage Act, 1873.
k) Administration of the Soil Reclamation Act, 1952.
l) Administration of the Land Improvement Tax Act, 1975.
m) Assessment of water rates.
n) Distribution of canal waters.

B Power Sector (Not relevant for the Case Study)

C Service matters, except those entrusted to Services, General Administration and Information Department.

D Purchase of stores and capital goods for the department.

2.2.3 Core Functions

- Operation and upkeep of the irrigation system of the province;
- Planning, prioritization and implementation of maintenance works through approved O&M Work Plans, and under third party top supervision;
- Optimizing the use of water resources in the province by the equitable distribution of irrigation water supplies (about 54 MAF) through 52,000 canal outlets;
- Assessing water rates based on actual field inspections by the revenue staff of the department;
- Implementing the development program portfolio and foreign-aided projects;
- Providing for and executing a plan for the management of river floods in the province, and to construct and maintain flood protection programs/works;
- Promoting the participation of beneficiaries in the management of the Irrigation and Drainage Systems of the province, in line with requirements of the Punjab Irrigation and Drainage Authority (PIDA) Act, 1997;

- Administering the Electricity Act and Village Electrification matters; and
- Acting as the Personnel Department for over 52,000 employees of the Provincial Irrigation Department, including matters related to career development, posting and transfer, promotion and in-service training.

2.2.4 Brief Description of Irrigation-related Functions

Irrigation-related functions of PID Punjab are briefly described below:

i) River Surveys and Hydrology Data

Pakistan's rivers are characterized by mobile beds and meandering river courses due to highly variable discharges and sediment inflow. Changes in river courses are quite frequent, particularly after each flood season. Mapping river courses and its longitudinal sections is an essential activity for effective and efficient planning of the flood protection works. This activity is carried out by the department's Hydrology Directorate and by engineers posted at various barrages. In addition, the Hydrology Directorate makes discharge observations and keeps a comprehensive record of river and canal flows and sub-soil water levels in the province. The record of discharges and water levels forms the basis of planning and designing new schemes. Suspended and bed sediments, as well as some climatological data, are also observed and recorded by this directorate.

ii) Operation and Maintenance of Barrages

Barrages are the gated structures across rivers to affect better control and command for the off-taking canals. There are 14 barrages in the Punjab Province, where 21 main canals off-take and provide irrigation water to 20.78 million acres of culturable commanded area (CCA). Being the most crucial component of the irrigation system for controlled diversion of irrigation supplies, proper and efficient operation and maintenance of the barrages is essential to sustain irrigated agriculture in the province.

Since the construction of new barrages has been frozen for the last two decades, the main responsibility of the department relates to the proper upkeep and maintenance of existing barrages. The major functions under barrage O&M include effective regulation, control of water and sediment flow into the canals, safe passage of floods, proper maintenance of all the barrage components (guide banks, marginal bunds, spurs, etc.), river surveys, repair and maintenance of gates and the superstructure, periodic safety inspections, and carrying out necessary repair works, particularly during the annual canal closures.

iii) Operation and Maintenance of Canals

Effective and efficient operation and maintenance of canals is one of the most important functions of the department for providing assured and equitable canal supplies to the irrigation area. The total length of canals in the Punjab Province is 23,184 miles, with about 4,000 miles of main canals and branches and over 19,000 miles of distributaries, minors and sub-minors. The

operation activities include the efficient management of canals to supply canal water reliably and equitably; data collection, processing and analysis; control of water levels and discharges; monitoring discharges of the canals and outlets; and feedback. The maintenance activities include maintenance inspections, field surveys, preparation of estimates, budgeting, contracting, and execution of approved works. Silt clearance, berm cutting and repair to the canal structures is carried out during the annual canal closure. Comprehensive rules and procedures have been prescribed to implement the works through proper supervision, checks by higher officers, and financial controls.

The department has employed exclusive O&M staff for canal operation and routine inspections, preventive maintenance, minor repairs to the canal banks and structures, and checking outlets, etc.. Inspection officials/officers (Sub-engineers, SDOs and XENs) also carry out routine and special inspections of canals, checking canal operations versus the planned schedules and identifying maintenance needs.

iv) Distribution of Irrigation Water

The main objective of canal operations is to achieve as much equity as possible and to ensure supplies to the tail-end farmers. Within the limitations set by surface water availability, the farmers have the authority to decide most matters related to crop production and cropping intensity. Exploitation of ground water is also managed by the farmers and they are free to share and manage this water. The state management ends at the turn-out (out-let). A seven-day roster called "*warabandi*" is formulated for all the farmers along a water course. The share-holders are expected to operate and maintain the watercourse and implement the *warabandi* system. In the case of a dispute, the state management intervenes and fixes the start and duration of the turn for each cultivator according to his land-holding size.

At the provincial level, a special regulation program is prepared for each crop season (two seasons in each year) and for all canals. These programs are prepared on 10-daily bases and are conveyed to the headworks where the canals off-take. The main canal flows are monitored at the headworks and conveyed to the Regulation Directorate. The Indus River System Authority (IRSA) distributes the water according to the apportionment accord between the provinces. An account of the provincial-level canal flow for a five day period is maintained by the IRSA.

The quantity to be released to a canal is based on the allocation made by the Regulation Directorate, or the indent placed by the canal management, whichever is less. This quantity is then released by the engineer in charge of the headworks. The engineer in charge of the headworks monitors the canal flow and informs variations from the schedule to the Regulation Directorate.

A sub-division is the basic administrative unit of the network and a Sub-divisional Officer (SDO) is the "Regulation Officer" of the sub-division. Each SDO works out the requirement (indent) of the area under his supervision. The water requirement from the tail-end to the head-end is conveyed by the respective SDOs. The SDO is expected to include the effects of events, such as rainfall, canal breaches, etc.. When the supplies are less than the demands, a rotation program is

implemented. An eight-day rotation is usually adopted. The tailend of the distributary would run under this system for seven days (Shafi and Zaigham, 1996).

v) Tubewells

In orders to control the twin menace of water-logging and salinity, about 10,000 tubewells were installed in the public sector under various SCARPs. These tubewells are mostly of deep well turbine type. In some areas, tubewells with centrifugal pumps under a `Grow More Food' program have also been installed. The SCARP tubewells provide supplementary irrigation supplies in fresh groundwater areas in addition to controlling water-logging. The achievement of these objectives very evidently depend on the efficient and economic operation and maintenance of the tubewells. For this purpose, the department has employed exclusive staff comprising operators, mechanics and properly qualified mechanical engineers, who take care of daily operation, as well as special and emergency repairs of the tubewells. The operators are stationed at tubewells for proper operation of tubewells as per operating schedules and local needs. The department also has workshops for the expeditious repair of tubewells. A complete record of the running hours, actual discharge of tubewells and sub-soil water levels is also monitored to evaluate the impact of tubewell operation. As a result of rapidly escalating energy tariffs, O&M costs of the tubewells have increased tremendously . This has forced the government to initiate projects for the dis-investment of tubewells in FGW areas. The responsibility for the O&M of SCARP tubewells in the SGW area, however, would continue within the public sector.

vi) Flood Protection Works

The construction of flood protection works, viz. flood embankments, spurs, studs, etc., is essential to protect irrigation infrastructures and to safeguard agricultural lands, and *abadies* (towns) from the onslaught of floods. Departmental activities in this regard include both, short term measures (temporary protection against river erosive action along its banks), as well as long-term measures (training river flow). For optimal results, precise planning of protection works between the control points on the basis of model studies and then implementing the package in one working season, is recommended. Financial constraints and delays in approval formalities, however, do not allow this and the packages are only partially implemented. This restricts the usefulness of the flood works. The department is also responsible for the proper upkeep of the existing *bunds*, spurs and other flood protection works covering a length of 1600 miles. Flood watching and flood fighting during the flood emergencies is another important function of the department. In addition, the restoration of damages caused by floods is also the responsibility of the Irrigation Department.

vii) Drainage Schemes

As a consequence of the development and intensification of canal irrigation, the necessity to construct surface drainage schemes was felt. Accordingly, a large surface drainage network with an aggregate length of over 4,800 miles has been constructed to facilitate the drainage of rain and seepage water. Major drainage projects are implemented by WAPDA, which are handed over to the Irrigation Department for subsequent O&M. Smaller drains are planned and constructed by

the department. The main functions of the department, therefore, relate to proper functioning and maintenance of completed drainage schemes, as well as monitoring the planning and implementation of new drainage projects undertaken by WAPDA. Maintenance activities include weed and debris clearance; bed clearance; maintenance of banks inlets, bridges, outfalls and other structures; and monitoring the drain flows to evaluate its effectiveness and identify the need to remodel.

viii) Land Reclamation

Soil and water quality and its suitability for irrigated agriculture has an important bearing on the development and sustainability of irrigated agriculture. The department has developed research facilities over the last 45 years to determine water and soil standards and measures for the reclamation of salt-affected soils. Both, biological and chemical methods, have been developed and demonstrated.

The Land Reclamation Directorate is equipped with research laboratories and experimental field stations spread all over the province. Research studies pertaining to soil deterioration, soil survey and land classification, water quality, irrigation water management and water requirements of crops, cropping patterns with regard to the physio-chemical aspects of salinity control and other features of land improvement, are undertaken by this Directorate.

ix) Construction of Small Dams

The development of *barani* areas has been specifically mentioned in the strategies of the 6th, 7th and 8th five-year plans, with special reference to agriculture. As one of the measures for increasing agricultural production in rainfed (*barani*) areas of the Potohar Plateau in the Punjab Province, a program to construct small dams was initiated in the early 1960s.

A common feature of rainfed areas is that agriculture is not developed due to erratic and uncertain precipitation and loss of rain water due to rapid run-off. The high velocity rain water flow generated by steep slopes of the plateau also causes acute problems of erosion of fertile land/soil. In order to address the problem of soil erosion and to conserve rainwater for agricultural development, the construction of small dams offer promising prospects. In order to plan and implement the construction of small dams in the *barani* areas of the Punjab Province, a Small Dams Organization has been established in the Irrigation Department. This organization is responsible for identifying potential dam sites, collecting hydrological, hydraulic, geo-technical and other needed data, conducting feasibility studies, preparing detailed designs, constructing small dams and allied irrigation network. A total of 31 small dams have so far been constructed in the Punjab Province, which provide irrigation facilities to about 36,000 acres of land. Under the Small Dams Umbrella Project (1987-95), 12 small dams have been constructed, along with comprehensive measures for command area development, fisheries development and institutional strengthening.

x) Irrigation Research

While developing the world's largest integrated irrigation system, irrigation engineers and scientists had encountered a number of complex problems associated with the design and construction of large hydraulic structures on permeable foundations, stable alluvial canals, and training / control of large rivers. The Irrigation Research Institute, established in 1924, has now grown into a premier research organization, with facilities for large-scale hydraulic model testing. The research conducted by this institute has led to the development of safe and economic design of large hydraulic structures, dams, spillways, bridges, river training and flood protection works.

Many research projects, of basic and applied research pertaining to the Agricultural Research Council, PCRWR, and WAPDA, are also handled by the Research Institute.

xi) Administration of Canal and Drainage Act

The Canal and Drainage Act was promulgated in 1873 to regulate and control the development of irrigation and the distribution of canal water. The rapid population increase has resulted in mounting pressure on land, increasing competition for canal supplies. The Canal Act is administered by the officers of the Irrigation Department. The divisional and sub-divisional canal officers (XENs & SDOs) have been given magisterial powers and legal authority for the expeditious resolution of water disputes among shareholders, effective administration of the Act, control of encroachments and equitable distribution of irrigation supplies. The enquiries and proceedings under the Act are deemed as quasi-judicial, requiring adherence to the prescribed procedure and a proper understanding of the law.

The main functions of the department under the Canal and Drainage Act include application of water for public purposes, construction and maintenance of irrigation works, supply of water, water rates, recovery of charges, drainage, internal water distribution, and offenses and penalties. Most work connected with the administration of the Canal and Drainage Act relates to the settlement of mutual differences among the shareholders (Section 68), supply of water for new area or change of source of water supply (Section 20), water rates and liability for unauthorized irrigation (Section 33-35), and offenses under the Act (Section 70).

xii) Assessment of Water Charges

Every irrigation system needs money to finance the O&M costs. This is done by collecting water fees from the farmers for irrigation water supplied to them. In the Punjab Province, service charges are recovered from individual farmers in the form of Occupiers' Rates or *Abiana*. This charge is in respect of matured crops in accordance with the provisions of the Canal and Drainage Act-VIII of 1873 (Nasir, 1993).

For the purpose of assessing water rates, there is an exclusive revenue set-up in the department. The revenue wing arranges the initial/final records on which canal revenue is assessed and collected. The cropped area of each field is measured, along with the complete data of each

owner/cultivator, village, channel, outlet and field. This data is recorded in the Field Measurement Book (*Khasrah*) and is subjected to checks and rechecks by a tier of departmental senior officials/officers. Demand Slips (*Parchas*) are prepared for the owners/ cultivators, with details of the crops and the area finally measured and assessed. These are finally delivered to the "*Lambardar*" for distribution among the cultivators. The demand statements (*Khataunis*) are prepared from the *Parchas*. The demand statements are prepared by villages / *tehsils* / districts, and are supplied to the civil administration for the collection of water rates. The district administration collects revenue through village headmen (*Lambardars*), who are allowed to retain a certain percentage of the collected amount.

2.2.5 Review of Current Functions and Activities Versus O&M Universals

All irrigation systems in the world must be properly operated and maintained to sustain its effectiveness. There are common aspects, or `universals', of good operations and maintenance that are present in all good irrigation systems. Basically, these `universals' can be categorized by disciplines (operation, maintenance, equipment management and organizational management) and activities (planning, implementation, inspections, reports). A review of the Discipline-Activity universals for the existing irrigation systems in Pakistan was conducted by USAID Consultants (PRC/Checchi, 1986). The results have been compared with the `universals' in order to assess the relative stage of development / implementation of each discipline and function for Pakistan's irrigation system. The conclusions drawn from the study were that all the disciplines are present in Pakistan's irrigation system; but that detailed functions among the activities in each of these are sometimes non-existent, or very obsolete. The main findings of the consultants include :

- The discipline of operation has an extensive degree of obsolescence scattered through its activities. The activities requiring attention in operations are: criteria/standards; adequate water measurement devices and methods of measurement; benchmark network up-dating; adequate and up-dated maps, files, inventory of facilities and longitudinal sections; coordination of inter-departmental policies and activities regarding priority of irrigation operations.
- The discipline of maintenance is outdated in many instances. The activities requiring attention in maintenance are: modernization of criteria/standards; appropriate physical and financial yardsticks; adequate scheduling of maintenance; updated Schedule of Rates; slow-moving, fractionated, small-scale contracting; lack of equipment at Sub-divisional and Divisional levels; lack of coordination of inter-departmental policies and activities regarding priority of proper maintenance, and enforcement of laws and regulations.
- The discipline of equipment management is very weakly equipped, staffed, organized and programmed to support irrigation system management activities.
- The discipline of management/training for O&M is obsolete in many instances, and in a number of cases, appropriate processes have not been developed. Examples of items needing attention include: authority and discipline; personnel planning and management; work unit responsibilities; job / task work specifications; supervisory transport and communications; and control systems, including budgeting and inspection.

2.3 Performance Assessment and Indicators

2.3.1 Framework for Performance Assessment

The performance of a system may be defined as the acquisition of inputs, and the transformation of these inputs into intermediate and final outputs, as well as the effects of these activities on the system itself and its environment. The performance of a system is represented by its measured levels of achievement in terms of one, or several, parameters, which are chosen as indicators of the systems' goals (Abernethy, 1989). Important aspects in performance assessment are those of scale and audience. The irrigation management impacts the water delivery system up to the national level. The level of achievement can have different contexts and implications according to the perceptions and objectives of the reference level. Another point of interest is that of change in performance expectations over time. An effective management system, therefore, needs to adjust to the changes, both within the system itself, as well as in the external environment.

Small and Svendson (1992) have categorized the monitoring of performance assessment into three types, as given below:

- Operational Performance Monitoring
- Accountability Assessment
- Intervention Assessment

In addition, the fourth category could be identified as Environmental Impact Assessment.

The operational performance monitoring deals with day-to-day monitoring of operational performance. The scheme managers need a consistent and continuous inflow of data to enable them to decide on operational matters. The data include river discharges and reservoir levels, water levels and discharges at various regulation points in the off-taking canals, cropped area, climatological and hydrological data, and water demands. The accountability assessment can be applied to the internal processes of the irrigation organization, the relationship and procedures of the Public Accounts Committees, and the relationship between irrigation agencies and the farmers. For accountability assessment to be fair and objective, the active participation of the various interest groups at different levels needs to be institutionalized. The intervention assessment deals with monitoring of strategic interventions in the system, and is undertaken to determine the ways and means to improve some aspects of the scheme's performance. This may range from modest changes in water distribution procedures to major institutional reforms. The intervention analysis involves assessment of scheme performance at a given time, evaluation of the performance with a view to identifying constraints in effective management, and taking appropriate corrective action.

Irrigation management experts point out that evidence of an effective performance assessment framework, which would help management to evaluate and improve overall performance is still lacking (Murray-Rust and Snellen, 1993). Setting a framework for irrigation system performance is a first step towards analyzing the functions of the irrigation system. This framework needs to be evolved in the context of various components of the system: the irrigation service, the agriculture service and the farmer (FAO, 1991).

Perry (1996) has proposed the minimum set of indicators for performance assessment of irrigation schemes. These indicators are listed below in Table 2.2.

Table 2.2. Perry's Minimum Set of Performance Indicators.

Indicator	Definition / Description
Output / unit land ($/ha)	Standardized gross value of output/ area irrigated
Output / unit irrigation supply ($/m^3)	Standardized gross value of output/ irrigation delivered
Output/unit water consumed ($/m^3)	Standardized gross value of output/ all water consumed
Return on investment	Standardized gross value of output/ cost of system
Financial self-sufficiency	Water charges / cost of O&M
Relative water supply	Total irrigation supply / irrigation demand
Water capacity	(Sub) system capacity / peak consumptive demand
Environmental indicators	- area lost to waterlogging and salinity - groundwater level fluctuations, etc..

2.3.2 Performance Indicators Used by the Punjab Irrigation Department

The present management information system is based on manual record keeping and data analysis, which depends on irrigation managers' skills and the experience of dealing with day-to-day operation of the canal network within the framework of the organizational structure. In order to help system managers to assess the irrigation performance and for Decision Support Systems (DSS) on operational controls, the departmental codes and manuals prescribe a systematic procedure for data collection, its analysis and reporting. The important performance indicators used by the PID include: operational indicators, accountability indicators, impact indicators, and others. These indicators are listed in Table 2.3, while graphical representation of some of the indicators is presented in Figure 2.1.

Another important dimension of the performance indicators has been that these were evolved in the context of the Irrigation Department's objectives. The main consideration in this regard has been the boundaries of the operation of irrigation schemes. The irrigation management follows a segregated system in Pakistan, whereby the irrigation agency's responsibility is limited to operation and maintenance of barrages, canals, drains, tubewells and flood works. The policy formulation related to agriculture, marketing and pricing mechanism that greatly influences irrigation management goals of higher order on one end, and the watercourse maintenance, farming practices, cropping patterns and use of non-water inputs that affect productivity on the other end of the spectrum, are beyond the jurisdiction of the irrigation agency. Therefore, it can be understood that output indicators involving yields, crop production and socio-economic impacts of irrigation have not been included for performance assessment.

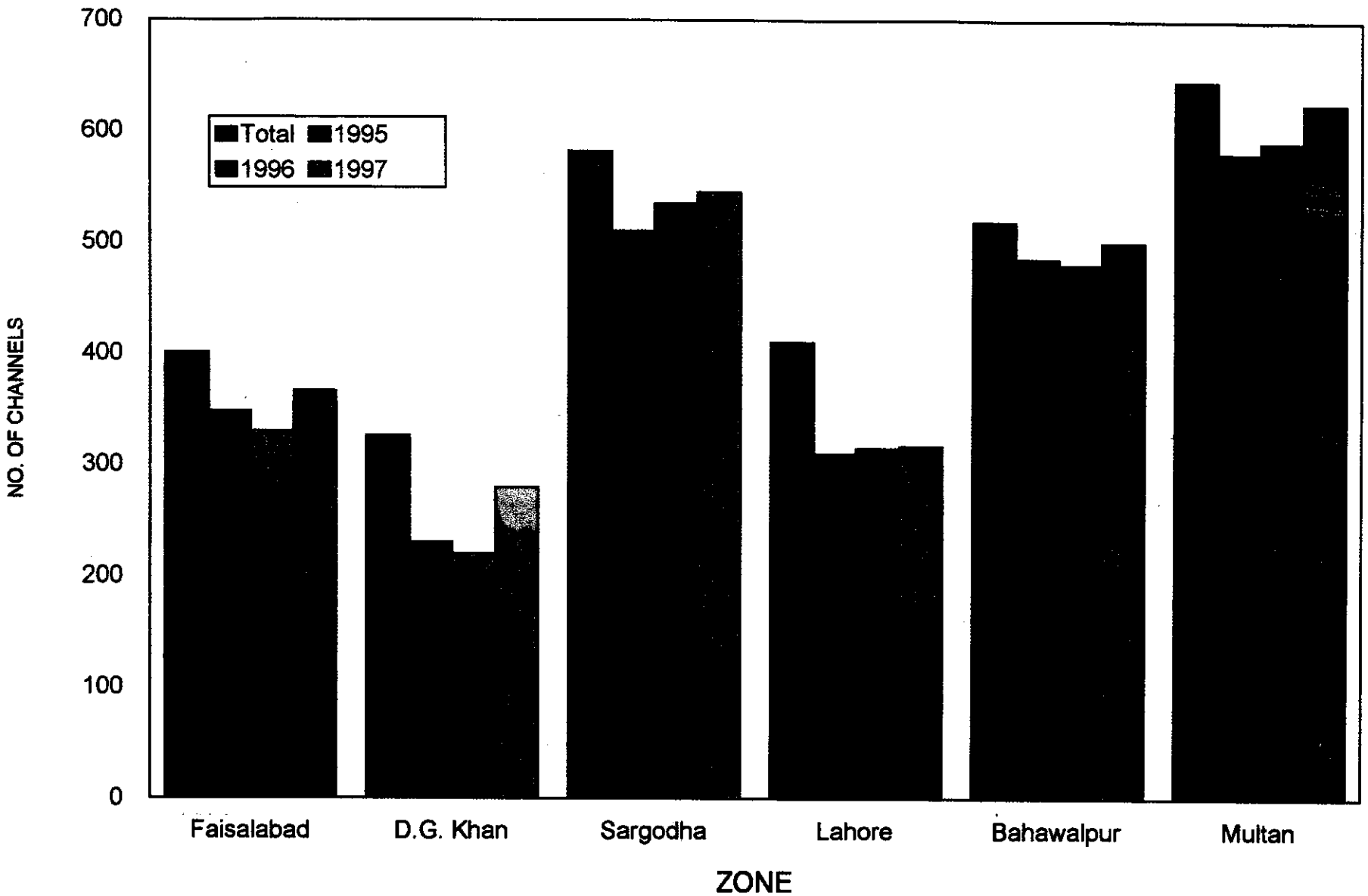


Fig. 2.1(a) . Conventional Performance Indicators of the PID:
Status of Equitable Distribution.

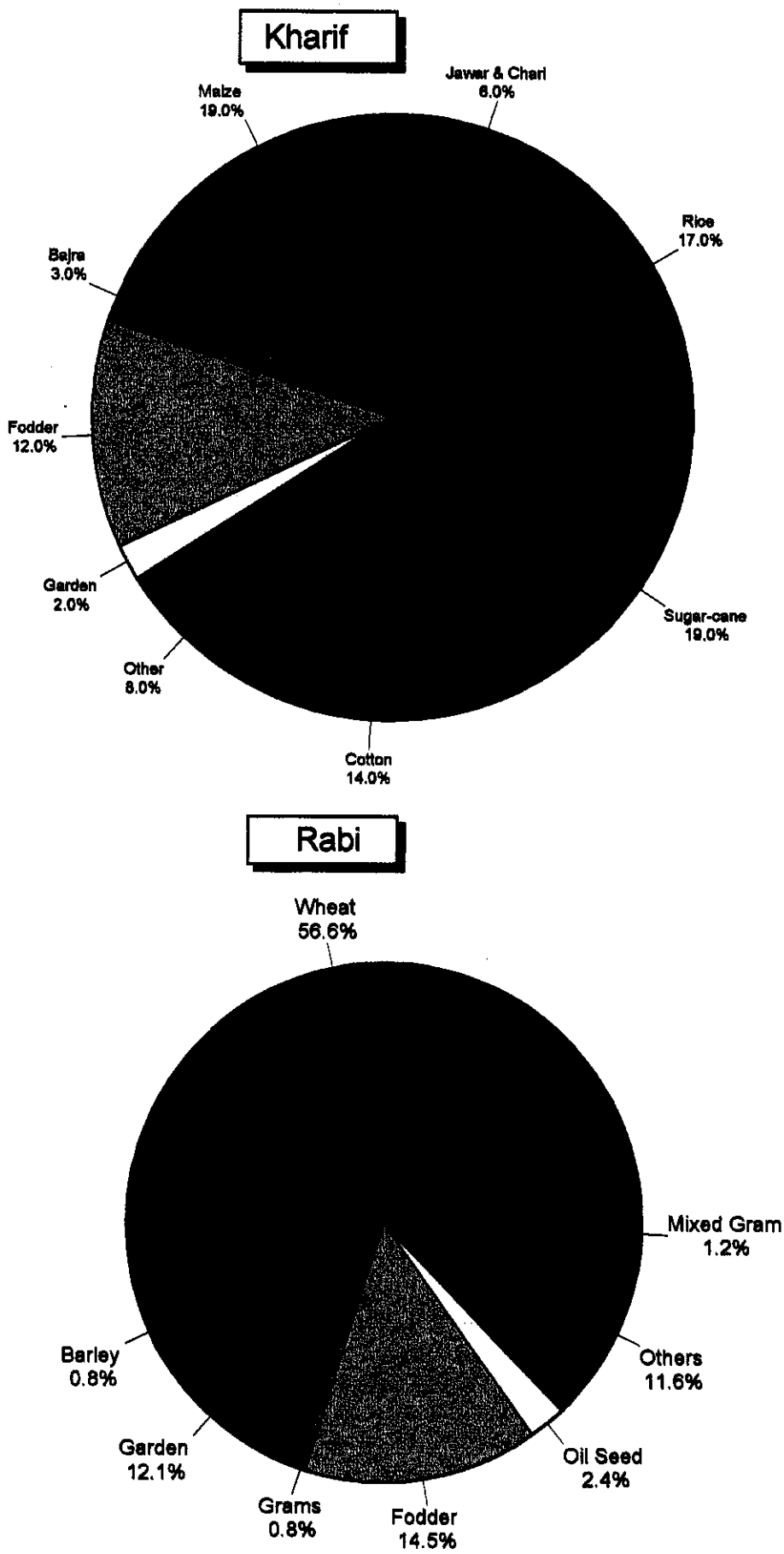


FIG. 2.1(b). CONVENTIONAL PERFORMANCE INDICATORS OF THE PID: CROPPING PATTERN (PIE DIAGRAM) FOR THE LOWER CHENAB CANAL (1978-82).

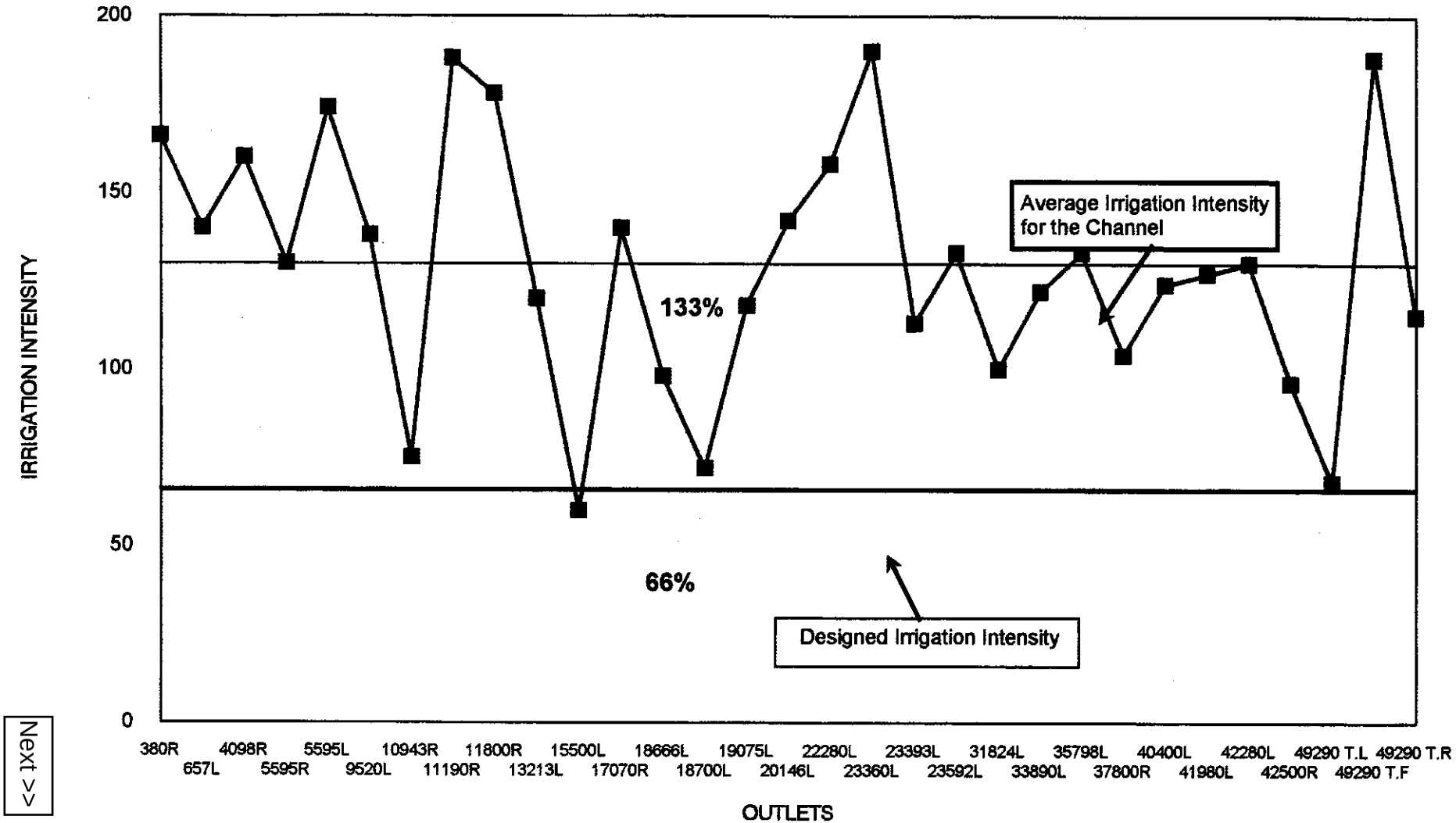


FIG. 2.1(C). CONVENTIONAL PERFORMANCE INDICATORS OF THE PID: ARURI DISTRIBUTARY (1988-89) EFFICIENCY DIAGRAM.

Next >>

The main concern about the performance assessment of departmental activities is the current practices that inhibit an effective evaluation of the performance. The problem areas include reporting delays, quality of data, inadequate analysis, erratic control and inaction on the part of the managers. In a departmental management study, the consultants attributed delays in monitoring and reports to lengthy procedures, inefficient / inadequate staff, lack of control by the upper echelons, defective format of reports and lack of staff training (UCL, 1985). In addition, PRC / CHECCHI (1986) identified that individual performance standards are not specified and monitored, the chain of command is either ignored or proper communication is lacking, and procedures and organization for enforcement against standards of accountability are not adequately developed.

Table 2.3. Performance Indicators of the PID.

S. No.	Indicator Type	Description
1	Operational Indicators	• Indicators that measure/equity of canal water distribution, like tail gauge statements and actual discharge in each off-take, compared to the design/authorized discharge. The specific indicators in this regard are tail gauges and H-registers of outlets and off-take. • Delta statement, comparing actual depth of irrigation supplies to that of the designed values. • Actual water and bed profiles of the channels, compared to the design profiles. • The incidence of cuts and breaches. • General conditions of maintenance of irrigation channels and structures.
2	Accountability Indicators	• Performance evaluation reports. • Number of public complaints. • Number of disciplinary/enquiry cases. • Number of audit paras.
3	Impact Indicators	• Cropping intensities and patterns vs. the designed and historic trends (Efficiency Diagrams). • Groundwater fluctuations (well measurements) and salinity monitoring. • Revenue generation. • Public complaints.
4.	Other Indicators	• Related to construction / implementation of works / projects. These include : ✓ No. of projects implemented. ✓ Timely completion of projects. ✓ Progress monitoring of implementation vs. planned. ✓ Delayed contracts. • Related to revenue works, it may include the no. of delayed revenue cases, farmers' complaints, etc..

2.3.3 Monitoring and Evaluation System

The monitoring and evaluation of the Punjab Irrigation System includes collection and processing of river and canal flow data on a daily basis. The canal gauges and discharges are observed at head, tail and at suitable intermediate points (falls, regulators, etc.). Information pertaining to the tail gauges are very important in a canal flow distribution network, as these are indicative of the equity and reliability of the canal supplies, and thereby, are representative of the overall channel and system performance. In addition, outlet discharges are observed periodically to monitor actual discharges delivered to the farmers at the head of the watercourse.

In order to help system managers to assess the irrigation performance, the departmental codes and manuals prescribe a systematic procedure for data collection, its analysis and reporting. Various statements which, have been specified, are presented in Table 2.4.

Table 2.4. PID Reporting System.

S. No.	Type of Report	Description
A	Monthly Reports	1. Statement of daily gauges and discharges of water received and used during the month. 2. Monthly Delta Statement. 3. Rainfall Statement. 4. Monthly realization of water rates by the Deputy Commissioner. 5. Monthly Irrigation Operation Statement. 6. Statement of unauthorized irrigation and waste of water. 7. Report on cuts and breaches in irrigation canals.
B	Quarterly Reports	Statement of delayed revenue cases.
C	Half-year Reports	1. Statement of assessment and realization of water rates. 2. Statement of rainfall during the half year as compared to the half year of the previous year. 3. Kharaba (remission of water charges) statements for both crops.
D	Yearly Returns	1. Budget Estimates of revenue receipts and expenditure. 2. Outlet efficiency diagrams. 3. Assessment and remission statements for both the crops.
E	Other Records	1. Outlet Registers. 2. Irrigation Registers. 3. Register of petitions regarding alterations to outlets and chaks. 4. Measurements and check measurement books. 5. Record of expenditures. 6. Register of stock, tools and plants.

The monitoring activity at the farm level includes collection of data on irrigated and cropped

areas, cropping patterns and planting dates, and conditions of crops. The rainfall data and ground water levels are observed at designated sites. At irrigation water user level, there is interaction between the farmer and irrigation manager that relates to arbitration of water disputes among shareholders, addressing the problems of shortage of canal supplies and alteration of source of canal supply from one outlet to another.

Monitoring and evaluation of the irrigation system also involves identification of operational problems of channels, such as the level of freeboard, stability of banks, extent of siltation of channel bed, and conditions of structures, etc.. This helps to plan maintenance and repairs of the irrigation network. On the operational side, the irrigation manager has to respond to a host of field conditions for the distribution of supplies that involves real time decision-making. These include fluctuating canal water demands, distribution criteria during water-short periods, management of excess flows during monsoon rains, sediment control and canal closures during floods, and remodelling of channels and structures, etc..

2.3.4 Review of PID Performance Indicators

Most of the performance indicators of the PID had been evolved at the time the irrigation system was developed during British colonial rule. At that time, modern concepts of irrigation management were not in place. Therefore, performance indicators were simple, representing the state of knowledge at that time. The more sophisticated indicators, like relative water supply, interquartile ratios and potential productivity, were not prescribed. Nevertheless, the indicators used were quite effective to assess the performance of the irrigation system in the context of its objectives. Some of these indicators are relevant even today, despite considerable differences in the environment and the time horizon. The set of performance indicators, however, need to be reviewed, updated and made more responsive to the present day requirements in keeping with the contemporary management concepts and new challenges.

2.4 Impact of Institutional Reforms on Irrigation Agency Objectives and Functions

As a result of implementation of the institutional reforms, the objectives and functions of irrigation agency will have to be redefined. The agreed institutional reforms focus on decentralization, participatory management, improved service and sustainability.

With the establishment of the Punjab Irrigation and Drainage Authority (PIDA), the Area Water Boards (AWBs), and the Farmers Organizations (FOs); the management functions of various entities would undergo a transformation and the current functions of the Irrigation Department would be shared by the proposed new institutions. For example, the Irrigation Department would retain the role of overall policy regulation and oversee. PIDA, as an autonomous entity, would be responsible for all the functions of the Irrigation Department, with emphasis on improving irrigation performance, optimizing water use efficiency, introducing the concept of participatory management, undertaking measures to improve assessment and collection of water rates, and making the Authority self-sustaining. The Area Water Boards would perform most of the above irrigation functions at the canal command level and would also adopt and implement programs aimed at promoting the formation and growth of FOs. The FOs would be expected to

operate and manage the minors / distributaries in their jurisdiction, obtain irrigation water from the Area Water Board at the head of the distributary and supply it to their members, assess/ collect the water charges from the water users, and perform any other functions assigned to them.

The reforms process is expected to be implemented in a phased manner. The redefinition of the irrigation management functions and objectives, therefore, would evolve over time, consistent with the main theme of institutional reforms that focuses on decentralization and participatory management. In order to expedite the process; the aiding agencies are funding an institutional reforms consultancy under the on-going National Drainage Program (NDP). The Consultancy, expected to be commissioned by October 1998, would propose the broad contours and working details of the new institutions. This would include identification of their functions and duties, organizational set-up, operations management, legal framework, financing / accounting systems, transition management, and monitoring arrangements. The proposed institutional set-up will be field tested in the pilot AWB and its performance would be closely monitored to learn from the experience and to spot the necessary adjustments in the roles and operating rules of the new upcoming institutions to optimize the process of reforms.

CHAPTER 3

PHYSICAL, HUMAN AND FINANCIAL RESOURCES OF THE ORGANIZATION

3.1 The Physical Resources

3.1.1 Water Availability

The total available surface water supplies to the Indus Basin are the sum of rainfall and river flows. The total annual average rainfall volume over the Indus Basin amounts to about 40 million acre-feet (MAF), about 25 MAF of which falls on the cultureable canal command areas. The inflow to the Indus System is derived from glacier and snow melt, and rainfall primarily outside the Indus Plains. The historic average annual inflow to the Indus Basin amounts to 147.04 MAF, while the post-tarbela mean inflow is estimated to be 151.23 MAF (Haq et al, 1997). Given the seasonal nature of the Himalayan run-off, about 85 percent of the inflow occur during the *Kharif* season, and 15 percent during the *Rabi* season. The average annual inflows from the western rivers are reasonably well-established; about 140 MAF net of uses in Pakistan above the rim stations. There is, however, dispute as to what the long-term system losses are, and what should be assumed for future abstraction in India and for environmental flows downstream of the Kotri Barrage (WSIPS, 1990).

Groundwater in Pakistan is an important resource for irrigation, as well as domestic and industrial water supplies. The Indus Plain comprises alluvium, predominantly sandy silts to depths in excess of 1,000 feet in the Punjab and upper Sindh Province, tapering down to about 200 feet in the lower Sindh Province. In total, about 10 Mha are underlain by usable groundwater. The remaining area is underlain with highly saline unusable groundwater. Recharge to the groundwater system of the Indus Plains has been investigated many times, and is currently estimated to be about 45.57 MAF per annum. Most of this recharge is from surface irrigation supplies, and thus, groundwater is not new water, but largely derived from water originally supplied to the irrigation command from the basic resource, i.e., surface water supplies. Not all of the recharge to the groundwater can be usefully recovered and much of the contribution to the saline groundwater areas falls into this category. Consequently, the concept of usable recharge has been developed to estimate the groundwater potential (WSIPS, 1990).

3.1.2 The Current Level of Water Use

As a consequence of irrigation development over time, the canal withdrawals increased from 67 MAF in 1949-50 to 108 MAF by 1979, then stagnated at this level up to 1989-90 and are now declining due to progressive sedimentation of the existing reservoirs. In the Punjab Province, post-Tarbela average canal withdrawals have been to the order of 53.80 MAF; 33.56 MAF during *Kharif* and 20.24 MAF in *Rabi* (WSIPS, 1990). The level of surface water utilization is restricted due to the uneven river flow pattern, limited storages to balance the seasonal variations

on the supply side, and capacity constraints of the canal network. As a consequence thereof, about 35-40 MAF of river flows cannot be utilized and run as waste into the sea.

The government does not exercise any effective control over groundwater pumpage. Nearly 44 MAF of groundwater is being pumped in the country by public and private tubewells, mostly in fresh groundwater areas. This uncontrolled abstraction may deplete the groundwater, as in 14 of 45 canal commands the water table is already declining (Mohtadullah et al, 1993). In the Punjab Province, the total groundwater pumpage through public and private tubewells is estimated to be about 34 MAF; 5.35 MAF from public tubewells and 28.65 MAF from the private tubewells (PID, 1994).

3.1.3 The Irrigation Infrastructure

The irrigation system of the Punjab Province serves as a lifeline to sustain the agriculture in the province. The irrigation network comprises irrigation canals, drains, tubewells, small dams and flood protection infrastructure. There are 14 major barrages on the five rivers flowing in the heart of this valley, with a total off-take canal capacity of about 1.2 lac. cusecs of irrigation supplies, and another, about 1.1 lac. cusec capacity of inter-river links. The colossal network of over 23,000 miles of irrigation canals provide irrigation facilities to fertile lands in the Punjab Province. The salient data of the Punjab irrigation system is exhibited in Table 3.1, while the map of the irrigation network is presented in Figure 3.1.

Table 3.1. Punjab Irrigation System: Salient Features.

1.	Headworks / Barrages	14
2.	Main Canal Systems	21
3.	Length of Main Canals and Branches	3993 Miles
4.	No. of Distributaries and Minors	2794
5.	Length of Distributaries and Minors	19191 Miles
6.	Total Off-take Capacity	1,20,000 Cfs
7.	Total Off-take Outlets	50,000
8.	Gross Command Area	23.35 Ma
9.	Culturable Command Area	20.78 Ma
10.	Overall Annual Permissible Irrigation	13.96 Ma
11.	Overall Designed Annual Intensity of Irrigation	67%
12.	Actual Irrigation	25.50 Ma
13.	Actual Intensity of Irrigation	122%
14.	Length of Inter-river Links	528 Miles
15.	Off-take Capacity of Links	1,10,000 Cs.
16.	Operable SCARP Tubewells	7943
17.	Other Operable Tubewells	1135
18.	Length of Surface Drain	4800 Miles
19.	Length of Flood Embankment	1600 Miles
20.	No. of Spurs	408
21.	Small Dams	31

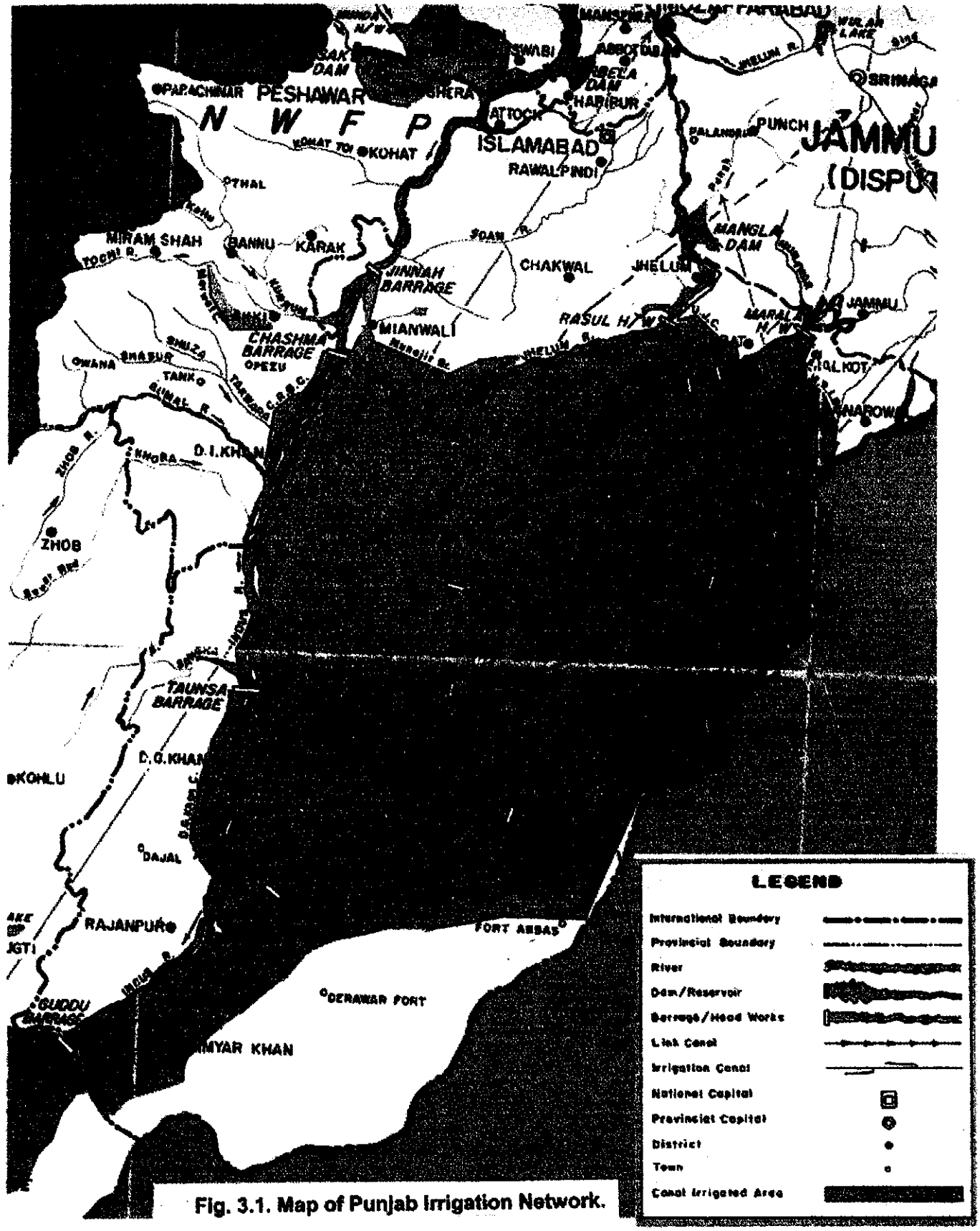


Fig. 3.1. Map of Punjab Irrigation Network.

3.2 Organizational Structure and Human Resources

3.2.1 General

An organization is a systematic arrangement of people to accomplish some specific purpose (Robbins, 1991). There are four characteristics common to all organizations. These include coordination of effort, common goal, division of labour, and hierarchy of authority.

In the case of irrigation schemes, two main systems of organization can be identified: integrated and segregated. In an integrated structure, all the management functions are performed by the centralized management group providing for the need of individuals. The organization is controlled and develops from top to bottom. In a segregated structure, the various functions are performed by different groups, such as the Irrigation Department, Agriculture Department, Rural Development Department, etc.. Lines of communication are not so clearly defined and the objectives of different departments may vary.

3.2.2 Organizational Structure of PID Punjab

The Irrigation Department is headed by the Secretary, Irrigation and Power, under the direction of the Minister for Irrigation and Power. The Secretary is assisted by two Additional Secretaries and five Deputy Secretaries in charge of five wings, i.e., Administration, General, Operation, Development and Power, and an Officer on Special Duty (OSD). The secretariat has about 200 members as support staff. Figure 3.2 gives the organizational pattern of the Irrigation Secretariat up to the level of Section Officers.

Under the Secretary, there are 13 Chief Engineers (C.Es) who carry out various functions of the department. Six Chief Engineers have territorial jurisdiction over different parts of the irrigation system, while the remaining seven have functional duties. For example, the Chief Engineer, Research, is responsible for research in hydraulic problems and other allied fields connected with Soil and Water, and the Chief Engineer, Development, provides services such as excavation machinery and workshop facilities required in the field. The schematic representation of this organizational structure is depicted in Figure 3.3.

As seen from the schematic diagram, each Zone headed by a Chief Engineer has a number of Circles, each under the charge of a Superintending Engineer (S.E), as depicted in Figure 3.3. In each Zone, there are two to three Canal Circles, and some subject-specific Circles such as Drainage, Tube-Well Operation, and Link Canal, etc..

CIRCLES

As far as the management of the canal system is concerned, a Canal Circle is a complete unit responsible for operation, maintenance, regulation of water distribution, recording of irrigated

FIG. 3.2. ORGANIZATIONAL SET-UP OF THE PUNJAB IRRIGATION SECRETARIAT

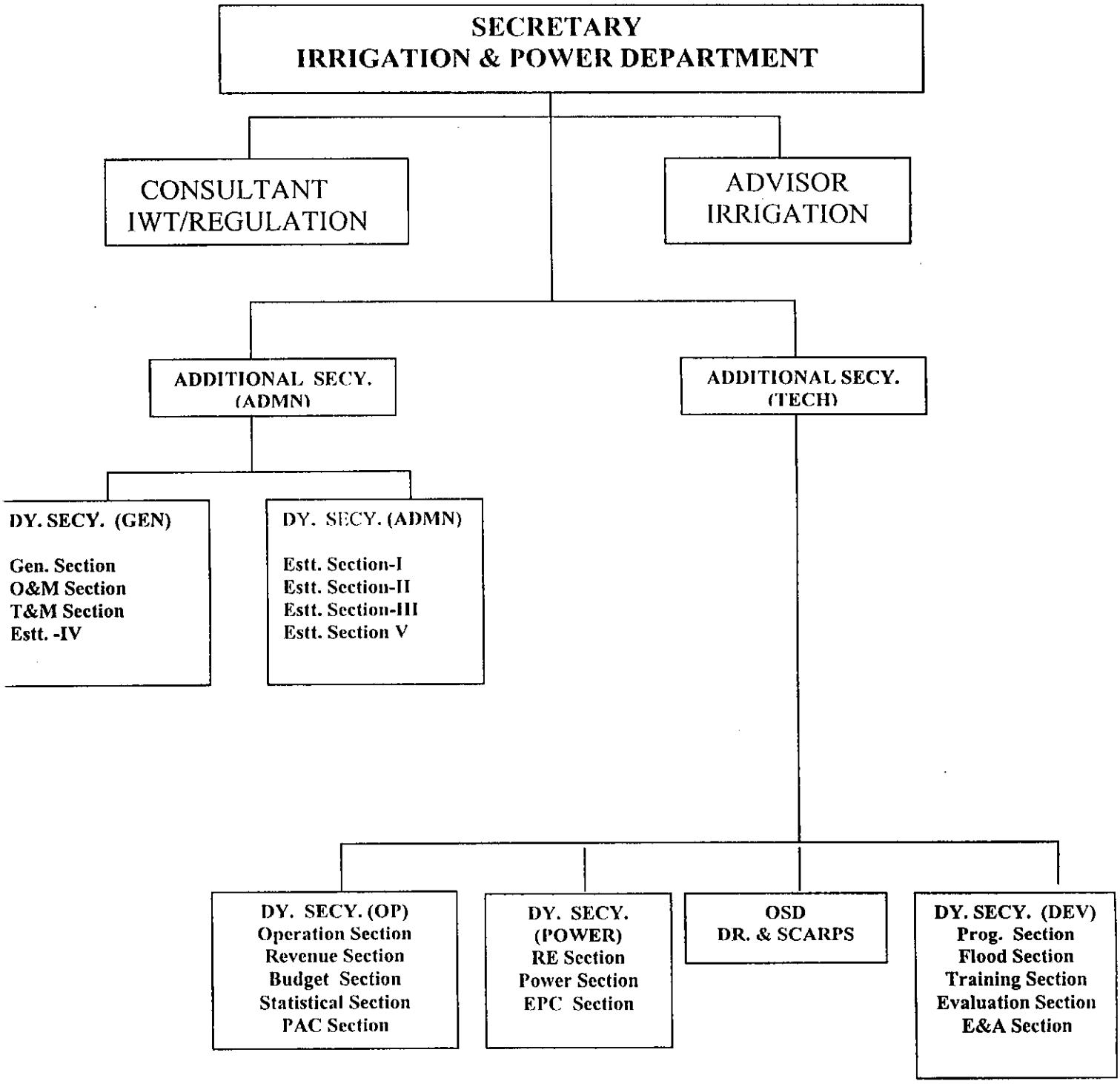
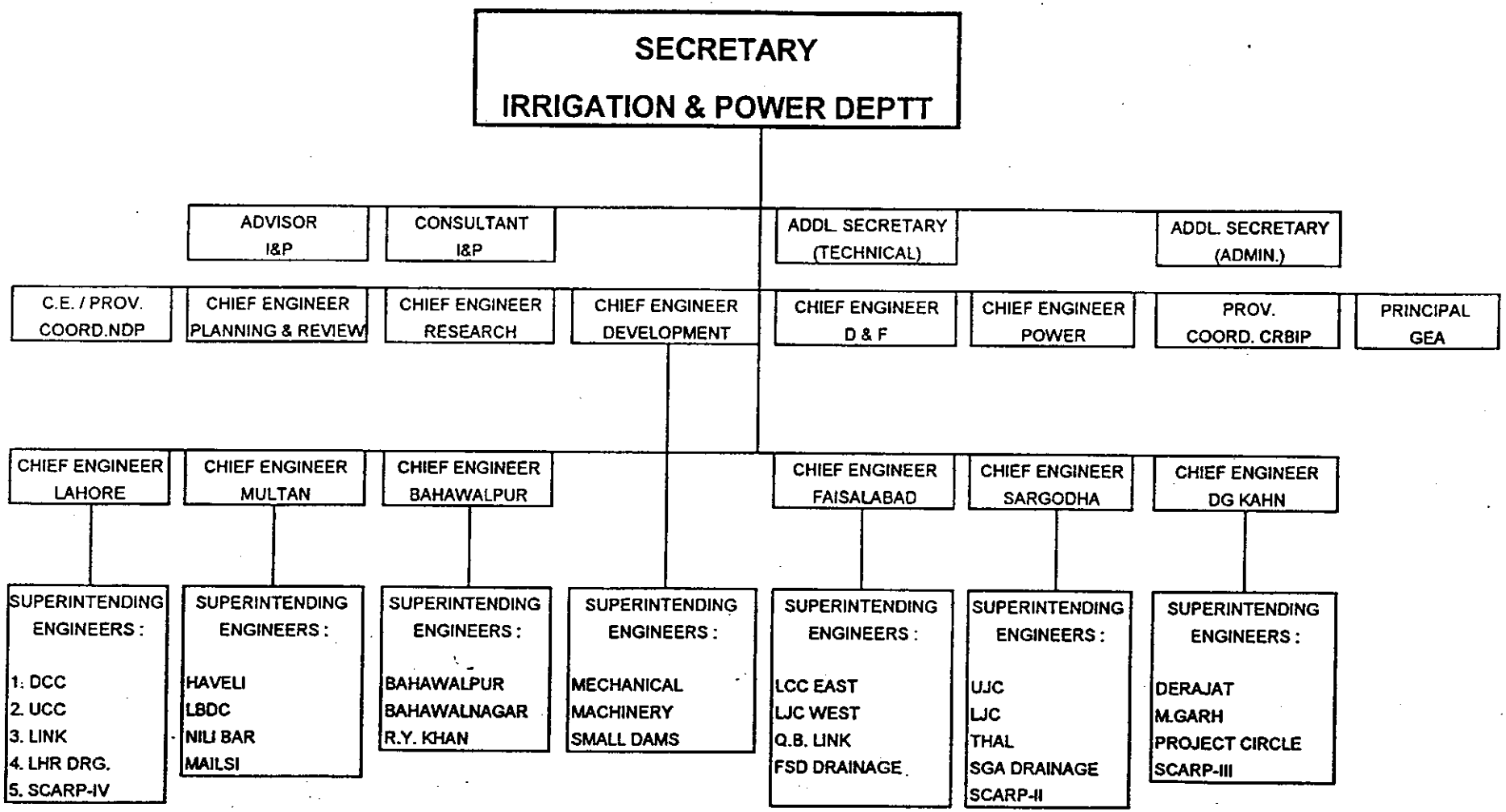


Figure 3.3. Punjab Irrigation & Power Department Organizational Chart.



area and assessment of water revenue of one complete canal system under its charge. A Superintending Engineer (SE), being the head of a circle, is responsible for all operations concerned with one canal system.

A Superintending Engineer has powers under the Canal and Drainage Act VIII of 1873, as Superintending Canal Officer, to hear irrigators' appeals against the decisions of Divisional Canal Officers (Executive Engineers).

DIVISIONS

For operation and maintenance of a canal system, a Circle is further divided into two or three Divisions. An Executive Engineer (XEN) is in-charge of a canal Division under the administrative control of the Superintending Engineer. The Division is the basic executive unit for operational activities, and the Executive Engineer is the "kingpin" of the department. The engineers above him are controlling and directing officers, while engineers and staff under his supervision are to assist him in performing his field duties. He is the custodian of basic records and has up-to-date information about the situation in the command area, and monitors the regulation and water distribution of all channels in the Division.

On financial and accounting matters, an Executive Engineer, as Head of a Division, is independently responsible to the Audit Department. For this purpose, the Audit Department posts a Divisional Accountant as its representative to assist the Executive Engineer to maintain the accounts of the Division properly, and to exercise initial checks.

To administer the canal supplies and to settle irrigators' disputes, an Executive Engineer is gazetted as a "Divisional Canal Officer" under the Canal and Drainage Act of 1873. He is declared Canal Magistrate to perform his duties under the Canal Act. All claims, disputes and complaints of irrigators are decided by him as the Divisional Canal Officer.

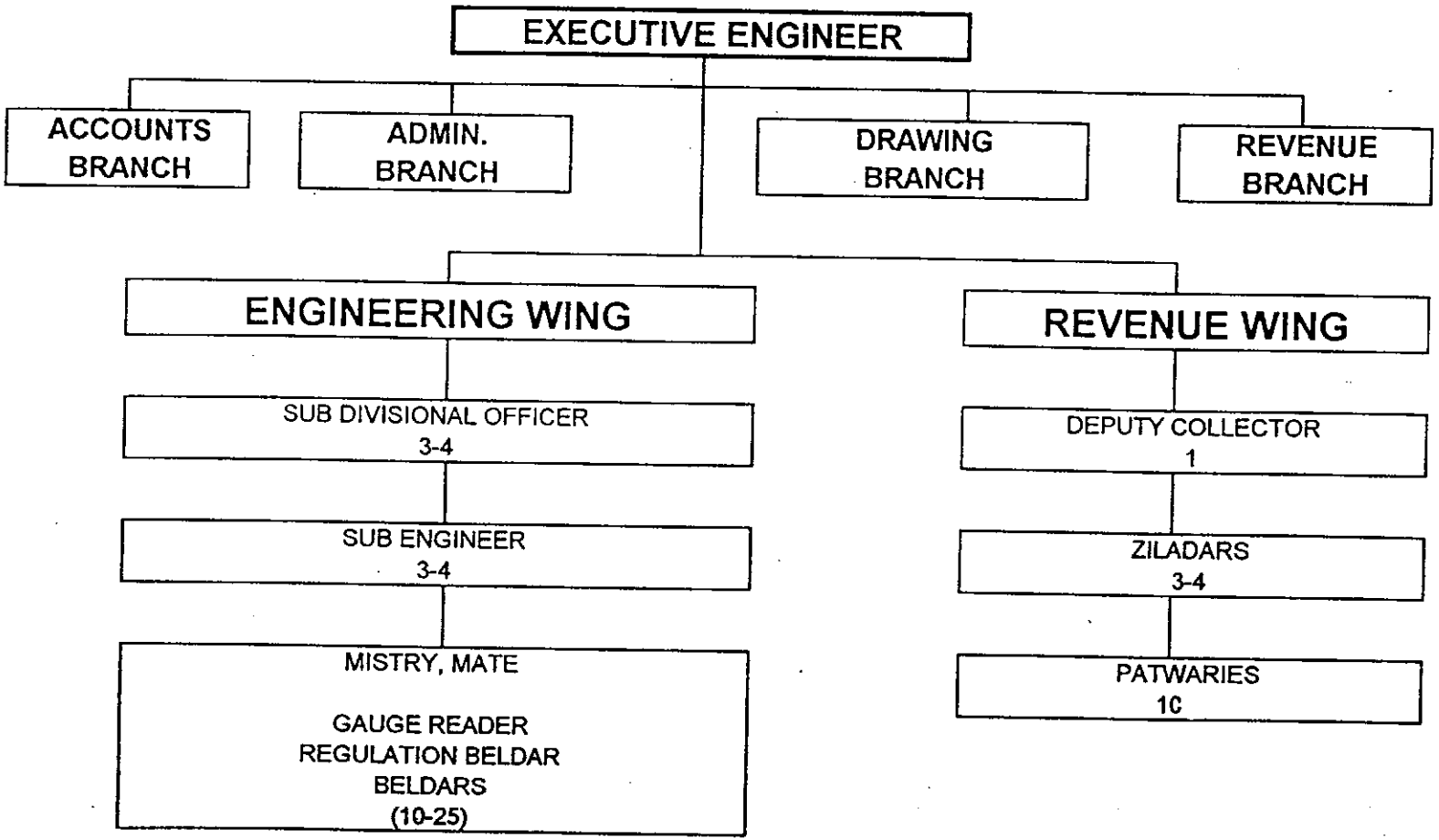
An Executive Engineer also has to perform duties to assess water rates. For this purpose, a Revenue Wing headed by a Deputy Collector is placed under his control. In this capacity, he is responsible for recording area irrigated under each outlet, along with crop data, and then preparing demand statements for the collection of water rates at the end of each crop season. These demand statements are submitted to the District Civil Administration for collection of revenue.

Figure 3.4 presents the organizational structure of a canal division and illustrates the hierarchical arrangement involving different levels of staff in a typical division.

SUB-DIVISIONS

A Division is further sub-divided into three or four sub-units known as Sub-divisions, each headed by a Sub-divisional Officer (SDO) who is a qualified engineer. He is also recognized as

Figure 3.4. Organizational Chart of a Canal Division.



the Sub-divisional Canal Officer under the Canal and Drainage Act of 1873, and has the powers of a Magistrate to adjudicate cases concerning the canal offenses under the Canal Act and to settle disputes among irrigators. He holds delegated administrative and financial authority for his area as a sub-unit of the Division.

The SDO is responsible for the operation and maintenance, distribution of water, and "booking" the irrigated area in the portion of canal commands in his charge, under the administrative control of the Executive Engineer of the Division. A Sub-division, ordinarily, consists of three or four Engineering Sections and two to three *Zilladari* Sections.

SECTIONS

The smallest unit on the Engineering side is a "section." The head of a Section is a Sub-engineer who is basically in possession of a diploma in Civil Engineering. He is responsible for the distribution of supplies and the maintenance of distributary / minor discharges. Sub-engineers' offices are located in canal colonies along the channels to ensure more intimate surveillance over canal operations and irrigation supplies. The Sub-engineer, who is assisted by *Mistries*, *Mates* (a Mate is the head gauge man) and Canal Patrols/Beldars for maintenance and watching of channels, also has gauge readers under him for regulation and observation of water flow. Each canal colony has a Rest House where inspecting officers stay, and a telegraph / telephone office to transmit gauge readings and other important regulations and urgent messages.

The smallest unit in the PID's revenue organization is the *Zilladari* Section, headed by a *Zilladar*, the canal official who supervises the work of about 10 *Patwaris* (Irrigation Record Keepers). A *Patwari* is selected from accepted lists in each Division, and given not less than three months' practical training, after which he has to pass the Patwari examination in order to be posted as a canal *Patwari*. Each *Patwari* is supposed to record an extent of irrigation of 3,000 to 5,000 acres, and thus, a *Zilladar's* supervision covers an area of about 30,000 to 50,000 acres. *Zilladars'* offices are also located in canal colonies, along with that of the Sub-engineer to facilitate easy access for irrigation.

3.2.3 PID Staffing Levels

In order to perform their identified functions, PIDs have acquired large numbers of human resources and have become enormous bureaucracies. The four PIDs have more than 80,000 employees, and the Punjab Irrigation Department, with over 50,000 employees, is a large organization by any standards (Bandaragoda and Firdousi, 1992). The staffing pattern and approved staff strength of the Punjab Irrigation Department is depicted in Table 3.2.

Table 3.2. Approved Staff Strength of the Punjab Irrigation Department.

S. No.	Category	Approved Strength
A.	**ENGINEERING**	
	Chief Engineers	13
	Superintending Engineers/Directors/PROs	38
	Executive Engineers/Dy. Dir/SROs	167
	Sub-divisional Officers/ADEs/JROs	457
	Sub-engineers	1468
	Office Staff	3794
B.	**Total**	5937
	REVENUE	
	Canal Collectors	6
	Deputy Collectors	45
	Zilladars	486
	Canal Patwaris	5095
	Office Staff	1271
B.	**Total**	**6903**
	REGULAR MAINTENANCE STAFF	
	Mechanical	12729
	Civil	26831
	Total	39560
	G. Total	52400

3.2.4. Adequacy and Compatibility of the Organizational Set-up

A number of studies in the recent past have reviewed and analyzed the organizational adequacy of the Punjab Irrigation Department, with particular reference to the objectives, manpower resources and its distribution (Mazhar Ali et al, 1981; UCL, 1985; PRC/Chechhi, 1986; Bandaragoda and Firdousi, 1992; ACE et. al, 1994; Shahid et al, 1994). All these studies reveal that the organizational structure, distribution of responsibilities and even the size of organizations basically remain as left by the colonial administration, except for the creation of new disciplinary wings, such as Drainage and SCARP, etc.. Since then, the demand for water has increased manifold due to fragmentation of lands, changes in cropping patterns, and substantial increases in cropped areas. All these factors have led to increased problems concerning the equitable distribution of water and disputes among the irrigators. The work load has, therefore, increased considerably at all levels of field formations. Increased emphasis on developmental activities, socio-political assignments, and coordination meetings at the departmental, district, divisional and government levels have compounded the situation. As a result, mid-level managers are kept away from the offices for most of the time, which reflects on their primary function of irrigation system management.

Another issue of concern is the overlapping jurisdiction of canals, tubewells and drainage wings of the department, which focus on the same geographical area. The headquarters of CEs, SEs, XENs, SDOs and even the Sub-engineers for these separate functions are at different places. The resultant problems of coordination are the main causes of administrative confusion and inadequate service to the farmers. The boundaries of civil administration (*tehsils* and districts) and irrigation agency units are also not compatible, with the result that most of the irrigation employees have to coordinate with their counterparts in more than one district. This adds to the problems of an increasing work load for irrigation agency staff.

The study group report (Mazhar Ali et al, 1981) recommended that the organizational set-up of the department needs to be redefined to achieve participation at various levels, adequate and effective delegation of authority, prompt decision-making mechanism, suitable consultative and review forums, promotion of professionalism and upgrading of skills. Decentralization and delegation of powers to the lower echelons, strengthening of the engineering and revenue establishment, and reducing the jurisdiction of the field outfits for improving the performance of the department was also advocated.

The findings of the management studies conducted by USAID consultants under the Irrigation Systems Management Project (UCL, 1985; PRC / Checchi, 1986) are also quite relevant with reference to the present organizational issues of the Punjab Irrigation Department. These include:

- Too much centralization; over the years regulations and practices have moved decision-making upwards.
- Uneven distribution of work load; the organizational units are either over-worked or under-worked.
- Diffusion of responsibility; staff responsibilities are often spread over a number of functions with insufficient training and inadequate discipline.
- Dispersion and authority; some elements of organization are expending too much time and effort on some activities, without adequate support of assigned authority.
- Increased legal and administrative work load; lack of specialist trained staff in these fields.
- Indistinct work loads.
- Erratic controls.
- Poor communications and lack of inter-agency / farmer coordination.
- Inadequate public relationing.
- Under-developed personnel management.

The above discussion clearly brings to focus a lack of compatibility between the Irrigation Department's objectives and its organizational structure. The static bureaucratic set-up has not been able to respond to the rapid changes that have taken place in the environment. There have been little effort within the organization to orientate its position in the upcoming grid, to visualize

the emerging issues, to redefine its goals and objectives and to formulate effective strategies to respond to the new challenges in the context of physical and socio-political constraints. Like most of the other sectors of society, the performance of irrigation agencies has been on the decline and the syndrome of inaction and indifference is impinging on the very sustenance of these organizations.

3.3 Budget Planning and Procedures

3.3.1 The Provincial Budgeting Procedures

Under Article 120 of the Constitution, a statement of estimated receipts and expenditure of the Provincial Government in respect of every financial year has to be presented to the Provincial Assembly. This statement is known as the `Annual Budget Statement'. The Finance Department (F.D.) is responsible for the preparation of the annual budget, on the basis of the information received from various departments. The provincial budget comprises the following items :

i) Estimates of Receipts
ii) Estimates of Charged Expenditure and Demands for Grants
iii) Schedule of New Expenditure in respect of Non-development Items
iv) Schedule of New Expenditure in respect of Development Works (Annual Development Program)
v) White Paper and Budget Memorandum

The process of budgeting consists of seven phases of management and control. These include: preparation of budget, consideration of the budget by the Provincial Assembly, authorization of expenditure, distribution of grants, implementation of the activities / incurrence of expenditure, post-budget allocations, and review by the Punjab Assembly of the budget implementation. The budget calendar for various activities is presented in Table 3.2.

Table 3.2. The Budget Calendar.

Sr. No.	Activity	Target Date for submission to FD
1.	All Budget and Revised Estimates of Receipts and Budget Estimates of Expenditure Heads	Ist January
2.	First List of Excesses and Surrenders	Ist January
3.	Schedule of Expenditure in respect of Non-development Items (continuing as well as new)	10th January
4.	Schedule of New Expenditure in respect of Development Items (continuing as well as new)	20 February
5.	Second List of Excesses and Surrenders	31st March

3.3.2 Budget Planning by the PID

Detailed procedures, proformas and controls for preparing Budget Estimates exist in the Punjab Irrigation Department. Budget preparation starts with the Executive Engineer at the Division level and budget estimates for receipts and expenditures under various heads of Account / Grants are prepared and moved upwards in the system (Division to Circle to Zone to Irrigation Secretariat). A consolidated budget is prepared by the Budget Wing of the Irrigation Department, based on the information received from various field formations.

The Receipts Budget. The major items of the Receipt Budget for the Punjab Irrigation Department include water charges, recoveries of expenditure and other items (sale proceeds, registration fees, and auction proceeds, etc.). The receipts from water charges account for 90-95 percent of the total receipts of the department. The receipt budget estimates are proposed in view of the previous years' receipts, changes in tariff structures, expected shifts in cropping patterns and irrigated area, etc.. The Irrigation Department's receipts are not kept separately, but these are credited to the Consolidated Fund of the Province. The following information is considered by the field formations of the Irrigation Department for preparing Receipt Budgets. The information is also consolidated and supplied to the Finance Department for finalizing the Receipt Budgets:

a) Budget estimates for the coming financial year;
b) Revised estimates of the current financial year;
c) Original budget estimate of the current financial year;
d) Accounts of the financial year just closed;
e) Original budget estimate of the financial year just closed;
f) Actual of the two financial years immediately preceding that just closed;
g) Actual for the last 8 months of the current financial year;
h) Revised estimates of the current financial year proposed by the Head of the Department; and
i) Budget estimates for the coming financial year proposed by the Head of the Department.

The Non-development Budget. On the Demands side, major items of expenditure include Canal Irrigation, Tubewells, Flood Control and Drainage, Special Revenue, Land Reclamation, and Administration, etc.. The `Maintenance Yardsticks' approved by the Finance Department are used against the existing inventory of irrigation facilities to act as a base line for estimating proposed Operations and Maintenance Budgets for works components. The yardsticks are the standardized estimate of cost per unit quantity of work. The use of yardsticks for various components of maintenance works greatly simplifies and facilitates the preparation of the non-

development budget. Maintenance yardsticks are readily understood by non-engineers, can be easily computerized and have been in use for more than 60 years. The yardsticks were first introduced in the Irrigation Department in 1937, and used in all the provinces for budgeting purposes by applying a multiplier to account for the inflation. The yardsticks were updated and revised in 1981 and 1992. The 1992 yardsticks are still in use, despite considerable inflation over the last five years. The typical yardsticks for some important irrigation components is given in Table 3.3.

Table 3.3. Typical Yardsticks for Various Components of Irrigation System.

Sr. No.	Component	Unit	1982 Yardstick (000 Rs)	1992 Yardstick (000 Rs)
1.	Main Canal and Branches			
	i. Upto 6000 Cs	Mile	9.5	19.5
	ii. 6000 to 10000 Cs	Mile	10.5	21.5
	iii. More than 1000 Cs	Mile	13.0	26.5
	iv. Lined Canals	Mile	15.0	30.7
2.	Distributaries and Minors	Mile	3.5	7.2
3.	Flood bunds	Mile	20.0	21.0
4.	Spurs on River Indus	Each	-	206.0
5.	Drains (Bed width > 15 ft)	Mile	5.5	11.2
6.	Qadirabad Barrage	Per lac Cfs of design discharge	325.0	666.3

The establishment budget is prepared in consideration of the number of posts, the salary and allowances and the cost of utilities needed for the field and office staff. These estimates include ordinary maintenance, as well as special maintenance. The initial budget estimation is done at the (irrigation) division level and the first step towards its proper formulation is to identify the O&M needs of the system. The major components considered for estimating O&M needs of the Irrigation Department include maintenance of headworks / barrages, repair to canal banks, silt clearance and berm cutting, special watching needs, repair of buildings, as well as maintenance of tubewells, flood control works, and drains.

Annual Development Program. The Development Budget is prepared in the form of an Annual Development Program (ADP). The individual schemes to be included in the ADP, along with the expenditure proposed for each scheme, is determined and specified. The size of the ADP for a particular year depends on the scope and purpose of the plan, as well as the availability of resources for financing the program in that year. The development schemes are grouped under appropriate sectors and sub-sectors. Generally, only those development schemes included in the ADP, are administratively approved by the competent authority. The approval procedures are

well-established and the approval limits of various officers / forums are also prescribed. The schemes to be included in the ADP are identified by various sources, including proposals by the Public Representatives, directives from the Chief Minister / Prime Minister, public demands, and the schemes proposed by the field staff of the Irrigation Department. These are sent to the Planning and Development (P&D) Department, where a number of meetings are held to finalize the program in consultation with the Finance Department (F.D.). This finalized program, along with a listing of development schemes and its allocations, is included in the Annual Budget of the province, which is presented to the Provincial Assembly for approval. After approval, details of the ADP are conveyed to the field formations for implementation. The progress of approvals and execution of work is closely monitored in the P&D Department in the monthly review meetings. Re-appropriation among various sectors/sub-schemes is processed in view of the implementation progress and any specific needs, after getting approval from the P&D/F.D.

Implementation and Budget Revision. After completion of budget returns by the divisional staff, consolidation and rationalization of the expenditure takes place at the level of the Circle/Zone and the Provincial Irrigation Department. The consolidated budget, along with the historic information on expenditures (as for receipt budgets), is forwarded to the Finance Department. The Department of Finance then reviews the departmental budget returns, compares budget requests with estimated overall provincial resources and prepares a Demand for Grant that is submitted to the Assembly for approval. The approved budget of the Irrigation Department, as released by the Finance Department, is then placed at the disposal of various field units (divisions) for implementing O&M works. Any revision in the budget grants under a particular head of account can be made by the competent authority through re-appropriation. The revised budgets are also prepared by the field units of the Irrigation Department in keeping with the budget calendar, and first and second lists of excesses and surrenders (E&S) are submitted to the Finance Department. These proposals are considered by the Finance Department, and if deemed appropriate, requisite approvals are accorded by the F.D. and the necessary provisions/adjustments are reflected in the Revised Budget.

3.3.3 Evaluation of PID Budgeting Procedures

Two significant aspects of the budgeting procedures include the overall control of the Finance Department in budgeting and the final appropriation process, and the great reliance placed upon budget and expenditure data of previous years. In addition, the following points / issues are also revealed:

- The yardsticks provide a satisfactory basis for O&M budgeting. But lack of a systematic approach to their continual revision / updating renders the budgeting process less effective. There is a need to build in a system of periodic review / revision of yardsticks in order to optimize O&M budgeting of the Irrigation Agency.

- In view of the general short-fall in O&M funding for works, the field officers make efforts to cover maximum works with the available fundings. Therefore only urgent

works / components can be executed and the maintenance efforts generally have to be spread somewhat thinly.

- In the ADP budget preparation process, better controls exist in the form of specific list of works and condition of administrative approval of the PC-I. There however, used to be a general lack of discipline in the preparation of annual ND budgets. This aspect has been given attention now and a system of O&M work plans has been institutionalized with effect from the last fiscal year.

- The department's capability to analyze alternative budgets scenarios appears to be inadequate. Also, the element of systematic monitoring and evaluation of O&M budgets/expenditure is quite sub-optimal.

3.4 Level of Funding, Expenditures and Recoveries

The level of funding and expenditures for the last five years, both for the Non-development (O&M) Budget as well as for Annual Development Program, is presented in Tables 3.4 and 3.5, respectively. The Receipts Budget for the last five years is shown in Table 3.6.

The above data and analysis of budget allocations, expenditure and recoveries appear to suggest the following general points :

- The O&M allocations have generally remained sub-optimal due to resource constraints. There is a considerable gap between the demand of the Irrigation Department and the allocations made by the government.
- While the overall O&M budget of the department has increased quite sharply after FY 1993-94, the increase in O&M allocation for canals has been comparatively much less. The exorbitant rise in the electricity tariff for tubewells has been the major contributing factor for the sharp rise in O&M expenditure of the Irrigation Department.
- The tubewells have been consuming 40-50 percent of the total O&M allocations of the Punjab Irrigation Department, compared to about 30 percent for canals and 10-15 percent for flood and drainage.
- The establishment accounts for about half of the total O&M allocations, while canal works get only around 10 percent of the total departmental O&M budget.
- There is a considerable gap between the estimated receipts and actual allocations of water charges. The collections have been progressively declining and the arrears of amounts due have been consistently building up.
- The ADP allocations of the Irrigation Department do not exhibit definite trends. The allocations are dictated by the available resources, particularly the portfolio of foreign assistance and special programs.

(Million Rs.)

Table 3.4. Non-development Budget Demands, Allocations and Expenditures Last Five Years.

Item	1993-94			1994-95			1995-96			1996-97**		1997-98**	
	Demand	Budget*	Expend.	Demand	Budget	Expend.	Demand	Budget	Expend.	Demand	Budget	Demand	Budget
521 Administration	87	94	90	93	107	97	107	118	110	132	183	126	132
522-Dams	20	21	19	23	25	24	23	23	23	26	34	28	32
523-Canals (Executive)	1128	906	920	1290	913	920	1580	1023	911	1589	1388	1798	1219
523-Canals (Special Revenue)	248	244	240	269	272	260	322	307	273	342	305	349	337
524-Tubewells	1862	736	***	2587	1470	***	1931	1751	***	1972	1887	2159	2457
525-MIW, BIW and Excavator Div.	46	46	43	50	48	47	59	55	50	65	65	60	61
526-Design & Research	24	22	21	26	27	23	31	31	29	26	30	36	31
527-Flood Control and Drainage	591	256	247	542	394	406	810	283	290	807	365	371	288
531-Land Reclamation	16	14	13	16	15	14	18	17	16	22	17	24	18
532-Waterlogging and Salinity	32	29	26	34	33	32	39	38	32	42	37	42	42
Engineering Academy	5	5	5	8	5	5	10	6	5	5	5	5	5
Total Establishment	1741	1428	-	1516	1617	-	1645	1792	-	1647	2354	1722	2268
Total O&M	2319	945	-	3424	1693	-	3379	1862	-	3384	1965	3279	2357
Grand Total:	4060	2374	-	4940	3311	-	5024	3654	-	5031	4319	5001	4625

Note: *Revised Budget Figures

****Expenditure figures not yet available.**

***** Energy bills of the Provincial Government retained by the Federal Government at source. Therefore, expenditure on tubewells is difficult to work out.**

(Million Rs.)

Table 3.5. ADP Allocations and Expenditure of Punjab Irrigation Department.

Sub Sector	1992-93		1993-94		1994-95		1995-96		1996-97		1997-98
	Allocation	Expend.	Allocation	Expend.	Allocation	Expend.	Allocation	Expend.	Allocation	Expend.	Allocation
Survey Investigation & Research	26.799	26.181	11.296	6,893	8,668	7,976	12,190	8,050	5,790	5,960	19,514
Irrigation	186.066	159.740	146.698	127.107	121.686	118.111	103.140	76.390	86.100	72.530	282.838
Drainage & Reclamation	23.601	21.766	12.998	12.706	47.394	37.141	49.260	43.020	26.410	24.070	60.372
Miscellaneous	22.629	23.164	6.237	3.454	2.495	2.314	0.360	0.280	0.260	0.260	0.269
Flood Works	153.968	148.148	36.223	31.592	47.331	40.805	59.110	58.120	90.500	55.460	196.767
Small Dams	0.000	0.000	0.000	0.000	4.602	4.278	5.710	4.360	1.560	1.020	3.200
Foreign Aided Projects (Counterpart funding)	223.532	195.526	99.100	92.594	155.628	190.774	236.290	172.530	249.560	238.770	536.040
Total Annual Development Program (Water)	636.595	574.525	312.552	274.346	387.804	401.399	466.060	362.750	460.180	398.070	1099.000
Social Program for Local Development											
Water	2.150	1.085	2.600	1.445	22.781	16.156	69.850	52.360	37.750	0.160	0.000
Power	85.151	75.645	542.054	50.273	140.224	132.444	25.150	14.260	9.050	3.000	0.000
Sub Total Spl. Development Program (W&P)	87.301	76.730	544.654	51.718	163.005	148,600	95.000	66.620	46.800	3.160	0.000
Priority Program (Water)			13.043	4.200	76.004	42.063	11.140	3.680	1.450	0.000	0.000
Priority Program (Power					3.252	3.252	115.050	115.850	40.340	10.000	0.000
Sub Total Priority Program	0.000	0.000	13.043	4.200	79.256	45.315	126.190	119.530	41.790	10.000	0.000
People's Program (Federal)					10.237	9.237	60.270	4.500	21.550	3.550	0.000
Sub Total	0.000	0.000	0.000	0.000	10.237	9.237	60.270	4.500	21.550	3.550	0.000
G. Total	723.896	651.255	870.249	330.264	640.302	604.551	747.520	553.400	570.320	414.780	10999.000

(Million Rs.)

Table 3.6. Estimated Vs. Actual Receipts of Punjab Irrigation Department.

Item	1993-94		1994-95		1995-96		1996-97		1997-98
	Budgeted	Actual Receipts	Budgeted	Actual Receipts	Budgeted	Actual Receipts	Budgeted	Actual Receipts	Budgeted
A. IRRIGATION WORKS									
Water Rates	940.000	838.000	997.000	900.000	1200.000	953.000	1450.000	1065.000	1700.000
Toll on Barrages	0.000	0.000	0.000	0.000	10.000	0.000	20.000	-	20.000
Others	35.000	46.000	36.000	36.000	50.000	43.000	51.000	73.000	56.000
B. EMBANKMENT & DRAINAGE WORKS									
Recoveries of Expenditure	1.000	0.000	1.000	0.000	1.000	0.000	1.000	1.000	1.000
Others	6.000	6.000	6.000	6.000	7.000	7.000	7.000	12.000	10.000
G. Total	982.000	890.000	1040.000	942.000	1268.000	1003.000	1529.000	1151.000	1787.000

- The revenue receipts have generally been matching the O&M expenditure on canals. The main reason for the widening gap in the overall cost recovery has been the high O&M on tubewells; the situation has worsened sharply after 1993-94 due to steep rise in the power tariff.

3.5 Financial Controls

Since the Irrigation Department deals mainly with spending public funds, therefore, a multitude of financial controls have been evolved over time. These controls are documented in the form of guidelines, instructions and orders in various Manuals, Codes and directives issued by the government. The main financial controls include estimation stage controls, implementation stage controls, financial powers, budget controls, and audit controls. The salient features of these controls are described below:

3.5.1 Estimation Stage Controls

The survey work forms the basis of all the engineering plans and designs, schemes, as well as cost estimates. The survey work is entered in the Field and Level Books, which are treated as most important records. A register of receipts and issues of field and level books is maintained in each divisional office by the Head Clerk. All field level books must be machine - numbered and provided with index sheets on the first two pages. The date of each day's work should always be given. The name of the person who carries out the survey work is to be clearly signed in ink by that person at the commencement, and at the end, of each work. No erasing or over-writing is permitted and incorrect entries are required to be neatly scored through and initialled.

The codal instructions stipulate that the Sub-divisional Officer (SDO) must check a reasonable amount of the survey work done by subordinates in the same way as prescribed for check measurements of works (refer sub-section 3.5.3). In exceptional cases (like underwater works, flood works, emergency works, etc.), or if considered appropriate by the competent authority, the check levelling limits of SDOs can be enhanced and even the higher officers (XENs / SEs), or specially - constituted teams, can be asked to inspect the site and check the field survey work / estimates prepared by the subordinates. The services of consultants are also hired on the foreign - aided projects for overall supervision of work, including checking estimates.

The estimates prepared by the subordinate staff are thoroughly scrutinized by the Divisional Drawing Branch, with particular reference to arithmetic checks and adequacy / accuracy of provisions and rates. After the check by the Drawing Branch, the estimate is sent to the Accounts Branch to ascertain the funding position. Subject to the satisfactory outcome of the above checks, the estimate is sanctioned by the competent authority. A return of all estimates sanctioned by the Divisional Officer has to be sent to the Superintending Engineer (S.E). These approvals, together with those accorded by the S.E, should be communicated monthly to the Audit Officer through the Chief Engineer.

3.5.2 Delegation of Financial Powers

The financial powers have been delegated by the Provincial Government to various officers / forums according to the nature and importance of the activity. These powers are comprehensively set out in the official document titled `Delegation of Financial Powers Rules, 1990'. The financial delegations for some important activities related to the Irrigation Department are summarized in Table 3.7.

Table 3.7. Financial Delegations for some Important Irrigation Department Activities.

Sr. No.	Description	To whom Delegated	Extent
1	Administrative approval of Works / Development Schemes	Admn. Department Sub committees Chief Engineer Superintending Engineer	Up to Rs 60 lac Up to Rs 15 lac Up to Rs 7 Lac
2	Technical Sanction of Estimates		
	i) In case of original works	Admn. Department Chief Engineer Superintending Engineer Executive Engineer	Full Powers Full Powers Up to Rs 50 Lac Up to Rs 10 Lac
	ii) Ordinary & special repairs	Admn. Department Chief Engineer Superintending Engineer Executive Engineer	Full Powers Full Powers Up to Rs 5 Lac Up to Rs 1 Lac
	iii) Special repairs to residential buildings	Admn. Department Chief Engineer Superintending Engineer Executive Engineer	Full Powers Rs 40,000 in case of each building Rs 20,000 in case of each building Rs 10,000 in case of each building
3	Acceptance of Tenders	Admn. Department Chief Engineer Superintending Engineer Executive Engineer	Full Powers Full Powers Up to Rs 50 Lac Up to Rs 10 Lac
4	Fixation of stock limit of various Divisions	Admin. Department Chief Engineer	Full Powers Full Powers
5	To sanction estimates for purchase or manufacture of materials to be used on works	Superintending Engineer	Full Powers within the limit sanctioned for reserve stock

Next >>

3.5.3 Bidding Controls

A fundamental rule is that no work shall commence unless properly detailed design and estimates have been sanctioned, funds allocated and orders for its commencement issued by the competent authority. Before calling bids for a work, the Divisional Officer must prepare the `Contract Documents', to include:

- A complete set of drawings showing the general dimensions of the proposed work, and as far as necessary, details of the various parts.
- A complete set of specifications of the work to be done and of the materials to be used, unless reference can be made to some standard specifications.
- A set of "conditions of contract" to be complied with by the person whose tender may be accepted.

In giving out works on contract, sealed tenders should invariably be invited in the most open and public manner, whether by advertisement in the Government Gazette or local newspapers, or by notice in English and Urdu posted at public places. The tender should be invited after the estimate has been technically sanctioned and the contract documents have been approved by an authority not lower than that empowered to accept the tender. The contractors should have free access to the contract documents. At the advertised time and place, all tenders received for the same contract should be opened by the Divisional Officer, or another officer in person, in the presence of such of the intending contractors or their agents as may choose to attend. No tender for the execution of works of any description should be received unless accompanied by cash or a treasury receipt for the deposit of cash as notified earnest money.

Usually, the lowest tender should be accepted, unless there is some objection to the capability of the contractor, the security offered by him, or his execution of former work. In cases where a tender other than the lowest tender is selected for acceptance, reasons should be recorded confidentially in the tender register. The Sub-divisional and Divisional Officer will also inform their immediate superiors whenever they accept a tender rate for use in work orders other than the lowest tendered, and the superior officer may, at his discretion, take action to accept the lowest rate tendered.

3.5.4 Check Measurements

As measurements form the basis of all payments, a Sub-divisional Officer must either make all measurements himself, or check measures personally, not less than the following percentages of the measurements made by his subordinates.

i) Works costing more than Rs 5,000; a Sub-divisional Officer is to check measures at least 35 percent of the cost of all such works.

ii) Works costing Rs 200 to Rs 5,000; a Sub-divisional Officer should check measures not less than 25 percent of the number and 25 percent of the cost of all such works.

iii) The Executive Engineers in the Irrigation Department should carry out check measurements of foundation works at least 5 percent in the case of major hydraulic works and under water works, costing more than Rs 1 lac. There will, however, be no change in the existing limits of check measurements by the Sub-divisional Officer.

The above limits apply to revenue sub-divisions and must, in all cases, be considered as the minimum. At headworks and on large construction works, it shall be at the discretion of the Divisional Officer to fix such limits as he may consider sufficient to ensure adequate control over the expenditure.

The check-measurements should be made promptly and usually within six weeks of presentation of the Measurement Book by the subordinate to the Sub-divisional Officer. In cases where checks have been delayed beyond six weeks, the Sub-divisional Officer should cite his reasons for such delays. The Divisional Officer is expected to keep in close touch with such check-measurements in order to see that the Sub-divisional Officers execute these efficiently and promptly. The Sub-divisional Officer should also frequently inspect the Measurement Books of his subordinates to see if they are correctly posted in accordance with the codal instructions.

In addition to the above Codal Checks, the controlling officer can enhance the scope and level of check-measurements in exceptional cases. The institution of Supervisory Consultants is also being increasingly used for verification of work quantities and contractors bills, particularly for foreign-aided projects. In order to ensure transparency and enhance credibility, this arrangement has now also been extended to the entire ambit of works (O&M, ADP and Flood Works) implemented by the Irrigation Department.

3.5.5 Payment Procedure

As a general rule, a Sub-divisional Officer should not make the final payment for any work until he has personally inspected it and satisfied himself that the work has been correctly completed. Before payment is made for a work, the contractor's account is totalled and abstracted in the Measurement Book by the officer who made the measurements. The Measurement Book should be submitted to the Sub-divisional Officer for his scrutiny and orders. If he is satisfied for a bill to be prepared, he will fill in the correct rates, or if no rates have been agreed upon, such rates as he may consider reasonable and suitable. If he considers it necessary as a precautionary measure, he will calculate the total amounts himself, or get the officer who has made the measurements to calculate these amounts. He will then sign and order, in the Measurement Book, the responsible clerk to check and prepare a bill.

The clerk will check the arithmetical work and will prepare a bill after a comparison with previous entries in the Bill Book or Earth Work Register. He will then resubmit the Bill, Measurement Book and Bill Book to the Sub-divisional Officer. The SDO will satisfy himself from inspection of the Bill Book, or Earth Work Register and Measurement Book, that all previous payments have been taken into account. He will then sign the bill itself as "Officer preparing the bill" and at the same time score out by a diagonal red ink line, every page of the Measurement Book containing the detailed measurements. The bills, along with the measurement books are submitted to the Divisional Office for pre-audit, where these are thoroughly scrutinized by the Accounts Branch. If the Divisional Officer (XEN) is satisfied that the bill has been prepared in accordance with the codal instructions and accounting procedures, then he will authenticate the payment. When making payment, the officer concerned will enter the number and date of the payment of the voucher in red ink across the abstract of the measurements in the Measurement Book, as a token of payment.

3.5.6 The Budget Controls

Incurrence of expenditure is subject to the provision of funds, and no government servant is authorized to spend public money in excess of the budget provision without previously obtaining an extra appropriation. In order to obviate the possibility of unauthorized expenditure by the officers authorized under the rules to draw money through cheques, it has been prescribed that:

- Copies of the distribution of budget grants shall be furnished to the concerned District Accounts Officer / Treasury Officer, Lahore, as soon as possible after the budget has been passed by the Provincial Assembly, and Schedule of Authorized Expenditure authenticated by the Chief Minister. Copies of orders containing distribution of the current Year's Budget Grants may be provided to the District Accounts Officer/ Treasury Officer, Lahore, immediately, if not already submitted.

- The District Account Officer / Treasury Officer shall note the original budget allocation, as well as all subsequent additions to, and reductions from, these allocations separately, in respect of each Public Works Division.

- The officer drawing the cheque shall fill up the proforma showing the budget demand, up-to-date expenditure and along with the cheque, send it to the District Accounts Officer / Treasure Officer. Cheques not accompanied by this proforma shall not be entertained by the District Accounts Officer / Treasury Officer.

- All cheques for payments shall be routed through the District Accounts Office / Treasury. The District Accounts Officer / Treasury Officer will make entries of payment of each cheque in his register, work out balances after each payment and record payment orders on cheques only if the budget provision is available. The District Accounts Officer / Accounts Offices shall not record pay orders in case the

budget provision has been exhausted, is insufficient, or the budget distribution statement has not been supplied to him.

3.5.7 Emergency Provisions

If in any case, whether on grounds of urgency or otherwise, an Executive Engineer is required to carry out a work for which no estimates have been sanctioned, or for which no financial provision exists, the orders of the officer authorizing the work should be conveyed in writing. Upon receipt of such written orders, the Executive Engineer should immediately intimate the audit officer concerned that he is incurring a liability for which there is no provision, or an inadequate provision of funds. At the same time, he should state the approximate amount of liability that is expected to be incurred on the emergency work. The audit officer will then be responsible for bringing the facts to the notice of a higher financial authority instantly, with a view to necessary steps being taken, either to stop the work or to regularize its implementation. This emergency provision, contained in para 2.89 of the PWD Code, is considered necessary in the context of canal breaches, severe river action during high floods, and other crises-provoked situations when danger to irrigation infrastructure is imminent. In case of such emergencies, the Superintending Engineer is empowered, under para 6.1(7) of the Irrigation Manual of Orders (IMO), to permit the award of work without recourse to calling for tenders. While exercising this discretionary power, however, the Superintending Engineer is required to record the reasons for his action.

In order to avoid mis-use of these emergency provisions, additional safeguards have been prescribed from time to time. These include: independent inspection of the site by a team of responsible officers, satisfaction and approval of the Chief Engineer for invoking the emergency clauses, intimation to the Civil / Audits authorities, and limiting the works only to emergency interventions.

3.5.8 Auditing System

The audit of transactions of the field divisions of the Punjab Irrigation Department is conducted in the following three stages (Dogar, 1976):

a) Preliminary audit by the Divisional Accountant in the Divisional Office;
b) Audit in the Audit Office; and
c) Test audit through periodical inspections of the Divisional Office.

a. Preliminary audit. As the representative of the Audit Department, and charged with the responsibility of applying certain preliminary checks to the initial accounts, the Divisional Accountant is responsible for examining the accounts returns of Sub-divisional Officers, and for pre-auditing all the bills of contractors.

b. Audit in Audit Office. The audit of works expenditure in the Audit Office is conducted mainly with reference to:

i) the sufficiency of the authority for incurring the expenditure;
ii) the accuracy of the classification of the charges against the works, persons, services and heads of accounts concerned;
iii) the proof of payment to the correct individual or payee; and
iv) the standards of financial propriety.

c. Inspection of Public Works Divisions. The audit conducted in the Audit Office is supplemented by periodical inspections and test audit of initial accounts and such other accounts as are not rendered to the Audit Office, or as can't be checked adequately except at a local audit. Local inspections are also meant to assure an Audit Officer of the accuracy of the original data on which the accounts rendered to him and his audit work are based.

Objections and observations arising from audit are communicated in the form of Audit Notes, Objections Statements, etc., to the Irrigation Department. The clearance of these objections is watched. In case satisfactory replies are not received from the Divisional Officers, the Audit Objections, etc., are changed to Advance Paras. The Advance Paras are discussed in Departmental Accounts Committee Meetings, which are attended by representatives of the Irrigation and Audit Departments. If the Audit Department is not convinced by the explanation offered by the Irrigation Department staff, then the Audit Paras are converted to Draft Paras. The draft paras represent either unresolved policy issues, or accounts irregularities of a serious nature that are placed before the highest forum, i.e., the Public Accounts Committee (a committee of the Provincial Assembly) for discussion. The decision of the Public Accounts Committee is conveyed to the department for implementation.

3.5.9 Adequacy and Implementation of Financial Controls

A general review of the adequacy and implementation of the existing financial controls bring out the following points:

- The financial controls prescribed by the government appear to be quite comprehensive. Most of the controls had evolved a long time ago during colonial rule. The controls have generally proved to be effective and workable in maintaining the financial discipline.

- Some additional safeguards have been built into the system of controls to make them more responsive and effective in the changing environment. These include: additional inputs in estimation stage controls, updating financial powers, enhancing the level of implementation controls (particularly in the case of foreign-aided projects and emergency works) by involving independent inspection teams and Supervisory Consultants, and more intensive budget controls to limit the expenditures within the budget allocations.

- Though absolutely necessary to address the field emergencies, there have been some concerns regarding misuse of the emergency provisions. Additional checks have helped in improving the discipline, but constant vigilance by the controlling officers is required in this direction.

- Despite quite strong controls, the overall financial management has been on the decline. The experts attribute it to the declining trends in the broader context of the society, whereby strict implementation of rules and regulations has become an issue. The other area of concern is the lack of monitoring the prescribed controls and inadequate action against the defaulters. Therefore, a need to review the field constraints in the implementation of controls and making these performance-oriented and more participatory/transparent, is indicated.

CHAPTER 4

PRESENT PERFORMANCE PROBLEMS AND ISSUES

4.1 The Backdrop

The apparent declining performance of the Irrigation Department has been engaging the attention of many national and international agencies and experts in the recent past. The under-performance appears more conspicuous and disconcerting when viewed in the context that the fascinating development of the Indus Basin was initiated, to a great extent, by the persistent and dedicated efforts of the Irrigation Department. In many respects, the Punjab Irrigation Department used to lead the world. Very high technical and managerial standards for the construction and upkeep of the irrigation network were maintained, and a comprehensive system for monitoring and evaluation and adequate support for research and development was set out. At that time, the Punjab Irrigation Department occupied the top position in the government hierarchy and national development. As a consequence of the changing environment and stagnation over time, the efficiency of the Irrigation Department has been on the downslide.

A host of factors are responsible for the declining standards of irrigation management. Various agencies and individuals identify the management issues and constraints according to their own visions and perceptions. The divergence in the views is sometimes amazing. While some of the departmental officers relate performance decline to the inadequate maintenance funding and external socio-political influences alone, some other experts and aiding agencies consider the government's treatment of irrigation water as a public good, and lack of market incentive, to be the real issue. Considerable discussion has gone into the subject and there is a growing recognition that the issues of irrigation management are multi-faceted and multi-dimensional. A focussed diagnostic review and identification of major system constraints is, therefore, an essential pre-requisite for evolving effective improvement strategies.

The irrigation performance needs to be reviewed in the context of system design objectives, operational constraints, institutional systems, and the broader socio-economic framework. Pakistan is a developing country whose socio-economic problems are very complex and peculiar in nature. The national economy is predominantly agriculture-based and the agriculture is very heavily dependent on irrigation in the context of an arid to semi-arid climate in the province. The changes in the physical environments, like those of population growth, increase in demand for land and water, ecological threats, modern technology and new developments in groundwater, all pose new challenges to the management of the irrigation system. Sustainability of an irrigation system depends not only on the economical, technological and ecological factors, but also on the institutional framework within which these factors interact. Within the matrix of opportunities and constraints, a particular system achieves a certain level of performance. The specific physical characteristics of a canal system and management practices strongly influence its performance outcome.

The present performance problems and issues facing the irrigation department have been identified under six broad categories. These include: the system and supply constraints, technical and managerial inadequacies, financial issues, environmental problems, institutional issues, and the external socio-political influences. A focussed description of the identified issues is presented in the following sections.

4.2 System and Supply Constraints

4.2.1 The System Constraints

The Indus Basin Irrigation System was designed with the objective of bringing as much land under canal command as possible. The designed annual cropping intensities were generally kept low, at 60 to 80 percent, and the diversion capacity of canals aimed at spreading the water thinly over a larger area. This policy was considered suitable for the requirement of a small population at that time. The expectation was for it to support a subsistence level of agriculture, reduce drainage requirements, and bring large blocks of crown waste land under cultivation.

Over decades of canal system operation, the population has increased manifold, and the sociological, cultural, agricultural and economic practices have changed radically. This has substantially modified the actual cropping patterns and intensities. As a consequence, the design considerations and capacities, which might have been relevant at the time of the system's construction, are now no longer relevant. With agricultural development over time, the irrigation intensities have increased considerably, as depicted in Figure 4.1. A study by the Consultants (ACE et al. 1994) estimates that the average cropping intensity in the Punjab Province is around 122 percent, against an average designed intensity of 63 percent. The cropping intensities in different canal commands vary between 80 percent to around 150 percent. In addition to the above, the extensive use of fertilizers, a shift towards higher-delta cash crops and high-yielding crop varieties, and increased water application to maximize the crop yields, have resulted in a tremendous increase in irrigation water demand not envisaged at the time of system design. A study by the Consultants (NESPAK et al, 1995) on the Lower Bari Doab Canal (LBDC) System concludes that the canals supply only 44 percent of the net overall crop water requirements, while groundwater contributes 34 percent of the requirements (Figure 4.2). This still leaves a deficit of 22 percent in a well-developed canal command area, which is endowed with fresh groundwater that the farmers can tap economically. A more recent study by JICA (1997) also reports that the canals in the Lower Chenab Canal (LCC) and the Lower Jhelum Canal (LJC) Circles supply only 40-45 percent of the net overall crop water requirements. These overall deficits in canal supplies become much more pronounced during peak demand seasons, as revealed in Figure 4.3, for the LBDC system. The system constraints, therefore, impose serious limitations on the efficient performance of the irrigation agency.

With the completion of the Mangla and Tarbela Dams, and the construction of various inter-river link canals, the Punjab Province's canals have been divided into the following two groups for the purpose of regulation:

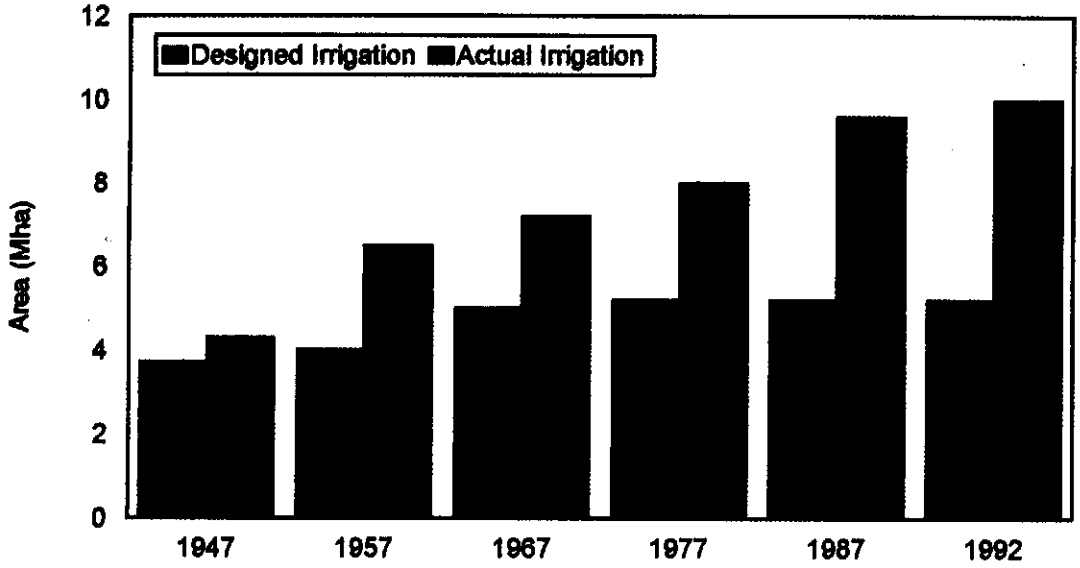


FIG. 4.1. PATTERN OF IRRIGATION DEVELOPMENT IN THE PUNJAB PROVINCE.

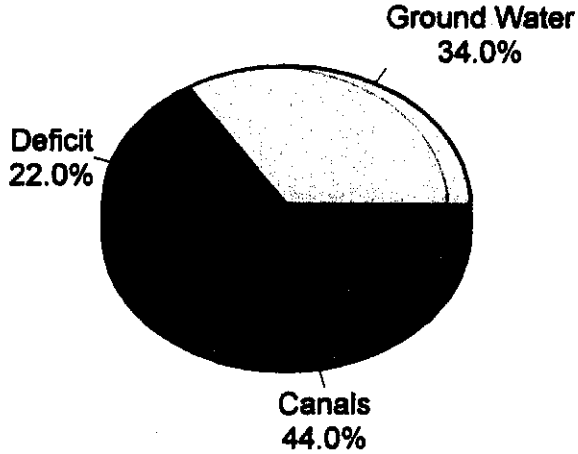


FIG 4.2. NET IRRIGATION REQUIREMENTS Vs CANAL SUPPLIES: LBDC SYSTEM.

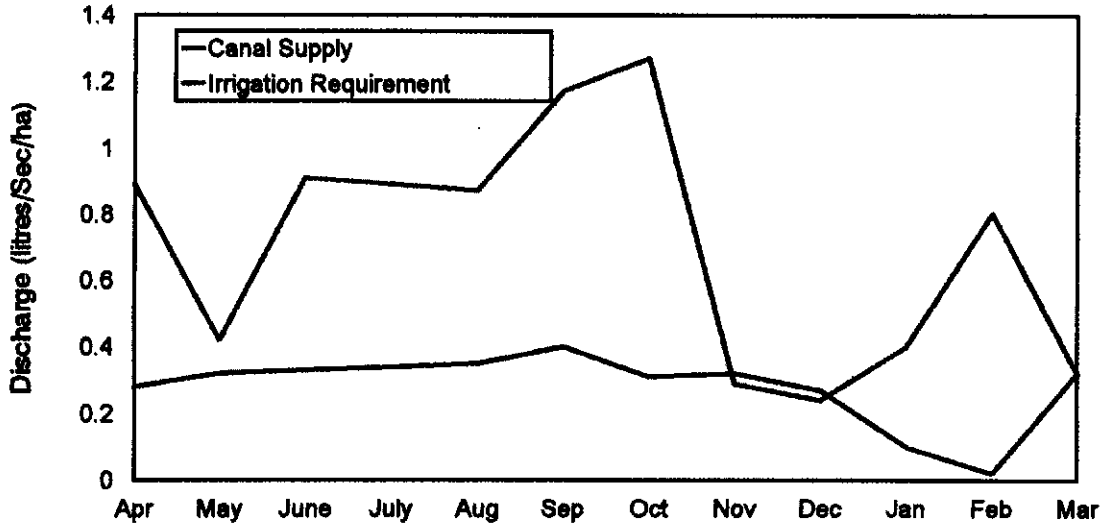


FIG 4.3. SEASONAL PATTERN OF DEMAND Vs. CANAL SUPPLY IN THE LBDC SYSTEM.

1. Mangla Command Canals, or Jhelum - Chenab Zone Canals; and
2. Tarbela Command Canals, or Indus Zone Canals.

Within the Mangla Command, the Marala head-works on the Chenab River is the key point to regulate river flows. The Marala barrage, however, is not connected to the Mangla Dam. As such, the Marala Canals have to depend entirely on the available river flows. The supplies in the river Chenab are generally short of the requirements during critical sowing and maturing periods of the Kharif crops. A shortage of river supplies during these periods reflect very adversely on irrigated agriculture in the canal commands fed from Marala headworks.

The inadequate capacities of the system, therefore, pose a major constraint in meeting the current irrigation requirements, particularly during peak demand periods when the system performance suffers serious setback. The head-end farmers are tempted to extract more water than their legal share in order to mature their sown crops, while the tail-end farmers suffer shortages.

4.2.2 The Supply Constraints

The second, and equally important constraint in system performance, relates to the overall water scarcity, stagnating water availability, and large variations in the seasonal river inflows. Low water availability during critical crop sowing and maturing periods, and limited storage capacity also hampers efficient system operation.

Overall Water Scarcity. Pakistan, as a whole, is situated in a water-short environment and her irrigation is based on the distribution of available water. Recent studies have concluded that for most of Pakistan, irrigation will continue to be constrained by overall water availability. An analysis of the situation at the full potential development stage shows that even if the entire available river inflow is utilized in conjunction with available groundwater, a deficit at the farmgate of over 5 MAF in 1995-96, and 10 MAF in the year 2000, would still remain (Mohtadullah, 1993). Another way of judging the adequacy of a country's water resources is the per capita annual water availability. In Pakistan, the annual per capita water availability was about 2,500 m^3 in 1951, which would drop to around 1,000 m^3 by the year 2000; a level commonly taken to indicate a severe scarcity of water (Haq et al. 1997). Therefore, it is obvious that water resources in Pakistan are quite limited when compared to the future demand projections.

Escalating Water Demand and Stagnating Water Availability. As against the rapidly escalating water demand, the overall water availability is stagnating, as no new projects to enhance the canal supplies have been undertaken after the construction of the Tarbela Dam in 1976. Private tubewell development, which has been instrumental in conjunctive groundwater use, also appears to have touched the peak in some of the freshwater aquifers. The historic water availability at the farmgate, compared to the population, is depicted in Figure 4.4. The water availability, which more or less matched the population growth up to the mid 1980s, is stagnating and has started lagging behind the population growth. This state of affairs poses a serious concern to the

sustainability of irrigated agriculture in the Indus Basin.

Large Fluctuations in the River Inflow. The Indus basin river flows are characterized by large fluctuations, both for the long-term, as well as for seasonal flow patterns. The long-term mean annual inflow (1922-95) for the western rivers is estimated to be 139.06 MAF, while the minimum and maximum inflows during this period have been 97.74 MAF and 186.79 MAF respectively. The seasonal variations, however, are much more pronounced. About 85 percent, of mean river flows are received during the *Kharif* season, and only 15 percent during the *Rabi* season. The inter-seasonal flow pattern is also skewed, as around 70 percent of mean annual inflows are generated during the three monsoon months. Figure 4.5 exhibits the seasonal river flow pattern. The pattern of water availability requires large storage capacity for balancing both the annual, as well as the seasonal fluctuations. The existing storage capacity, however, is very limited and inadequate, being less than 10 percent of mean annual flows. As a consequence, the irrigation system is subjected to serious water shortages, particularly during the peak demand periods, which impacts adversely on the crop yields due to water stress during sensitive growth periods. During this critical period, the system operation is exposed to the maximum stress, because all the farmers attempt to meet the crop requirements, which is just not possible in view of the system and supply constraints (Haq et. al, 1997)

4.2.3 Physical Constraints

The Indus Irrigation System is the largest contiguous irrigation network in the world. The canal systems in the Punjab Province comprise a network of over 23000 miles of channels off-taking from 14 barrages that serve 20.78 million acres of culturable commanded area. The entire irrigation system has been interconnected after the construction of two dams and link canals as a consequence of the Indus Waters Treaty. The existing principal river storages, besides being inadequate, are far away from many canal systems. The canal systems are long and quite huge by any standards. Water takes 7 to 14 days to reach the fields after its release from the storages. The lack of system flexibility, due to a limited number of escapes, is another physical constraint that becomes more pronounced during the emergency operations.

The other physical factors that affect the canal system performance in the Punjab Province include flat topography of the Indus Plain and the varying concentration and size of the silt carried by the river waters in different seasons. Flat topography implies that the necessary slopes, to carry the incoming silt load, cannot always be provided in the tail reaches of distributaries and minors. This gives rise to siltation trends, which in turn reflect on the equity of distribution. The ejection of silt involves technical complexities and also has limited scope due to constraints of disposing of silt-laden water.

On the drainage side, the physical constraints include poor natural drainage, porous soils, and a semi-arid climate with a high rate of evaporation. In such an environment, irrigation without drainage has inevitably led to rising water tables and salinization. These environmental hazards are threatening the very sustainability of irrigated agriculture.

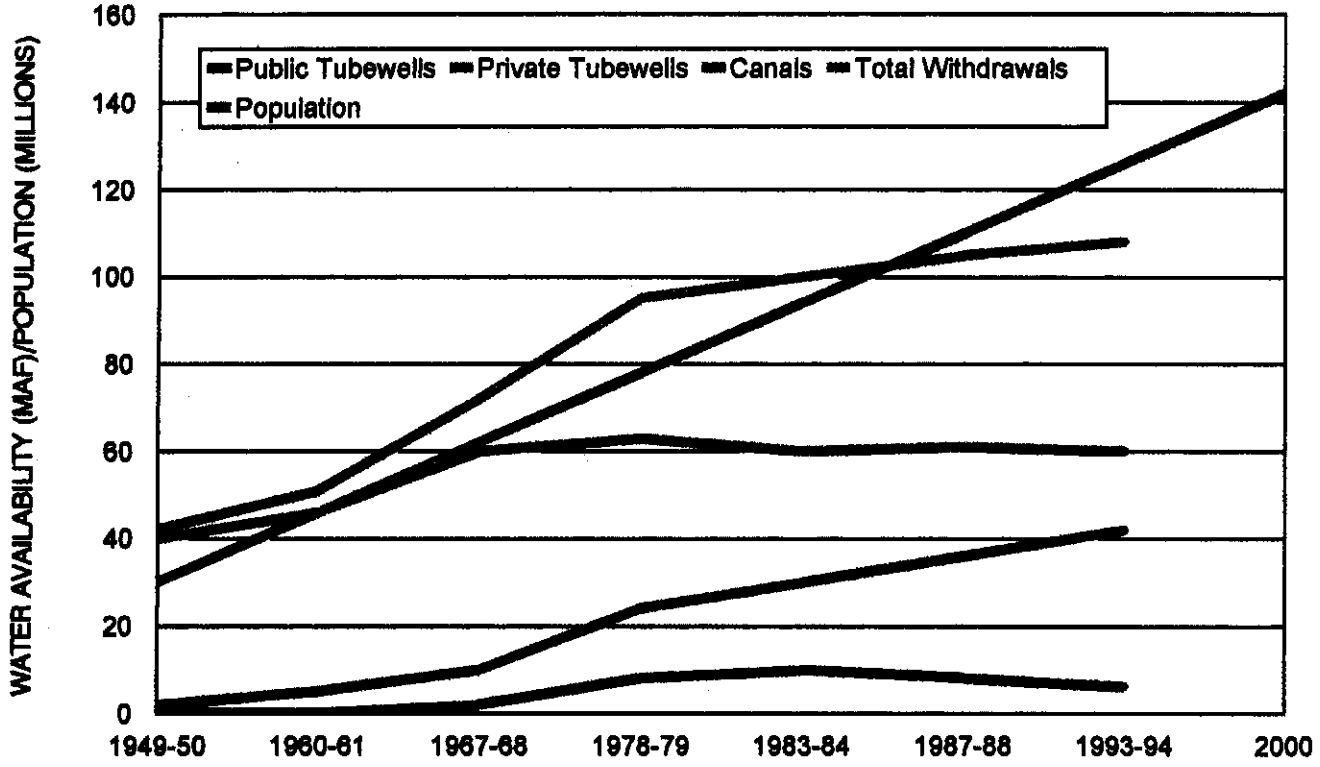


FIG 4.4. STAGNATING WATER AVAILABILITY: HISTORIC FARMGATE WITHDRAWAL VS. POPULATION.

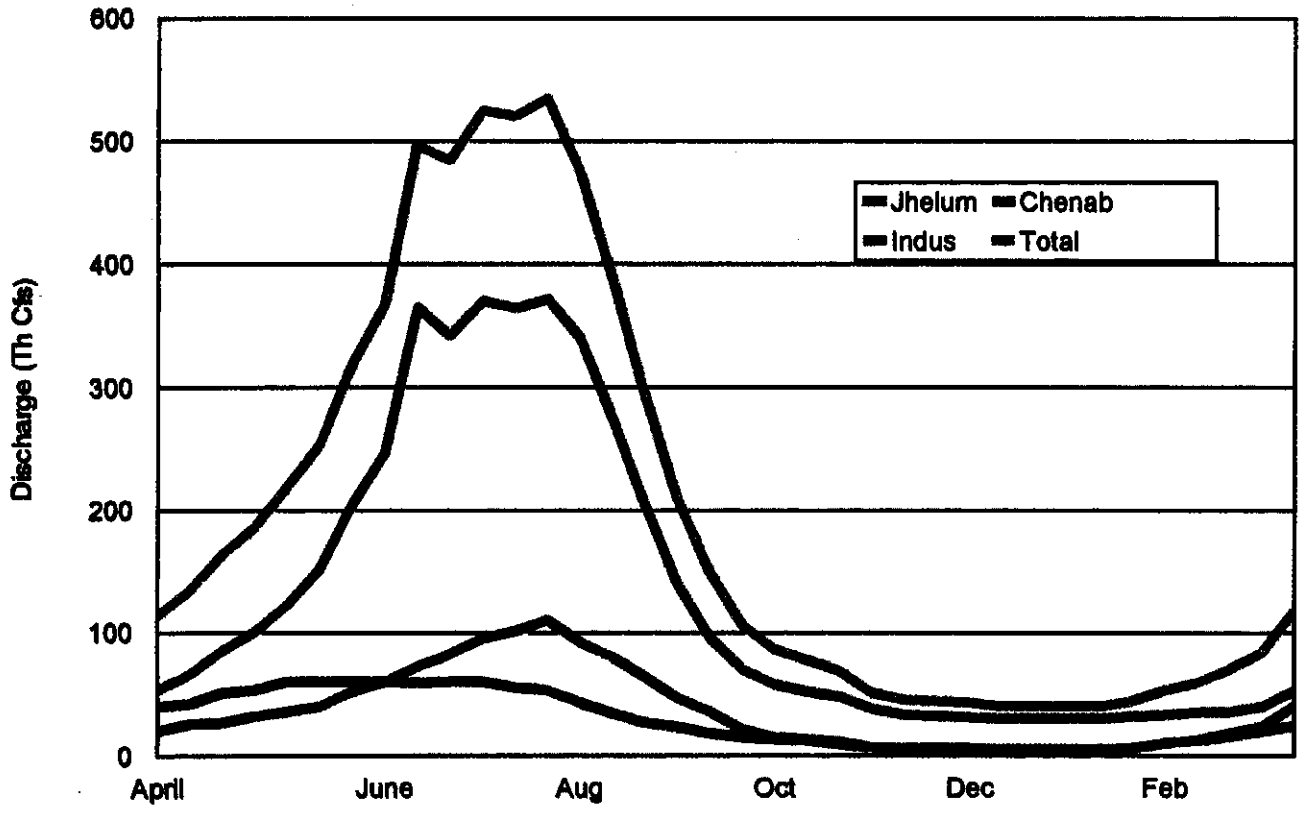


FIG 4.5. MEAN SEASONAL RIVER INFLOW PATTERN.

4.3 Technical and Managerial Issues

4.3.1 Operational Constraints

The operation of an irrigation system is as important as its design in determining the level of system performance and it is one of the most challenging management exercises. This is due to the interaction of social, political, economic and technical factors. Planning for operation involves an estimate for future water supply, future water demand and optimal use of the available resources. The implementation of operational plans require control of flow and the level of water to suit the needs, careful monitoring, appropriate adjustments and effective communication with the farmers.

The design of Pakistan' irrigation system reflects a situation in which the primary resource constraint on agricultural production is water. The intent was to allocate this scarce resource over a large geographic area on an equitable basis, in approximate proportion to the amount of cultureable land. With low design cropping intensities, water scarcity was to be imposed on all farmers, creating strong economic incentives for them to make efficient use of the water they received. The desired pattern of water allocation was to be achieved through the design of the system's structures, coupled with its operations according to a few fundamental rules relating primarily to supply conditions and equitable distribution of available supplies. As a result, the system was built with a minimum of adjustable control structures, limiting the possibility for the operating agency to modify the designed pattern of water allocation through day-to-day management interventions. The irrigation channels of Pakistan's irrigation system had been designed to be operated at, or near, full supply capacity. Operational flow significantly below the design capacity leads to both, inequities in the geographic distribution of water (because of the design of the outlets) and problems of excessive deposits of silt in the canal beds.

As the Irrigation Department attempts to satisfy the increased demand of various individuals and groups of farmers who are using their power to influence the distribution of water in their favour, it is likely to become increasingly difficult to follow the operational rules. Furthermore, even when channels are closed and rotations instituted, pronounced inequities have been observed to exist among channels with respect to the relative length of time of channel closure (Kuper and Strosser, 1992).

Based on their analysis of system operation, Mellor et al. (1994) have concluded that the canal systems continue to be operated on the basis of the historic withdrawals. This mode of operation leads to some of the systems receiving surplus supplies, while other systems face periodic shortages. The adverse effect of such operations imbalances distribution. In a similar review, an IIMI study (Shahid et al, 1992) have reported that the gaps in system operation and essential water delivery information were more serious than heretofore recognized. The main problem areas include sub-optimal operation planning and its ineffective monitoring. Another study in the Fordwah Eastern Sadiqia Canal Command exposed the frequent occurrence of fluctuations in the

water levels and discharges in the Chishtian Sub-division. Also reported, was that the regulation at the field level, to a large extent, is left to the local operations.

The main operational issues requiring attention, as identified by PRC/Checchi (1986), include: inadequate criteria / standards; lack of measurement devices; outdated maps, files, inventory of facilities; sub-optimal farmers participation in evolving operational plans and their implementation; general lack of inter-agency co-ordination; and mounting external pressures inhibiting the implementation of operational rules / plans. In addition to the above, the following specific operational issues are identified:

- The canals have to be run beyond their designed capacities in order to meet the increasing water demand. This affects the channel regime and also impinges on the operational safety and water distribution patterns due to raised water levels.

- The increasing incidence of tampering of outlets and other regulation structures, combined with cuts / breaches of irrigation channels, causes serious distortions in the established operational patterns, thereby impinging adversely on the system performance.

- The O&M staff employed on the canals has to supervise long canal reaches. Typically one beldar is expected to look after 2 miles length of a link or main canal on both banks. They perform the watching duty for one shift of 8 hours during day time, whereas canals run continuously 24 hours a day. Additional watching establishment needed for the remaining time can not be managed due to paucity of O&M funds.

- There are long berm-less reaches on many of the Main and Link Canals due to pushing of excessive supplies, discharge fluctuations, and increased trespass. Presence of burrowing animals pose serious threat to canal safety in these reaches.

- During monsoon season and particularly during intense rainfall periods, there is a dramatic reduction in irrigation water demand and the farmers tend to close their outlets to prevent flooding of the fields. As a result excess discharge can and do pass to the downstream reaches posing potential threat of canal breaches. The Irrigation Department staff is required to take emergent remedial measures in such situations, but their response gets constrained due to long lead times, limited canal escapes and general lack of transport and communication facilities.

4.3.2 Unsatisfactory Maintenance

An irrigation system which is not adequately maintained will fall into disrepair. The irrigation supplies may become irregular, unreliable, inadequate and uncontrolled. As a consequence thereof, crop production will decline, farmers will become frustrated and discipline will deteriorate. When looking at why an irrigation system has deteriorated, one must look at the global picture and consider all influencing factors.

Pakistan's extensive irrigation has progressively deteriorated because of inadequate maintenance funding, over-stressing of the channels to meet an escalating water demand, and a phenomenal increase in the use of canal banks by the human, animal and vehicular traffic. The increased trespassing has been triggered by rapid population growth, farm mechanization, changing social order, and weakening controls. The system deterioration is characterized by weak canal banks, eroded berms, channel cuts and breaches, frequent sedimentation of distributaries and minors, and dilapidated condition of canal structures. The photographs 1, 2, 3, 4, 5 and 6 vividly demonstrate the impacts of inadequate maintenance on the irrigation infrastructure.

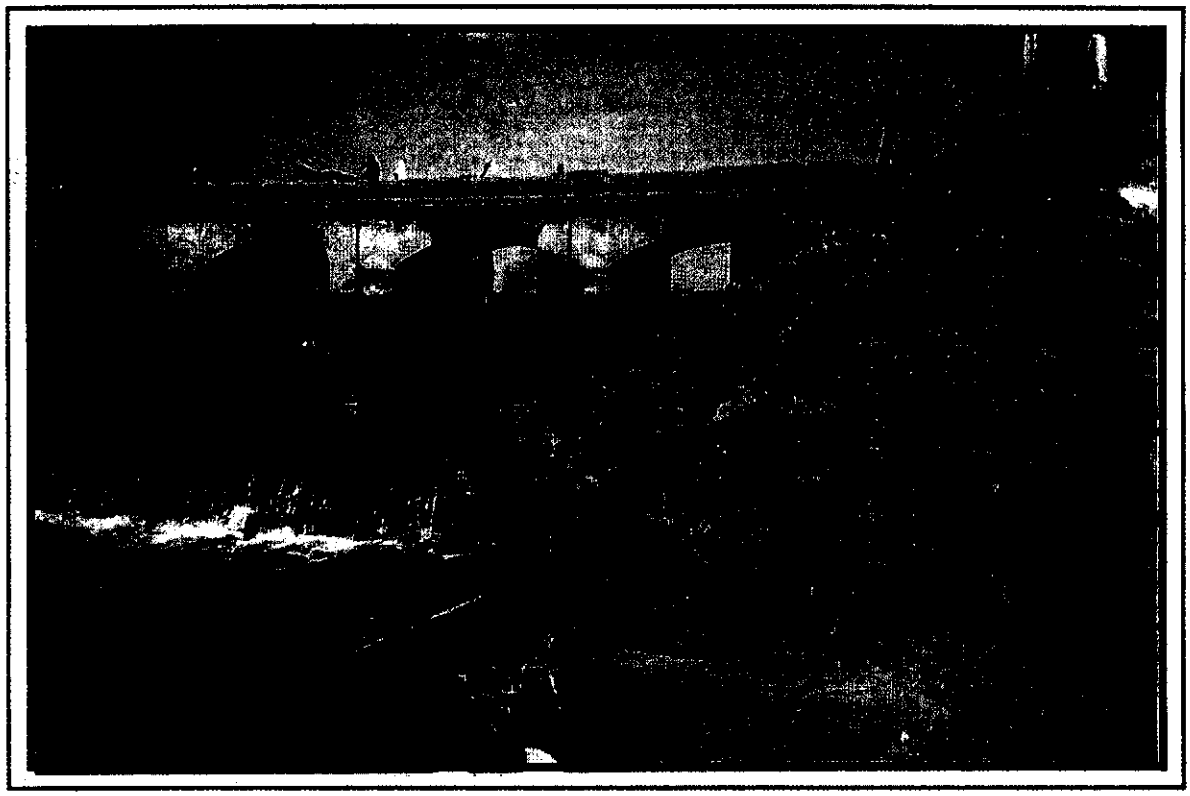
The 1996 collapses of two major structures, the out-fall structure of Balloki - Suleimanki-I Link and regulator-cum-bridge on Marala-Ravi Link, have raised serious concerns about the state of health of the irrigation network in the province. Moved by the colossal damages caused by the failure of major structures, the provincial government has undertaken a detailed study through consultants to assess the state of health of major hydraulic structures, and to work out comprehensive plans for restoring their operational safety. The initial findings of the study indicate that the safety of many structures is threatened due to the aging process, changes in operating conditions, deferred maintenance, damage to mechanical components, and overloading of bridges.

The maintenance failure is often attributed to inadequate maintenance funding. While this does represent one major cause of deferred maintenance, there are also other factors that reflect on systematic maintenance. Problems of maintenance are not generally anticipated through managed programs of prevention. Instead, management either responds to actual, or near-threatening crises. The main constraints in this regard include the following:

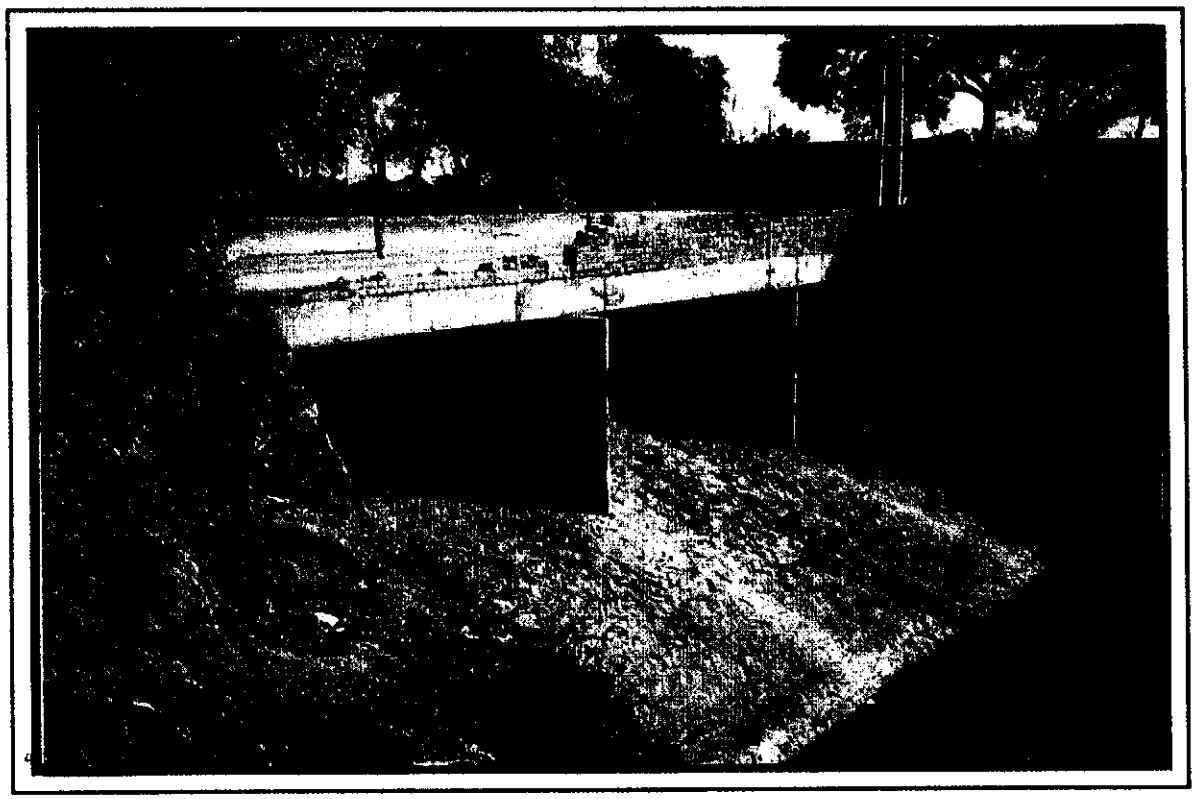
- lack of inspections, maintenance planning and prioritization
- outdated criteria / standards
- inappropriate construction scheduling and progress monitoring
- inadequate supervision and quality control
- slow-moving, fractionated, small-scale contracting, and
- lack of beneficiary participation and inter-agency coordination.

4.3.3 Low Irrigation Efficiencies

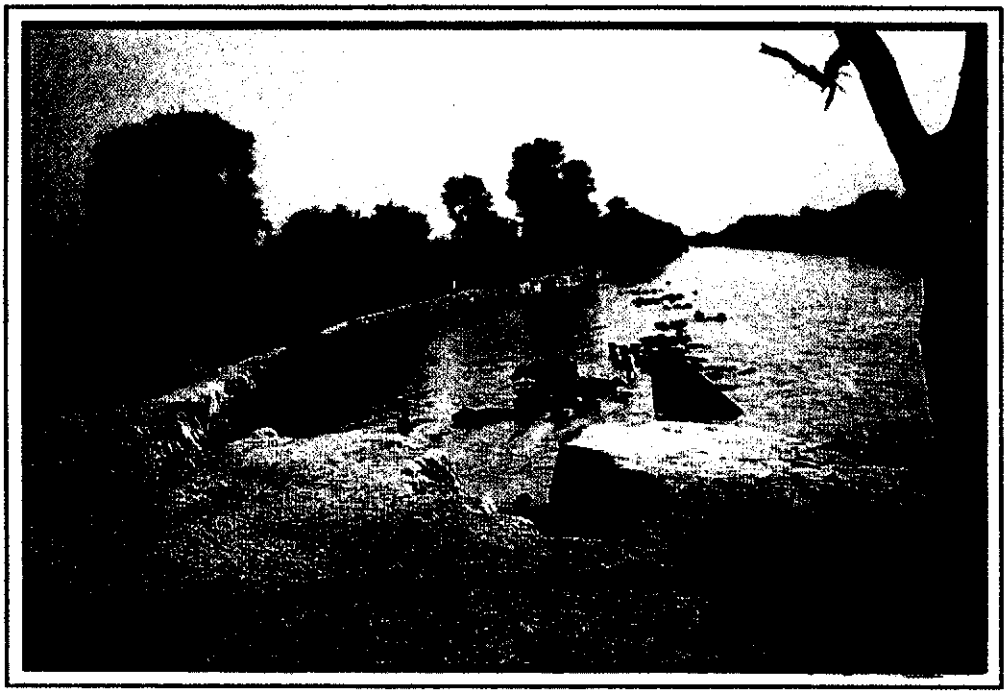
The overall efficiency of Pakistan's irrigation systems is estimated to be around 40 percent, implying that for every 100 units of water diverted at the canal head, only 40 units are available to the root zone for meeting the evapo-transpiration needs of the crop. The overall irrigation efficiency is the product of conveyance losses, distribution losses and the application losses. There is a general lack of a scientific basis and consensus on the extent of these losses in various



Photograph 1. Fall-cum-bridge RD 227 LBDC: Serious Damages to D/S Left Side Protection

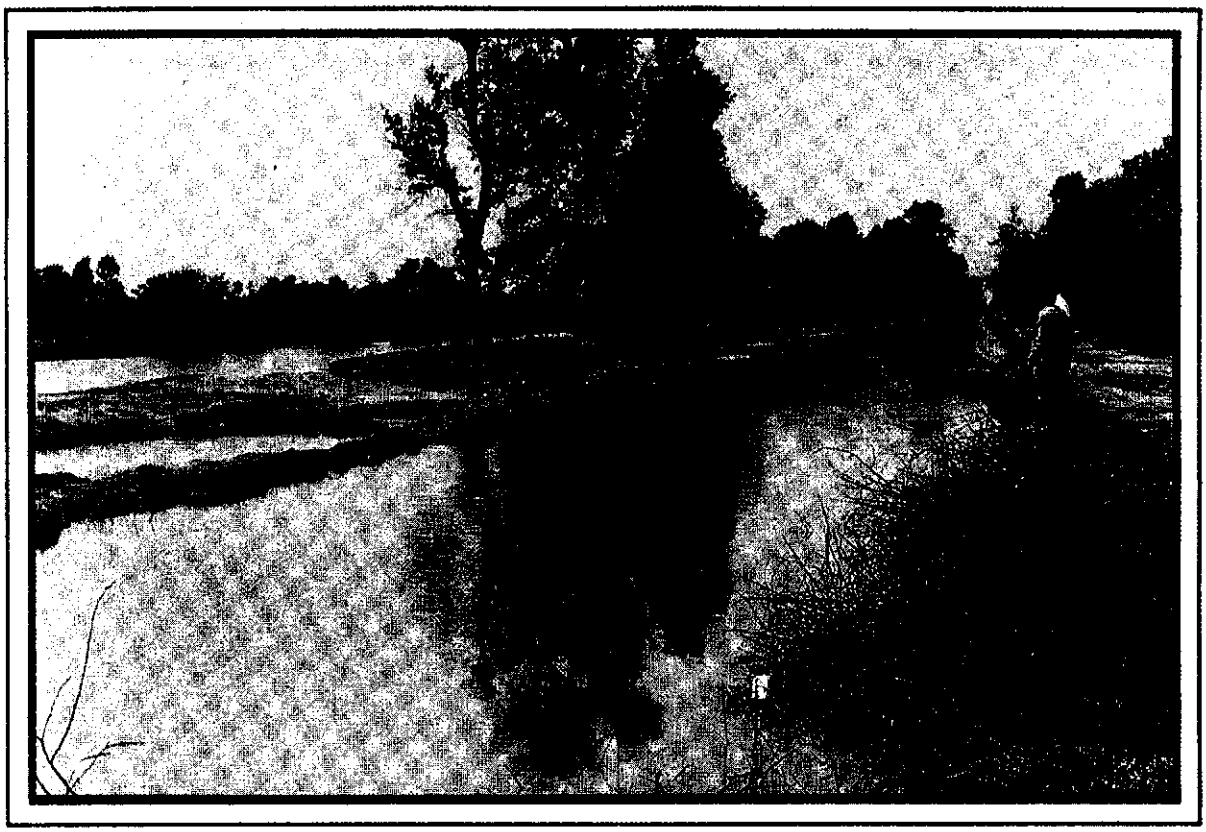


Photograph 2. Fall-cum-Regulator Rd62 Shujabad Branch: Damage to the D/S Glacis, Wing Wall and Bridge Parapet.

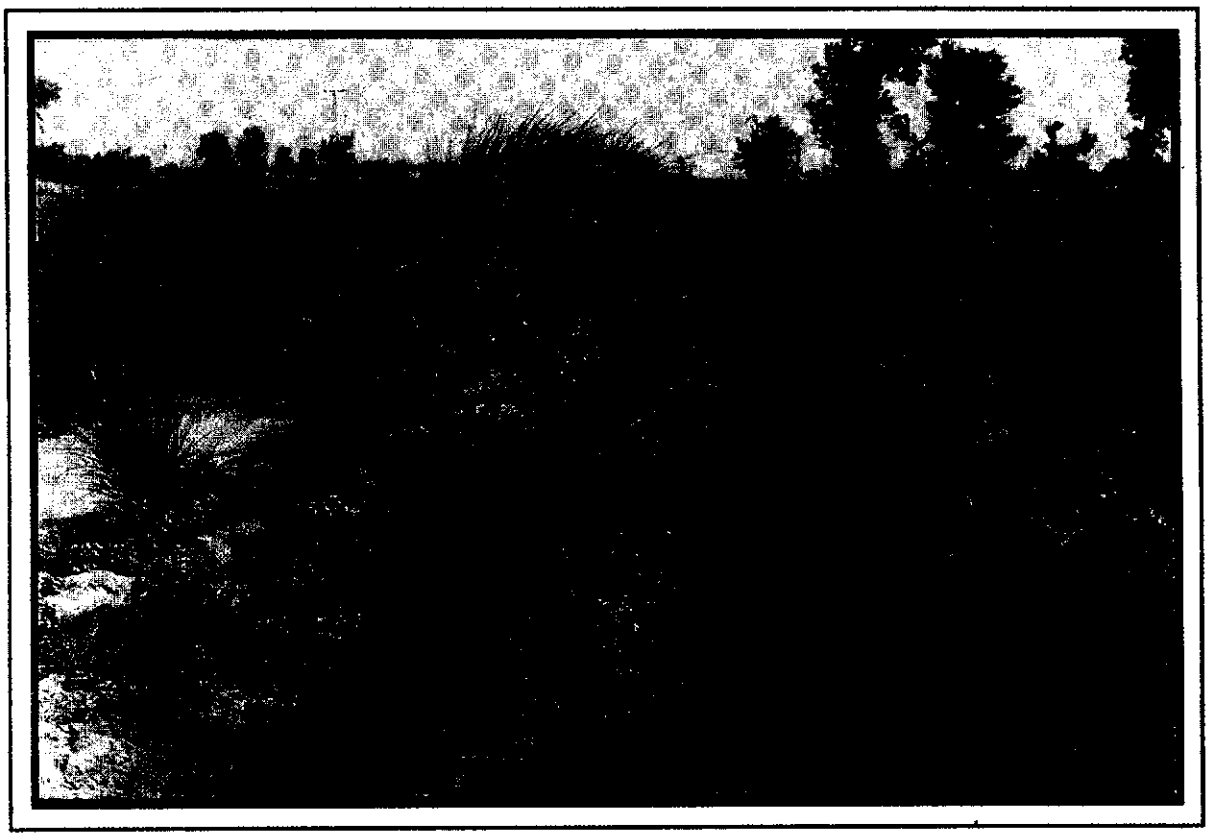


Photograph 3. A Vulnerable Site on BRBD Canal: Abnormal Widening and Serious Bank Erosion.

Photograph 4. Weak Banks and Eroded Berms on BRBD Canal: Effects of Increased Tresspassing.



Photograph 5. Malay Distributary (LJC System): Weak Bank and Inadequate Freeboard Causing Overflows.



Photograph 6. Thatha Umara Distributary (LJC System): Excessive Weed Growth, Causing Canal Constriction.

system components. In the face of an escalating water demand and the system and supply constraints, low irrigation efficiencies compound the problem of water shortages. Water losses vary within a considerably wide range depending upon the seepage characteristics of the soil, the elevation and the state of maintenance of canals and watercourses, on farm practices, as well as the depth to water table, etc.. The channel design and capacities, however, are based on empirical assumption of seepage losses throughout the system. This impacts on the operation of canals at various levels. Another dimension of the problem is related to inadequate monitoring of water conservation measures and evaluation of benefits of various interventions.

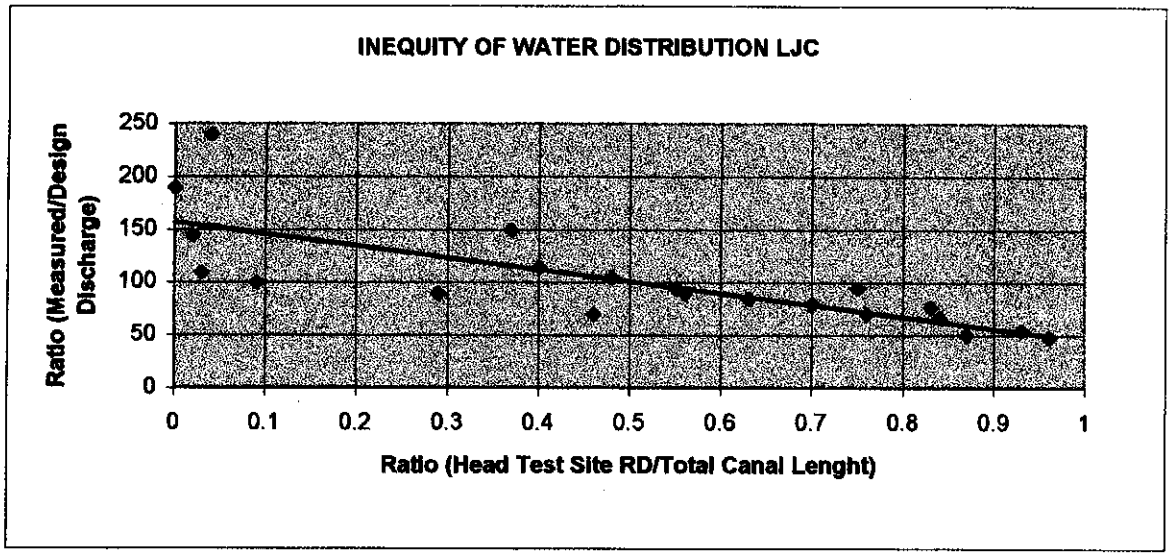
4.3.4 Inequitable Distribution of Irrigation Water

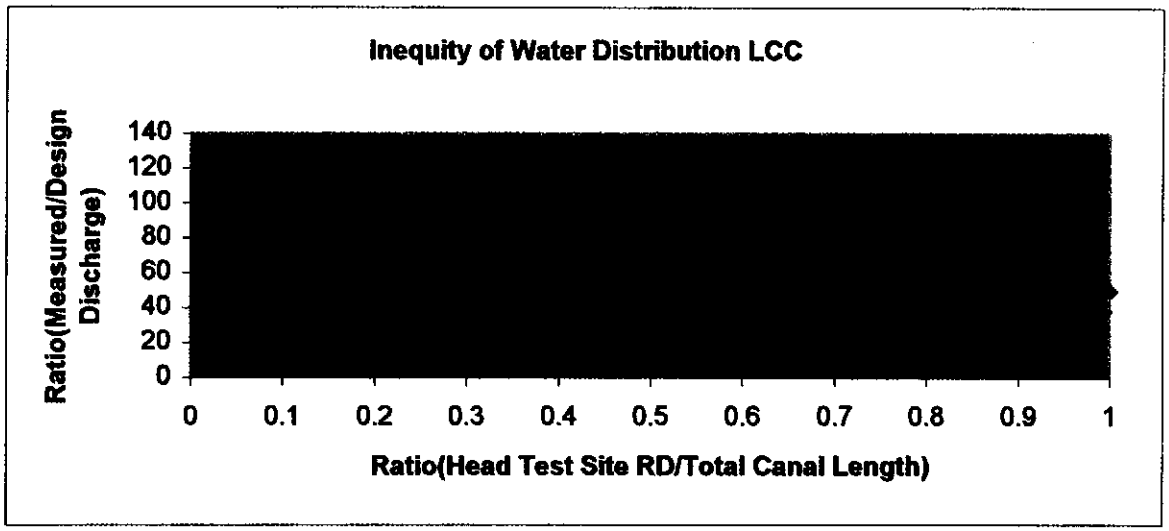
An irrigation system that most farmers consider to be fair is more likely to be productive and efficient contrary to the one that farmers consider unfair. Equity in water allocation and distribution has many dimensions and levels: inter-and intra-canal equity, inter- and intra-distributary equity, and inter- and intra-watercourse equity. Generally, the head end channels and outlets receive more discharge than the tail ends of the system. The growing inequities in canal water distribution has been identified as being major issue that reflects on the system performance. A number of studies have documented the nature and extent of the emerging problems. Recent studies by JICA (1997), presented in Figure 4.6, clearly demonstrate the grave problem of inequitable distribution of canal water in the LCC, LJC and CBDC systems.

The issue has become increasingly severe over the last two decades, and is the outcome of a host of factors. Increasing water demand, deferred maintenance, siltation of channel prisms, excessive withdrawals by outlets, and illegal water extractions all contribute towards the increasing inequity in the system. This has eroded the confidence of the tail users in the integrity of the system. Confronted with the canal water shortages, the tail end farmers have been forced to use marginal quality groundwater without the proper mixing required. This is causing environmental degradation due to the build-up of secondary salinity and surface sodicity. As a result, irrigated agriculture and crop yields have received serious set-back in the tail portions of the system (Kinje and Vander Velde, 1990).

Another important aspect of the issue concerns inequity in access to the use of groundwater. These inequities arise from two fundamental causes. The first relates to the natural occurrence and random geographic distribution of groundwater quality in the province, while the second factor stems from the scale of economies. The farmers in saline groundwater areas are virtually deprived of groundwater use in the context of currently available technologies, whereas the farmers in the fresh groundwater areas are greatly benefiting from the conjunctive groundwater use. With regard to the scale of economies, the uneven distribution of land holdings with predominance of sub-economic farms, compounds the equity of access to the groundwater. The small landholders suffer the worst as they do not have the resources to install tubewells, or money to purchase expansive pumped water. The recent policy pertaining to the dis-investment of public tubewells is complicating the problem still further. An evaluation by the Punjab Economic Research Institute (PERI, 1992) has revealed that the dis-investment of public

Next >>





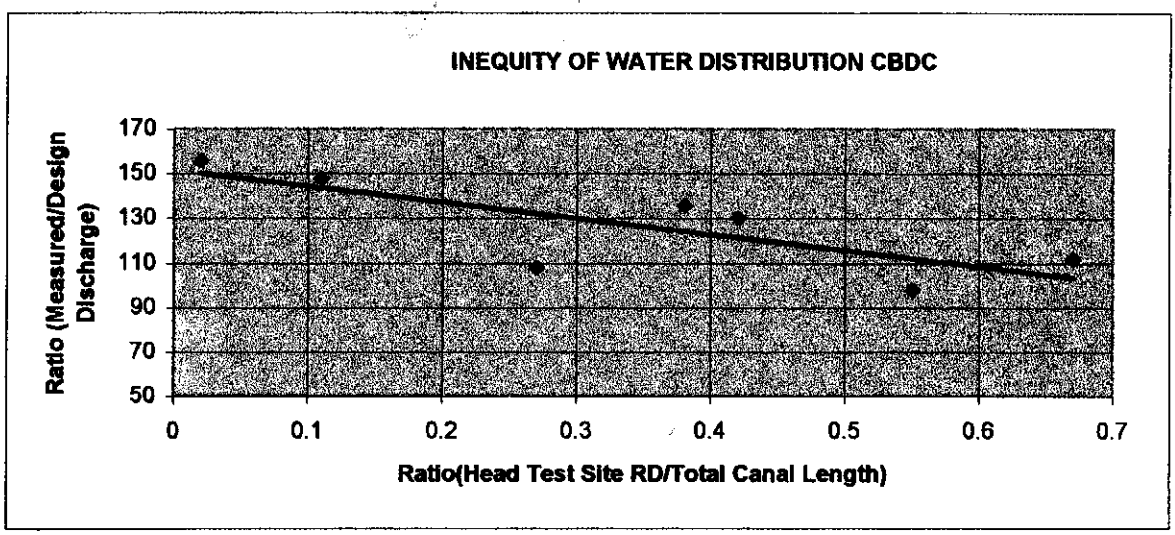


FIG. 4.6. INEQUITIES IN IRRIGATION WATER DISTRIBUTION IN VARIOUS PUNJAB CANAL COMMANDS.

tubewells in the Khanqah Dogran Pilot Project has disturbed the equity of access to groundwater, depriving the poorer sections of the farming community of the benefits of conjunctive groundwater use. The alternative arrangements to address the problem, implemented under the SCARP-I transition project, therefore, require close monitoring and objective evaluation to evolve appropriate strategies in this regard.

4.3.5 Lack of Systematic Monitoring and Evaluation

Monitoring and Evaluation (M&E) is an essential activity for supporting and guiding the management decisions. The M&E system provides the means for effective irrigation system operation and management, and enables the managers to anticipate and address the emerging problems and new situations. Fair to say is that the management of an irrigation system can only be as good as the data it collects, processes and evaluates. Poor, or inadequate, information seriously restrict management's capability to formulate policies, take effective decisions and manage the system.

At present, the management of the Punjab Irrigation System is severely constrained due to inadequate monitoring and evaluation. While modern methods have not been introduced, even the prescribed monitoring activities, like those of discharge measurements, L-Sections and H-observations, etc., conducted regularly in the, past are either totally neglected, or only partly implemented.

Another concern about the performance assessment is the lack of an adequate information system. The problem areas include inadequate information / reporting framework, reporting delays, quality of data, lack of monitoring and evaluation systems, erratic controls and inaction on the part of the managers. In a management study of the department, the consultants had attributed delays in monitoring and reports to lengthy procedures, inefficient / inadequate staff, lack of control by the upper echelons, defective format of reports, and lack of staff training (UCL, 1985). In addition, PRC/Checchi (1986) identified that individual performance standards are non-specific and inadequately monitored, the chain of command is either ignored, or proper communication is lacking, and procedures and organization for enforcement against standards of accountability are not adequately developed.

A reliable and efficient communication system is an essential requirement for effective M&E. The information on monitoring and evaluation of the system is to be communicated to the managers / decision-makers well in time to enable them to take operation control decisions and needed actions. The existing communication system in the Punjab Province is, however, grossly inadequate for supporting implementation of an adequate management information system.

The monitoring and performance assessment remains a low-profile activity in the Irrigation Department. There are no in-built mechanisms or incentives that could motivate the managers to determine the level of their performance and the necessary improvements. They more or less play a passive role, and find it more convenient to respond to the problem situations when public

complaints arise, rather than anticipating them and taking corrective action in advance. The reasons for this attitude of indifference can be traced to the declining morale of the irrigation agency staff triggered by the lack of emphasis, institutional constraints, increasing external socio-political influences, and weakening internal controls.

4.3.6 Inadequate Inspection and Communication Systems

The present inspection system of the Punjab Irrigation Department is based on the daily observation of the facilities by the operating personnel, and periodic inspections by the supervisors, field officers and senior managers. The responsibilities for inspection starts with the field workers (*Beldars*, *Patwaris*, etc.), and move upwards to Sub-engineers, Sub-divisional Officers and Executive Engineers. The field staff is deployed for inspections, according to the schedule given in Table 4.1.

Table 4.1. Inspection Schedule for Irrigation Staff.

Type of Staff	Area of Coverage	Frequency of Visit
Gangmen (Beldars), Mates, and Mistries	Beldars: 1 for every 2 miles of main canals; 1 for every 6 miles of distributaries - minors	Daily
Sub-engineer	30 to 50 miles of channels, drains, embankments, etc.	Lives in the area and may travel almost daily
Sub-divisional Officer	110 to 160 miles of channels, drains, embankments, etc.	Frequent touring for field inspections
Executive Engineer	350 to 900 miles of channels, drains, embankments, etc.	Planned field inspections
Superintending Engineer	900 to 1,500 miles of channels, drains, embankments, etc. (generally one canal system)	Has discretion in scheduling field visits
Chief Engineer	6,000 miles of channels, drains, embankments, etc. (generally 3-4 canal systems)	Has discretion in scheduling field visits

Though well-documented and well set-out, the implementation and compliance with the inspection system has been on the decline due to inadequate attention, increased work load, weakening controls, abandoned reporting systems and a general lack of monitoring by the higher echelons. Another major concern in this regard is the lack of proper transport facilities. Currently, there is an acute shortage of vehicles with the field officers and supervisors. This restricts the mobility and efficiency of the field staff, particularly during critical monsoon and flood seasons, as well as in surprise night inspections for checking water thefts.

The PID's existing telecommunication system comprises a dedicated telegraph and telephone network, linking canal regulation points and rest houses with the sub-divisions / divisions and circles, along with the wireless sets at the barrages. In addition, the senior and mid-level managers (up to the Executive Engineer level and also some sub-divisional officers) are connected through the public telephone network. The canal telegraph system, however, is obsolete, outdated, and mostly out of working order. The situation becomes worse during critical monsoon rainfall storms and floods when the telegraph system collapses almost totally. As a consequence, communication black-outs between the managers, operators and regulation points severely hamper the system managers' capability to remain abreast of the field conditions and to respond effectively to the emergency situations. The communication problems are largely under-estimated in the context of the irrigation system characterized by limited flexibility, long lead times, huge size, and over-stressing much beyond the designed capacities. Hafizullah et al. (1996) observed that unless an efficient communication network is in place, the data will not reach the managers in time, and therefore, may be of little value for decision support systems.

4.3.7 Issues Relating to Public Tubewells and Surface Drains

The evaluation of SCARPs has shown that these projects have generally been able to control waterlogging and provide valuable additional irrigation supplies in the useable groundwater areas, thereby raising the cropping intensities and agricultural production. Its demonstration effect boosted the installation of private tubewells in the useable groundwater areas. The sub-surface drainage provided by tubewells, coupled with additional irrigation supplies, created an environment for the reclamation of soils by leaching and other reclamation measures.

Despite these benefits, the SCARPs program has fallen short of the expectations of their planners, because it had generally exhibited a cycle of initial success; control of waterlogging, additional irrigation supplies, increase of irrigation intensities, reclamation of lands; followed by a decline in the expected benefits due to a decrease of tubewell pumping capacity. This resulted in the reappearance of waterlogging, static or declining cropping intensities, closure of tubewells due to intrusion from saline groundwater, etc.. Besides, the problem of tubewell design and construction, and that of operation and maintenance and management, have also affected the performance of SCARPs. The high rate of tubewell deterioration is partly due to deficiencies in design and construction, and partly due to inadequate maintenance. Operation of SCARP tubewells has also left much to be desired (Wahab, 1992).

Coupled with the uneven performance of SCARPs, another factor is the financial burden, which includes the high operation and maintenance costs of these projects on public sector resources. Under-funding of these requirements resulted in further deterioration in the performance of the SCARPs. One of the major reasons for this situation is the sharp rise in the power tariff, thereby resulting in a higher subsidy requirement. The government has, therefore, been forced to dis-invest these expensive projects in phased manner. The project planning and design of deep/ large

capacity wells developed by foreign consultants, against the advice of local professionals to use shallow / low capacity wells, appear to have been quite sub-optimal when viewed in the context of long-term sustainability of the projects.

The surface drainage systems have been constructed in order to address the problem of rising water tables. Most of these drains are seepage - cum - storm water drains. The surface drains have generally been designed with rule-of-thumb criteria of capacities, ranging from 1 to 4 cusecs per square mile of the catchment area to evacuate the excess rain water within 3 to 5 days. The review of the operation of surface drains suggests that the designed capacities are lower than normally required for effective drainage, particularly during intense rainfall events. The inadequate capacities of surface drains have been further aggravated by man-made obstructions; ill-planned construction of roads, embankments, link canals, blockage of natural drainage lines, and lack of adequate cross drainage works. The inadequate maintenance of drains has led to its clogging with sediments and weeds. Poor outfall conditions during peak flow seasons of drains, when the rivers are also in a high flood stage, is a significant factor that inhibits effective drainage. The other problem that is becoming increasingly severe relates to the disposal of untreated municipal and industrial effluent into the drains. This is turning out to be a serious environmental hazard and little appears to have been done so far to check this highly harmful activity.

4.3.8 Flood Problems

The flood problems in the Punjab Province are triggered by very sharp flood peaks due to intense monsoon rainstorms in the upper river catchments. The flood problems are compounded because of inadequate flood forecasting systems and highly active and meandering river channels. Inadequate cross drainage capacities on hill torrents and financial constraints also hamper effective flood protection and maintenance of river training works.

The main issues relating to flood works in the Punjab Province include the following:

- Lack of strategic / master planning for flood management and implementation of flood protection works.

- Concerns related to planning, design and implementation of river training works, particularly with regard to the absence of objective / coherent selection criteria and repeated damages to the constructed facilities.

- Partial implementation of the identified interventions due to inadequate planning, delay in approval and funding, and delays in construction.

- Sustainability concerns with particular reference to lack of criteria / mechanisms for financing the O&M and restoration costs.

4.3.9 Technological Stagnation

The Punjab Irrigation Department, which once led the world in development of the science and art of irrigation engineering, is now left far behind in the fields of research and development, and the use of modern tools in irrigation management. Rather than acquiring the modern technologies for improving irrigation performance, the department has not been able even to sustain the old practices and systems. Despite some individual brilliance and isolated efforts to transform the system management, the general trend has followed the pattern of adhocism and status quo. This has been mainly due to the prevalence of a culture of indifference and stagnation in the organization, inadequate incentives for performance enhancement and a lack of forward planning and imagination on the part of the leadership.

The major areas of concern relating to technological stagnation include: the lack of a reliable forecasting system for expected river flows; an obsolete telecommunication network; the absence of a database for the irrigation system and an inadequate capacity to acquire the real time data, its analysis and evaluation of various competing scenarios. The lack of access to a geographic information system and modern computers and systems for irrigation management, flood control and decision support, hampers the departments' capability to respond to the emerging challenges in an effective and efficient manner. Not only has the department lagged behind in acquiring state-of-the-art technologies, but has also not been able to keep itself abreast of, and practice the essential traditional mid-level technological interventions, like observation of discharges, updating maps and L-sections, and information and performance assessment systems. There is an urgent need to review the present stagnation and to implement priority programs for addressing the identified issues.

4.4 Financial Issues

The main issues under this heading include inadequate maintenance funding, inappropriate distribution of budget allocations, rise in maintenance expenditure of public tubewells and flood works, escalating expenditures on establishment, stagnation of *abiana* rates, and a widening gap between the expenditure and cost recovery. These concerns, and the extent of the problems, is described below.

4.4.1 Inadequate Maintenance Funding

One of the main reasons for system deterioration is the deferred maintenance due to a consistent shortfall in maintenance funding for the O&M of canals. During the appraisal of the Irrigation Systems Rehabilitation Project, it was determined that inadequate funding was a major reason for deferred maintenance, which has been threatening the operational safety of the irrigation system (World Bank, 1988).

The yardstick for estimating requirements of maintenance funding was prepared for the first time in 1937. With the passage of time, the labour rates and the cost of material continued to rise. The increase in maintenance funding, however, did not keep pace with inflation. A review in 1963 revealed that drastic cuts in O&M funding had been applied from time to time, in view of the financial constraints. This resulted in deferred maintenance with a visible cumulative effect. The revision of yardsticks during 1963 provided funds for routine maintenance, but did not provide funds for making up the deferred maintenance. The revised yardsticks also did not account for the additional physical needs triggered by the over-use of the system due to agricultural development and increasing trespassing (ACE et al 1994).

The yardsticks were revised in 1982 and again in 1992. These revisions also did not provide for deferred maintenance needs and only partly covered the growing rate of physical deterioration. The urgent deferred maintenance needs, however, were partly addressed under Phase-I and II of the Irrigation Systems Rehabilitation Project. Despite the yardstick revisions, it is estimated that the shortfall in O&M funding ranges from 24 percent to 33 percent (World Bank, 1994; Mellor, 1994).

The 1992 yardstick is still in operation despite phenomenal inflation during last six years. The consultants appointed by the Government of Pakistan (ACE et al, 1994) calculated realistic O&M needs of the Punjab Irrigation Department for 1992-93, and also made future projections for realistic O&M needs. The projected level of realistic O&M funding is compared to actual allocations during the last five years in Table 4.2. The analysis clearly brings out that O&M allocations have been far short of the requirements, and that the issue of inadequate maintenance funding continues to perpetuate.

Table 4.2 Realistic O&M Needs Vs. Actuals.

Year	Realistic O&M Needs (M.Rs.)	Demand by PID (M.Rs.)	Actual O&M Funding (M.Rs.)	O&M Funding Gap	
				(M.Rs.)	(%)
1993-94	4,624	4,060	2,374	1,250	49
1994-95	5,058	4,940	3,311	1,747	34
1995-96	5,514	5,024	3,654	1,860	34
1996-97	6,011	5,031	4,319	1,692	28
1997-98	6,552	5,001	4,625	1,927	29

4.4.2 Exorbitant Rise in O&M Funding for Tubewells, Flood Works and Establishment

The O&M funding for tubewells, flood works and establishment has escalated tremendously over the last two decades, with the result that the entire budget planning of the Irrigation Department has been upset. The O&M funding for tubewells increased form Rs 51 million in 1971 - 72 to Rs 470 million in 1981-82 and to Rs 1750 million in 1995-96. The expenditure on establishment has risen from Rs 52 million in 1971-72 to Rs 321 million in 1981-82 and to Rs 1792 million in 1995-96. The expenditure on flood works has also increased considerably, particularly during the

last decade, due, partly, to exceptionally high floods during 1988, 1992, 1996 and 1997, and due, partly, to the construction of a number of spurs in the open river reaches under the Flood Protection Sector-I Project. These spurs are more prone to river attack and require more frequent restoration input. The main reason for the rise in O&M funding for tubewells has been the substantial increase in the power tariff over the last decade. Similarly, the establishment costs have increased mainly as a result of the upward revision of salaries to cover inflationary trends.

As a consequence of the above increases, the O&M funding for canals has been stagnating. The analysis of various components of the O&M budget for the period FY 1981-82 to 1988-89 (Table 4.3) reveals that while funding for tubewells, establishment and other items increased in real terms, and the amount spent on canal maintenance works has suffered a decline at an annual rate of 5.5 percent (Mellor et al, 1994).

Table 4.3. Annual Growth Rates in O&M Funding (Percentage in Real Terms).

Items	Punjab	Sindh
Establishment		
• Canal	5.8	10.7
• Tubewell	4.6	26.6
• Other	8.7	6.0
• Total Establishment	6.0	13.2
Works		
• Canal	(-)5.5	0.1
• Tubewell	1.3	6.0
• Total Works	1.0	13.2
Totals		
• Canals	2.0	4.3
• Tubewells	1.9	10.1
• Others	11.4	14.4
• Total O&M expenditure	3.0	7.5

The historic data of O&M funding has also been analyzed and presented in Figures 4.7 and 4.8. That establishment (49%) and tubewells (35%) are the major contenders for O&M funding is clear, while canal maintenance works receive only about 11 percent of the total Irrigation Department budget. This analysis clearly brings to focus the major financial issue that is impinging on the state of health of the irrigation infrastructure.

4.4.3 Sub-Optimal Utilization of O&M Funding

The main issues in this regard include distortions in the distribution of funds, delays in the release of allocated funds, inappropriate priorities, and a lack of financial discipline. In a study

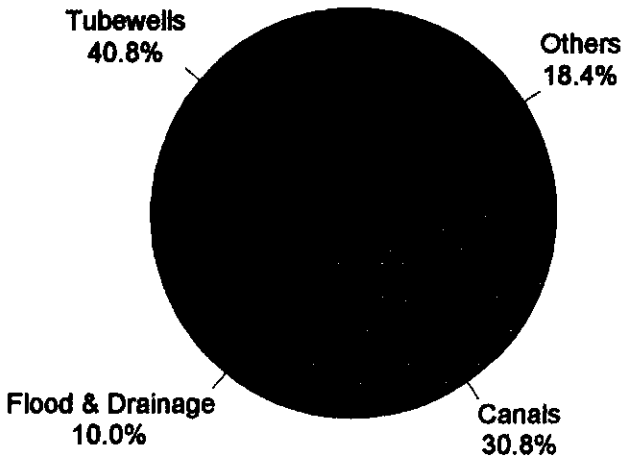
of existing financial systems, the consultants (ACE et al, 1994) have reported that the O&M cost for each canal command is generally not related to yardsticks, and that the expenditure also varies from year to year. The average O&M expenditure on various canal systems for the years 1988-89 to 1991-92 varied from Rs 20.60 to Rs 105.73 per acre of CCA. These distortions in the distribution of funds among the canal commands impacts on the performance of various field units. Similarly, the delay in the release of O&M funds inhibits effective planning and efficient utilization. Another problem has been the retaining of some funds by the senior managers as reserves, and the distribution of reserve allocations generally lack a rational basis. The existing centralized budgeting system, therefore, results in sub-optimal utilization of already inadequate O&M allocations.

4.4.4. Cost Recovery Concerns

The Irrigation Department used to be a revenue-earning department with a significant positive balance sheet during the colonization era. The irrigation revenues, apart from covering full O&M costs, also used to finance the capital cost of irrigation schemes in phases. With the passage of time, revenues started to decline as water rates could not keep pace with the rising inflation. Till the early 1970s, however, revenues were still meeting the full O&M cost of the irrigation system. The situation could not be maintained in the subsequent years due to a number of reasons; the gradual build up in the O&M cost of public tubewells, flood works and establishment, stagnation of water rates, and declining collections.

The gap between the O&M cost of the Punjab Irrigation Department and its revenue-earnings has been progressively widening since the 1970s. At present, the revenue collections finance only 30-35 percent of the O&M expenditure of the Irrigation Department. The historic expenditure and cost recovery trends are depicted in Figures 4.9 and 4.10. The analysis reveals that while the overall gap is increasing, the revenue receipts have generally been balancing the total O&M expenditure of canals. One management deficiency, however, has been that for the past many years, the practice on feedback on canal-wise and division-wise revenue collections is not being maintained in the field units. This is due mainly to the increasing work load and declining inter-agency coordination, as water rates are assessed by the Irrigation Department and collected by the Civil Administration.

The O&M needs of drainage and flood control have been escalating as discussed in the previous sub-section, and it has not been possible to evolve adequate recovery mechanisms because the impacts of these functions are diverse and extend to other sectors of the economy as well. Stagnating water rates and declining collections are also a source of concern in the context of the cost recovery gap. The historic data on assessments and collections shows that recovery levels have dropped to 70-75 percent during the 1990s, as compared to 80-85 percent recoveries during the 1980s. The historic trends of increase in O&M expenditure Vs water rates are presented in Table 4.4.



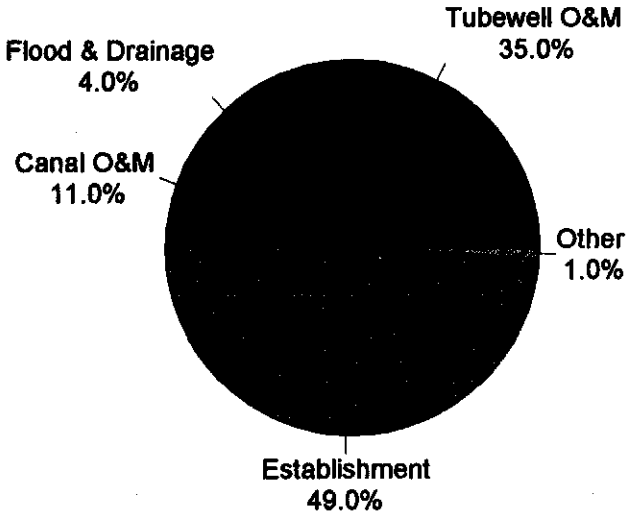


FIG 4.7. COMPONENT AND CATEGORY-WISE BREAKDOWN OF O&M EXPENDITURES (FY 1992 TO 1997).

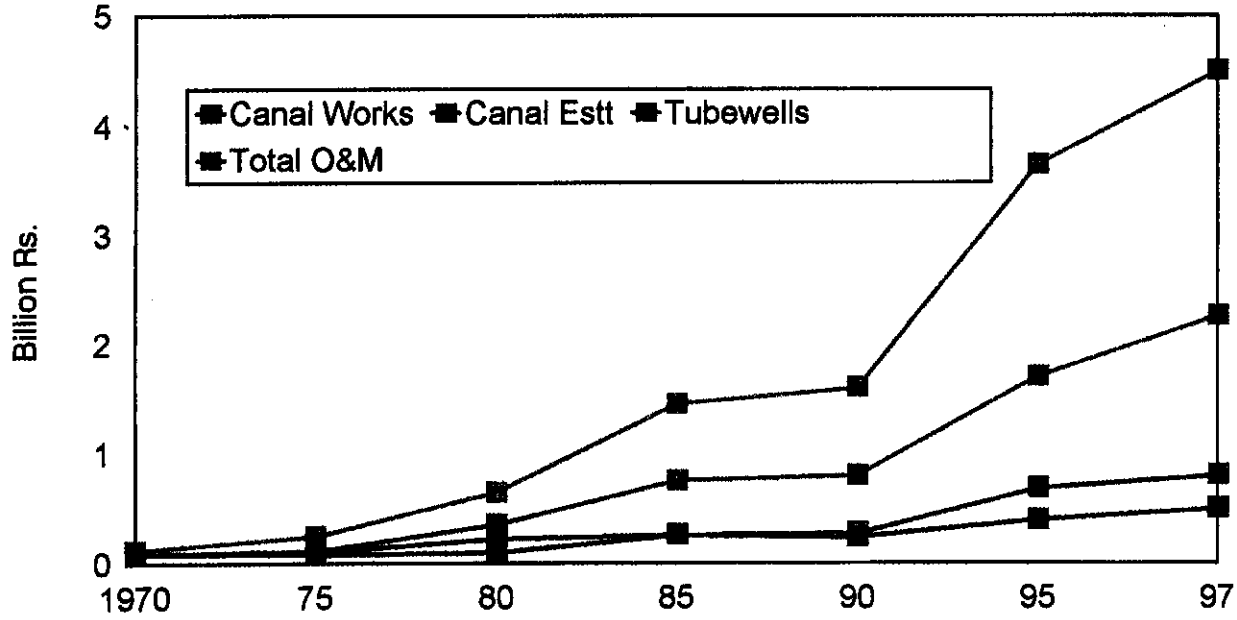


FIG 4.8. HISTORIC TRENDS OF O&M EXPENDITURES.

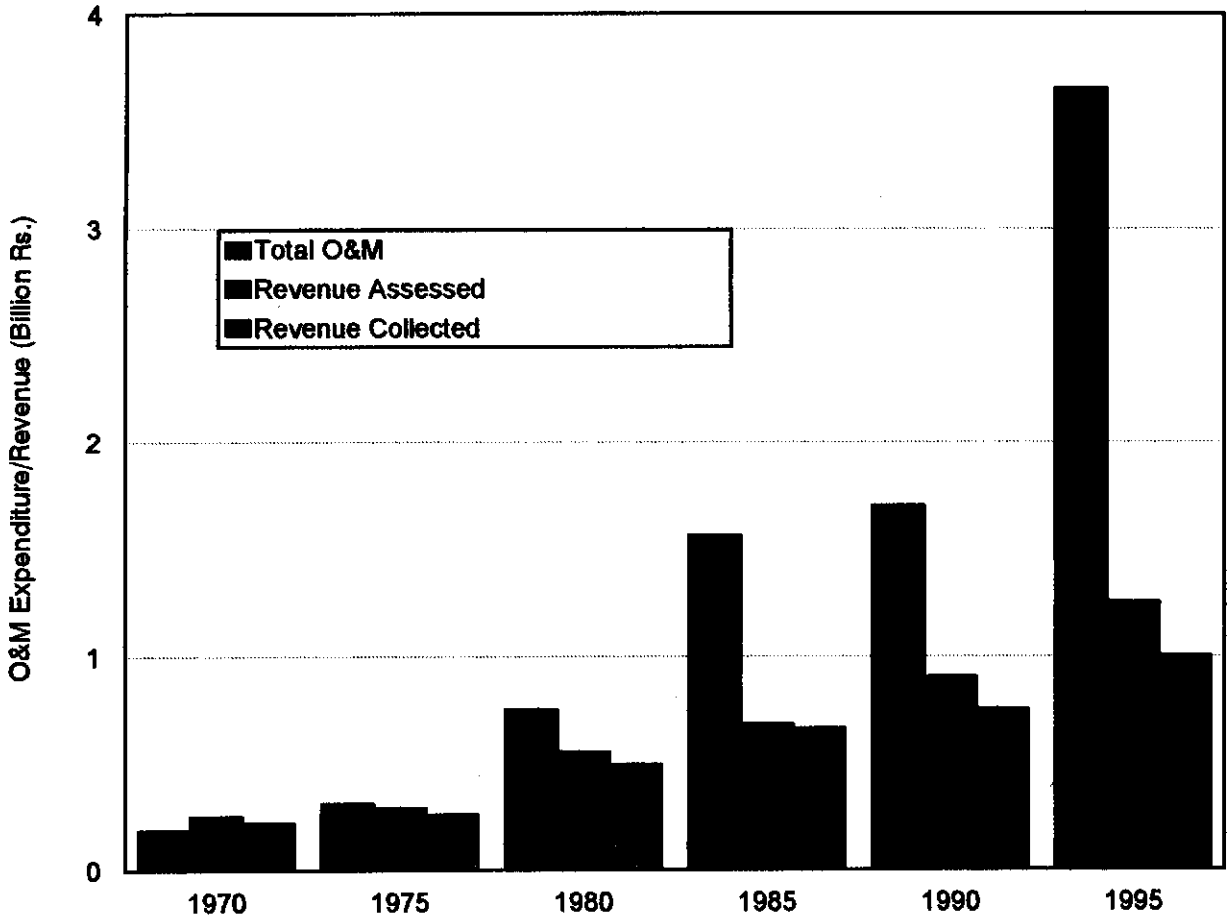


FIG 4.9. O&M EXPENDITURE Vs REVENUE: THE HISTORIC TREND.

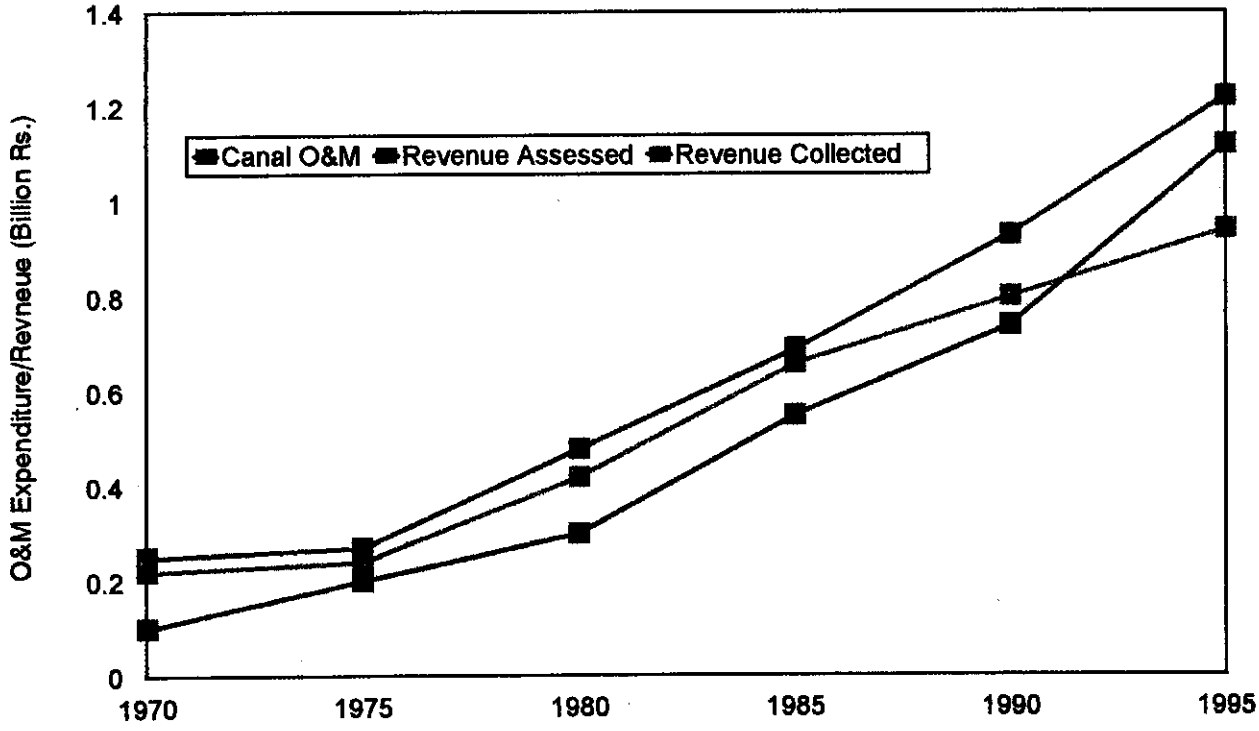


FIG. 4.10. HISTORIC PATTERN OF O&M EXPENDITURE ON CANALS Vs. REVENUES.

Table 4.4. Increases in O&M Expenditure Vs. Water Rates (Percentage in Nominal Terms).

Period	Increase in O&M Expenditure	Increase in Water Rates
1970s	290%	25%
1980s	180%	50%
1990s	140%	95%

The analysis confirms the hypothesis of stagnating trends in water rates and the declining pattern of cost recoveries. Both these factors have complicating socio-political and economic dimensions that extend much beyond the realm and control of irrigation managers. The issues, therefore, require careful consideration for evolving appropriate strategies aimed at financial sustainability of the irrigation infrastructure.

4.5 Environmental Problems

4.5.1 Waterlogging and Salinity

Any irrigation without adequate drainage in an environment like that of the Indus Basin has inevitably to lead rising water tables and salinity. An increase in the diversion of river flows for irrigation, seepage from canals, watercourses, and irrigated areas have resulted in a progressive rise of the groundwater table. Despite the implementation of a number of drainage projects, over 30 percent of the gross commanded area in the country is waterlogged, and about 14 percent is considered highly waterlogged. Although irrigation water is relatively free of salts, repeated irrigation and the rise in groundwater levels has been mobilizing the dissolved salts, resulting in the build-up of salinity. The estimation is that about 6 percent of the gross canal commanded area is severely salt-affected and another 8 percent is moderately affected.

The impact of salinity on agricultural productivity is severe; a 25 percent reduction in the production of Pakistan's major crops is attributed to soil salinity alone. In the Sindh Province where the problem is much more severe, experts estimate that the impact may be closer to 40-60 percent in Saline Groundwater (SGW) areas. The critical threshold at which salinity begins to affect the productivity of agricultural land varies with the crop and salt tolerance limits. The effect of waterlogging on yields is also startling. As the depth to water table decreases to within 5 feet, yields of all major crops begin to decline rapidly. At 0 to 0.8 feet depth to water table, yields are 2 percent for cotton, 9 percent for sugar cane, and 21 percent for wheat. In addition, there are serious environmental and social impacts associated with waterlogging and salinity (World Bank, 1996).

Another observation has been that in areas situated at the tails of distributaries and where canal supplies are limited, groundwater of marginal quality is being used for irrigation in large

quantities. Continuation of this practice over extended periods of time is giving rise to secondary salinization and surface sodicity. This has serious implications for the sustainability of irrigated agriculture.

4.5.2 Over-exploitation of Fresh Aquifers

This is an emerging threat that faces the irrigated agriculture in Indus basin. Groundwater extraction through tubewells not only supplies additional water, but also provides flexibility to match surface water supplies with crop water requirements (Amir and Abidi, 1993). Due to the rapid development of groundwater by the private sector, there is a danger of excessive lowering of water tables, impending threat of secondary salinization due to use of groundwater of marginal quality, and intrusion of saline water into fresh water aquifers (World Bank 1994). A study by Nur-ud-Din and Nazir (1990) has reported that watertables in some canal commands have already gone down considerably. A study by the Consultants (ACE et al, 1994) has estimated recharge and pumpage in various canal commands in the Upper Indus Plain. These initial estimates appear to confirm the emerging problem.

4.5.3 Salt Imbalance

In arid and semi-arid regions, the greatest threat to the sustainability of irrigated agriculture comes from the accumulation of salts in the soils. Under ideal conditions, the salts must be removed from an irrigation system at the same rate at which they are added to the system. If this does not happen, the salinity in the soils and in the aquifer will continue to increase, and it is only a matter of time before salinity would exceed tolerable limits.

Presently, about 130 Bm^3 (106 MAF) of water is diverted annually from the rivers into the canals of the Indus Plain for irrigation purposes. This water contains about 28 million ton (mt) of salts, if the average salinity of river water is taken to be 200 ppm. As such, 28 mt of salts are being added to the system every year. Except for the LBOD Project, drainage effluent is being recycled within the system in one form or the other (Mohtadullah, 1997).

4.5.4 Disposal of Drainage Effluent

Besides the potential impact of saline drainage effluent on wet lands, there is environmental concern about the disposal of saline effluent into the evaporation ponds, or back into the river or canal system. Evaporation ponds can, in any case, deal with only relatively small amounts of water, especially as evaporation rates tend to reduce as salinity reaches a high concentration. Such ponds are a hazard, particularly when subject to rainfall or storm water inflows that could cause them to overtop, or spread. Lateral seepage and the contamination of groundwater and low lying land is another problem. The evaporation ponds located in the SCARP VI (Rahim Yar Khan) Project are posing serious hazards to the adjacent areas, and the environmental degradation has been increasing despite the implementation of mitigatory measures.

The quality and quantity of drainage effluent that will be generated by the anticipated drainage development is difficult to quantify accurately. However, as drainable surplus for most irrigated areas had been estimated by WAPDA or its Consultants, an assessment for the quantity and quality of the anticipated drainage effluent has been made, along with planned disposal, as depicted in Table 4.5.

Table 4.5. Existing and Anticipated Saline Effluent.

Area	Quantity	Mode of Disposal (Maf)			
	(Maf)	Canals	Rivers	Ponds	Sea
A. Existing					
Punjab	1.524	0.393	0.638	0.493	-
Sindh/Bal.	0.498	0.514	0.434	--	-
Total	2.472	0.907	1.072	0.493	0
B. Total Anticipated (including existing					
Punjab	2.948	0.606	1.229	1.113	-
Sindh/Bal	2.964	0.751	1.174	0.027 (L)	6.012
Total	**10.912**	**1.357**	**2.403**	**1.140**	**6.012**
Source: NESPAK et al (1995)					

4.5.5 Water Quality Concerns

The main water quality concerns include:

- Disposal of untreated industrial and municipal effluent into rivers, drains and irrigation channels. This results in degradation of surface water quality. The untreated industrial effluent is particularly harmful because it contains toxic substances also. The dissolved and suspended salts in the industrial effluent ranges from 5000 ppm to over 450,000 ppm (Zuberi, 1997).

- The addition of salts by irrigation supplies. A study by the World Bank reported by Mellor et al. (1994) indicates that irrigation water with an average salt content of 200 ppm adds 0.690 tons per acre of CCA per year, of which 75 percent is added to the groundwater. Slightly more than one-half of the total salts end up in fresh water aquifers, which explains its declining quality. The accumulated salts on soil surface affect land productivity.

- Disposal of the pumped saline water into the drains, canals and rivers. This affects the quality of the surface water, particularly during the low-flow river regime.

- Disposal of untreated effluent from the cities and towns into water bodies (drains, canals and rivers). The pollution loads from the major cities include 443 Ton BOD/day from Karachi, 247 Tons BOD/day from Lahore and 42 Tons BOD/day from Multan and Rawalpindi/Islamabad.

- Excessive application of fertilizers and pesticides by the farmers. This is reflecting on the quality of groundwater, particularly in the shallow aquifers.

4.6 Institutional Issues

4.6.1 Broader Strategic Issues

Irrigation institutions are broadly defined to include both, the rules and organizations. Rules include both, purposely established formal rules (laws, regulations, and procedures) and socially-evolved informal rules (practices, norms, customs and conventions). Viewed from this perspective, the irrigation rules become as important as organizations in influencing the performance of irrigation agencies.

Reviewing the performance of irrigation institutions in Pakistan, Bandaragoda and Firdousi (1992) have observed that these institutions appear to remain conspicuously static. Their changes lag behind those that have taken place in resource base and technology over the years. For this reason, the relevance and adequacy of the current institutional set-up is perceived to be outdated in the context of the changed environment and socio-political transformation. To sustain irrigation performance, therefore, much greater attention is needed for adaptations in the institutional framework in keeping with the social and environmental changes.

The main institutional factors that influence irrigation performance in Pakistan include:

- the overriding effect of socially evolved informal institutions over the application of formal rules and management decisions;
- the obsolescence of irrigation rules, codes and procedures;
- the declining relevance of organizational structures in the light of changed circumstances; and
- the low value attached to the validity and reliability of information and to the necessary awareness relating to proper irrigation management.

The field observations and interactions with agency staff point toward at least four main causes relating to the problem of conflicting institutional influences and declining irrigation performance (Bandaragoda and Firdousi, 1992).

- an increasing work load for all levels of irrigation officials;
- a rapid process of politicization of the administrative and social environment;
- a resultant change of attitudes and values toward the application of formal rules; and
- a situation of declining law and order in the field.

The officials who have been given responsibility through formal rules to act against unauthorized irrigation, cannot, in fact, cope with the task, as they either do not get adequate administrative and political support to apply the rules or get entangled into the vested interests. Due to the rapid politicization process since independence, the bureaucratic power intended by the formal rules has been substantially eroded. Consequently, the existing formal rules and implementation mechanisms have lost its significance. Staff supervision, disciplinary action, and legal and administrative measures for punitive action have all declined in their quality and effectiveness.

4.6.2 Lack of Inter-agency Coordination

Under the provisions of the Irrigation and Drainage Act, the Provincial Irrigation Department is responsible for all aspects of distribution and use of irrigation supplies, including on-farm use. However, in practice, the O&M responsibility of the Irrigation Department virtually ends at the head of the watercourse, and the OFWM Directorate is responsible for watercourse and other on-farm improvements. On the other hand, the Agriculture Department extension service is mainly concerned with the use of non-water inputs.

The irrigation management has a number of other provincial and federal agencies, which have a role in irrigation management alongside the Irrigation Department. Effective liaison and coordination with these agencies, therefore, is critical for good management. These include:

WAPDA for managing river storages, inter-provincial link canals and constructing major drainage projects.

Punjab Revenue Department/Civil Administration for collection of the revenue assessed by the Irrigation Department. The civil administration and police also help to check water theft cases and to fight flood emergencies.

Finance / P&D Departments; the P&D Department coordinates, approves and finances the development projects, while the Finance Department coordinates and controls the O&M budget allocations.

One of the main concerns inhibiting effective irrigation management has been the general lack of inter-agency coordination. At least two major attempts were made during the last decade to strengthen and improve the performance of water-sector institutions, and to deliver integrated water use and agricultural support services to the farmers. These comprised the institutional strengthening measures put forth first under the comprehensive Revised Action Plan of 1979, and then under the Water-sector Investment Planning Study of 1990. Despite these efforts, effective inter-agency coordination has not been realized, which is inhibiting optimal resource management.

4.6.3 Inadequate Farmers Participation in Irrigation Management

The Irrigation Department manuals and guidelines stipulate close liaison and coordination between the field staff and the farmers for efficient operation of canal systems, control over water theft, and transparency in revenue assessment and collection. The engineering / revenue officials, Sub-divisional Officers, and Executive Engineers were instructed to spend a minimum number of mandatory nights out in the field rest houses for this purpose, and it was expected that they would meet the farmers during inspections and when checking revenue assessment work. These measures had been designed to evolve a user-responsive management system.

The desired level and frequency of contact between the irrigation agency staff and the farmers has, however, diminished over time. Resultantly, the water theft and misuse of canal roads is on the increase. The lack of farmer participation in management is considered to be a serious handicap that is causing the decline in the performance of the Irrigation Department. There has been a growing recognition that any worthwhile improvement in system management may not be possible without implementing effective programs for farmer participation in the prevailing socio-political environment.

4.6.4 Financial Indiscipline and Declining Moral Values

These issues are among the most serious concerns that are reflecting on the system performance. The general decline in moral values of the society, strong economic incentives / compulsions, outmoded bureaucratic procedures, and weakening internal controls are believed to be the main reasons for the gradual buildup of the field problems.

Chambers (1988) argues that the human domain so dominates in the operation of the irrigation system that to exclude them from the analysis is not just misleading, but, in a practical sense is unscientific. He goes on to say that "they are not just a part of the system; for purpose of reform, they are the key". Quoting research on the subject in the Indian states, Chamber concluded that corruption on canal irrigation systems has five adverse effects: costs to farmers, especially the poorer and weaker; bad physical work in maintenance; bad canal management with rumour-mongering to induce farmers to pay; in-discipline of field staff; and managers being demoralized and distracted from their proper work.

In the context of Pakistan, at least notionally, financial in-discipline is widely accepted as a practice pervading all patronage-based public services. Particular notable services in the irrigation sector that suffer from this syndrome identified by Bandaragoda and Firdousi (1992) include assessment and collection of revenues, construction and maintenance, and water distribution activities. Ethically, the practice is not condoned by the society; but its long-term survival and the lack of serious social sanctions against it tend to place it in the category of informal institutions. This is a rapidly growing problem, which has a strong impact on the emerging social setup in general, and the irrigation management in particular. The stature and

performance of irrigation agencies get evaluated by millions of the farmers in this backdrop because the vast majority of the rural population is influenced by this informal institution.

4.6.5 Organizational Inadequacies

The main points and issues of concern relating to organizational inadequacies include the following :

Centralization. There is too much centralization of authority at the top management level. Over the years, regulations and practices have moved decision-making upwards. This causes delays and impedes efficient working because responsibility is often not accompanied with the authority needed to accomplish the tasks. The delegation of powers, in administration and in financial matters, is rather restrictive. The departmental rules give far less flexibility than required for effective management. The field officers at all levels complain of over-centralization, which is proving to be rather counter-productive in the efficient working of the organization.

Increased Work Load and Static Organizational Structure. The work load for all levels of irrigation officials has increased considerably due to the increased water demand, fragmentation of land holdings, and changes in socio-political conditions. Organizational structure, distribution of responsibilities, and even size of the field units, however, has generally remained in the same form. The increased work load reflects on the efficiency of irrigation field engineers, particularly at the Sections, Sub-division and Divisional level. The duties assigned to the field officers have grown in multitude over time. These include development activities, increased emphasis on socio-political aspects, coordination meetings, dispute resolution, legal and accounts matters, etc.. The enhanced responsibilities take a major portion of staff time, leaving much less time and emphasis for the primary functions of irrigation management.

Uneven Work Distribution. The work load within the Irrigation Department is not evenly distributed. The work load analysis has not been conducted, with the result that some of the field units are over-tasked, while others are under-tasked. There is a general lack of systems for judging the performance of the staff and there are no specific incentives for doing the assigned tasks in a given time. Similarly, procedures for re-assignment of staff are not in place.

In-adequate Personnel Policies and Lack of Career Planning. Personnel policies with regard to job responsibilities, posting and transfers, performance evaluation, training, and career planning, are either inadequate or out-dated. These inadequacies restrict efficiency of the staff, which in turn reflect on their performance. Most officers are too busy with routine field work. There is no incentive for attaining the state-of-the-art knowledge or specialization. The concept of documenting projects and learning from experience is lacking. The main areas of concern include:

- lack of competitive environment for achieving higher order objectives/goals;
- general lack of recruitment and incentives / policies;

- inadequate procedures and programs for postings and transfers;
- sub-optimal performance evaluation procedures and systems; and
- difficulty in retaining the highly qualified professionals due to inadequate incentives

Absence from Headquarters. The operation and management of the irrigation network requires round-the-clock vigilance. Considering this, residential colonies have been provided at important locations along the canal systems, so that the field staff could reside there and have quick access to the channels in case of emergencies. However, it has been observed that there is a growing tendency for officers, and even sub-engineers, not to live at the headquarters. Due to the prolonged absence of irrigation officers from their specific locations, serious indiscipline has crept into the lower formations also. This state of affairs adversely impinges on the performance of irrigation agencies.

Diffusion of Responsibility. Staff responsibilities are spread over many functions with insufficient training and inadequate discipline. This means that the staff often gets stuck and cannot devote the desired attention to their main tasks.

Inadequate Legal Administrative Support. Continued disputes over water rights, contracts, and other legal matters and court cases increasingly occupy staff and diverts them from their main responsibilities of system operation and maintenance. At present, there is no legal staff within the department to assist the system managers in these matters, with the result that irrigation performance is affected.

Contracting Practices and Construction Industry. The present contracting system is posing increasing problems to the system managers. These include delay in completion of works and sub-standard quality. The contracting procedures are neither well-developed nor well-practiced. The annual renewal of contractors' registration is a routine affair without detailed scrutiny of performance. The employment of qualified engineers by big contractors is generally unsatisfactory. Contractors enlistment / renewal and other contracting procedures need to be reviewed and streamlined. The construction industry is also not well developed, which adds to the problems of quality and standards of new construction, as well as to routine maintenance.

Outdated Manuals. The working of the Irrigation Department is controlled through systems and procedures laid down in different manuals. The manuals are old and out-dated and the instructions are not consolidated in a single manual. The irrigation staff, therefore, has to refer to various manuals for guidance, which causes considerable confusion. In such a situation, the staff has to rely on oral advice, which sometimes results in complications.

Instability of Tenure. Posting and transfers of irrigation agencies is one dimension of irrigation management that manifests the impact of the changing environment and increasing political influence. As a consequence, stability of tenure has suffered a serious setback. Unnecessary and excessive transfers have serious repercussions on the performance of individuals and the

organization. The problem gives rise to insecurity, diffused responsibility, diminished interest and demoralization of staff, which, in turn, hampers the efficient working of the system.

Insufficient Attention to Training. Training is a sorely neglected aspect of personnel management in the Punjab Irrigation Department. In general, overall training plans are not in place, except for routine training in the Government Engineering Academy. The need for training of the professional staff at all levels through specialized courses, study tours, case studies, workshops and seminars, is totally unrealized. As a consequence, the technical knowledge and skills of the agency staff stagnate and initiatives for acquiring modern know-how is dampened. Insufficient attention to this important aspect invariably impacts the performance outcome of the agency staff.

4.7 External Influences

Irrigation systems are an integral part of the total institutional framework of any society. Irrigation management, therefore, has to be considered in the broader perspective of the socio-economic and political conditions, as well as the prevailing law and order situation. As in many developing countries, there has been a general decline in the discipline of the society in Pakistan. On the canal systems, this has been manifested by frequent violations of law by the more powerful and influential users. This has resulted in a general weakening of the irrigation agency performance and control, and the morale of the staff is declining (Haq, 1997).

As in many developing countries, political modernization has tended to grow at a faster rate than economic and social development. The external social pressures, therefore, have generated a high degree of conflict within organizations. The individuals in organizations are consequently sandwiched between external pressures and normative roles expected through organizational rules and procedures (Bandaragoda and Firdousi, 1992). This state of affairs is particularly relevant in the case of irrigation agencies, which have to interface with an extremely huge rural population in managing a vast physical network and a scarce natural resource vital for sustaining agriculture in the arid to semi-arid climate. As a consequence, there has been a general decline in the discipline of the society in Pakistan, which has resulted in frequent violations of law among the more powerful and influential users. This, in turn, has reflected on the performance and control of irrigation agencies.

The overwhelming impacts of external influences on irrigation management in Pakistan have been brought out by various researchers and consultants in their studies. The relevant extracts from those studies presented below emphasize the role and significance of socio-political pressures as a major determinant of the performance of irrigation agencies:

> *"The stability of administrative and physical systems seems to be at stake when confronted with the overriding effect of some social institutions, when the `exception' becomes the `rule'. An administrative style meant for strict compliance is no longer effective in the light of liberalized social behavior where unity and lines of command give way to numerous sources of pressure, objectivity*

is eroded by contradicting demands, and deviations from formal rules often stand unchallenged..... In view of the changed circumstances, canal water is far more valuable now, and the consequent competition and the high rent-seeking potential associated with it make the efficient and equitable distribution of water more important than in the past. For equitable distribution of water and to ensure that the outlets draw their authorized full supply discharge, a strict and constant watch over the hydraulic performance of a distributary becomes imperative, requiring an equally strict discipline among the members of the staff. For this, rigid compliance with formal rules is essential, but ironically, it is now that such strict compliance seems to be easily circumvented by other social institutions, giving rise to a seemingly immutable viscious circle (Bandaragoda and Firdousi, 1992)."

"The high rate of illiteracy among the rural populace and the feudal traditions in the village society has led to concentration of power in the hands of the few who are economically affluent and politically influential. On the other hand, traditional splits in the society have inhibited the cooperative action at the village level, allowing the minority of landlords to maintain their hold on rural society..... Because the lower quality groundwater is expensive, while the higher quality canal water is virtually free, individual farmers face strong economic incentives to increase their access to canal water. This, in turn, leads to outright theft of water. Unless the irrigation agencies can regain control over this, it will not be able to deliver water equitably. The problem is primarily a behavioral and institutional one, and not a technical one" (Mellor et al, 1994)."

"Another very important factor is the social structure of the farming community. In our conditions, rural society is dominated by powerful elite having a strong political influence. It is particularly difficult for the field staff with their low salaries and status to resist powerful external pressures for mis-allocation of canal water. One of the most common weapons used against senior officers, who show signs of being uncompliant, is the threat of having them transferred. In some cases even more harsh pressures are exerted on the field staff. It takes considerable courage on the part of an irrigation official to stand up to such threats particularly, when he is unlikely to obtain any tangible reward for doing so. Therefore, it should not be too surprising that most of the field staff opt for a tension-free life by making compromises (ACE et al, 1994)".

CHAPTER 5

IMPROVEMENT STRATEGIES AND MEASURES

5.1 The Framework

As determined in Section 4, the irrigation management issues are multi-faceted and multi-dimensional in nature. The improvement strategies, therefore, need to be conceived and evolved in a comprehensive and integrated manner to address all the identified issues that impinge on the management and performance of the irrigation system/agency. The isolated interventions, with partial coverage/impact, are neither expected to transform the system performance to any great extent, nor would they bring about improvements in the system management on a sustainable basis. For instance, it appears to be unlikely that just changing the institutional framework or fiscal policies of the irrigation scheme in isolation of the overall context and without addressing the physical constraints, can significantly improve the system performance (Haq and Shahid, 1997). In this context, observations of Tanton and Stoner (1992) are quite relevant. While reviewing the performance of irrigated agriculture in Pakistan, they have emphasized the need to identify true bottlenecks in the system management and comprehensive strategies to overcome them. That many development initiatives are based on preconceived ideas with little understanding of the complex systems that control the performance outcome has been reported. As a result, the projects end up not addressing the real constraints simply because these constraints are either not recognized, or the interventions contemplate only partial solutions.

There is a need to clearly define the goals and objectives of irrigation management. Formulation of appropriate strategies for achieving these goals is the next step. For instance, the strategy for water allocation requires careful consideration. Whether the water allocation objective is to maximize yields per unit of land by meeting full crop water requirements, or alternatively, to foster the welfare of the maximum number of farmers by continuing with the present system of partial irrigation has to be decided. As brought out by Upton (1994), it should not be assumed that partial irrigation essentially represents the sub-optimal use of water resources. In situations where water is the limiting resource, as in the case of Pakistan, the optimal allocation of scarce water resources is to spread it thinly and attempt to maximize crop yields per unit of water.

Yet, another dimension of irrigation management in developing countries with an arid to semi-arid climate with an uneven rainfall distribution, is that the irrigation water is an essential input for sustaining irrigated agriculture. Large public irrigation schemes have been constructed to support a very large rural population with small land holdings in Pakistan. These schemes, in addition to supplying irrigation water, also serve as a vehicle for social uplift and the general welfare of the less privileged rural communities. In this environment, irrigation schemes cannot be treated purely as commercial enterprise. Therefore, analyzing these schemes strictly with reference to the economic criterion may not be relevant, or justified. Rydzewski (1987), advocating the use of social analysis for irrigation schemes in preference to strict economic analysis, has observed that the distribution of benefits within the nation should be a more

important consideration for less developed countries. This approach is particularly relevant where the national policy favours redistribution of income to the less privileged classes.

Another aspect requiring attention relates to the design and impact of fiscal policies on irrigated agriculture. Most of the farmers' forums (e.g. National Commission on Agriculture) have identified the transfer of resources from the agriculture sector to other sectors of the national economy as a major issue that concerns the sustainability of agriculture. The farmers complain of unfavourable taxation packages and government-controlled low prices for the crops that inhibit the growth of the agriculture sector. Responding to the issue of self-sustainability of the irrigation system, many progressive farmers postulate that they would be willing to pay the full O&M cost if state control and unfavourable cross-subsidies are removed, and if agriculture is allowed to operate in a level field.

The foregoing discussion brings to focus the need to appreciate and clearly understand all the complex issues that impact on irrigation management. The need to evolve optimal improvement strategies in the context of the overall local environment is also highlighted. The improvement measures have, accordingly, been identified in this section, and include structural measures, management interventions, financial measures, institutional reforms, and participatory irrigation management. The improvement measures have also been prioritized and urgent interventions by the various stakeholders have been identified for immediate implementation.

5.2 Structural Measures

The need for structural measures stems from the system and supply constraints in the backdrop of rapidly escalating water demands. To comprehend any worthwhile and long-lasting improvements in the irrigation system performance if the necessary structural interventions are not implemented, is difficult. In the absence of the structural measures, the pressure for additional water would continue to mount, and the shortages would become more and more acute. The irrigation management, in such a situation, could be visualized as a Boeing aircraft being propelled by a Fokker engine.

The main structural measures include remodelling/modernizing the canal systems, renovation of hydraulic structures, optimal harnessing of river flows, water conservation measures and improving drainage facilities. The proposed interventions are described in the following paragraphs.

5.2.1 Remodelling / Modernizing the Canal Systems

That the system design greatly influences the performance of irrigation schemes is recognized. In case there are no provisions in the system design to accommodate future changes, or in case the system design becomes outmoded due to over-use and environmental changes, the irrigation performance suffers serious set-backs with symptoms of poor water management and low crop yields. This can reflect on the confidence of the users and also affects the morale of the irrigation

agency staff. In such cases, modernization of the system becomes essential. Modernization is the process of improvement of an existing system to meet the enhanced needs. While rehabilitation is required by the defaults internal to the system itself, modernization is necessary to cope with external events.

In order to meet the enhanced water demands and to address the system constraints, the Punjab Province's irrigation system requires modernization in line with the present level of agriculture development. Suitable provisions also need to be made for accommodating the future developments.

That widespread use of groundwater from private tubewells in the FGW areas has created an overall conjunctive-use environment that is much more demand-driven is argued. This has given the system much-needed flexibility, reducing the need to operate the canal system on a demand basis (Amir and Abidi, 1993). In case of a saline groundwater zone, however, canal water remains the only source for meeting the irrigation requirements. The modernization strategies, therefore, need to be defined separately for a fresh and saline groundwater zone. The proposals in this regard are given below (Haq, 1995a).

Fresh Groundwater Zone. The water allowances of different systems need to be reviewed and rationalized, using existing agro-climatic data. The canal capacities may then be re-defined, after accounting for the groundwater contribution. There would be various alternatives under different operating scenarios. All these alternatives may be evaluated to evolve the optimal design criteria. The existing operational procedures of running the canals at, or close to, full supply constant discharge, may continue. The variations in the crop water requirements may be met from planned conjunctive use of groundwater, so that the over-exploitation of aquifers is avoided. The L-sections of all the channels should be updated / revised to conform to the existing / required water levels, and outlet settings be adjusted correspondingly in order to ensure the equitable distribution of canal water. Various alternatives need to be studied for evolving a workable mechanism to ensure equitable access to groundwater resource.

Saline Groundwater Zone. Since no groundwater contribution is available in this zone, efforts need to be made to meet the irrigation requirements of this zone from canal water to the maximum extent possible. Towards this end, a strategic review of the existing water allowances and water conservation measures can substantially improve the water availability for crops. The equitable distribution of canal supplies is of utmost importance. Revision of channel L-sections and outlet adjustments should be undertaken. The feasibility of skimming the top layer of fresh groundwater through shallow wells may also be explored.

5.2.2 Renovation of Hydraulic Structures

The recent inspections of hydraulic structures and review of their design features by the Consultants has revealed that many of the structures, which are 50 to 80 years old, have out-lived their useful life and are susceptible to sustaining lethal damages at any time if not renovated

Next >>

properly and expeditiously. The broad categories of damages/deficiencies identified by the Consultants include design-related deficiencies;

a) changes in operating conditions;
b) deferred maintenance;
c) aging process;
d) inefficient, or indifferent, maintenance; and
e) civil, hydraulic/structural and mechanical problems.

Presently, about 40 percent of the structures inspected by the Consultants require detailed study and analysis, while the remaining need specific repairs/rehabilitation. Many structures have damaged gates and hoisting arrangements, which are causing serious constraints to effective gate operations. Repairs have not been undertaken for quite some time, because of the lack of adequate funds and the non-availability of technical resources for quick mechanical repairs.

The rehabilitation proposals need to be formulated and prioritized as the most urgent (SOS) repairs, and short/long-term improvements. The structure rehabilitation has to be designed in a manner to cover all the identified design and operational handicaps. The importance of structure renovation cannot be over-emphasized because failure of just one structure on the main canal can interrupt irrigation supplies to vast areas.

The lack of adequate reliable measuring structures, and gaps in essential water delivery information, is another serious issue that calls for immediate attention. A study by Shahid et al., (1993) has demonstrated that the agency's water measurement capacity can be significantly upgraded by providing an adequate number of well-designed measuring structures. A number of the existing falls/regulators can be economically remodelled to meet these needs. In addition, fixing gauges at appropriate locations and level, repair of the existing control structures to the designed dimensions, calibration of flumes and its regular monitoring, can greatly enhance the system management control.

5.2.3 Optimal Harnessing of River Flows

In the backdrop of overall water scarcity, severe water shortages in the saline groundwater areas, and rapidly escalating water demands, optimal harnessing of the available river flows is going to be the centerpiece of future water sector strategies. This can be accomplished by the construction of additional storages for seasonal and inter-year transfer of widely fluctuating river flows. There are a number of feasible locations on the Indus River, where the summer surpluses, presently running waste into the sea, can be stored. This stored water can subsequently be utilized for meeting the seasonal water shortages, intensification of agriculture, development of new areas, generation of cheap hydro-electric power, and for mitigating effects of floods and droughts. The construction of additional multi-purpose storages, therefore, has been proposed for the integrated development of the country's water resources by all the sector studies.

The current status is that no new storage has been added to the system after commissioning the Tarbela Dam in 1976, while the Lieftink Report proposed that additional storages with 12.65 MAF capacity should be operational by 1992. The subsequent studies [Revised Action Plan (1979) and Water Sector Investment Planning Study, (1990)] confirmed and supported the need for new storages, with some changes in the priorities and sequence of implementation. But leaving aside the sequencing of the proposed storages, the present stalemate and inaction on the construction of new storages is just not understandable, as it poses a serious threat to the sustainability and development of irrigation agriculture in the Indus Basin. A recent analysis by WAPDA has brought out that new storages would be essentially needed to regulate the additional apportioned shares for release on a sustained basis over the whole cropping season (Mellor et at, 1994). In addition, new storages are also needed to compensate for the depletion in capacities of the existing reservoirs due to sedimentation.

5.2.4 Water Conservation Measures

The need for water conservation stems directly from an effective limit on water availability in the Indus Basin. With the rapid population growth, merely meeting minimum food needs will require substantial improvements in water-use efficiency. The water conservation can thus play an important role in sustaining agricultural development. This may be achieved though a package approach, combining both, the structural as well as institutional measures. The structural measures include lining irrigation channels and watercourses, land levelling, use of more efficient irrigation methods, and improved maintenance of irrigation facilities. The institutional measures for water conservation may include economic instruments like water pricing structures for canal water, a rationalized tariff for electricity-driven tubewells, incentives for water conservation, and the adoption of cropping patterns suited to different agro-climatic zones.

The most important attribute that requires consideration for water conservation is the quality of groundwater. In fresh groundwater areas, the water losses contribute to the groundwater storage and are recycled. The overall system efficiency of water use in such cases may be quite high, effectively approaching 100 percent. The groundwater recharge, as such, provides the much-needed flexibility to the water-short canal systems, during periods of peak demands. In the saline water aquifers, however, the seepage losses represent irrecoverable water loss to the system. Efforts for water conservation should therefore be focussed in these priority areas. In this way, drainage surplus would be reduced and water availability at farmgate would also significantly improve. Thus, there is a need to implement a phased program for lining of irrigation canals in saline groundwater areas; starting with the seepage control in the most problematic reaches involving high filling, porous soils, and high water tables.

5.2.5 Improving Drainage Facilities

The drainage problems in Pakistan relate mainly to the saline ground-water areas, as private tubewells are generally helping with drainage of FGW areas. Urgent need to carry out a diagnostic review of the current drainage practices is indicated with a view to identify constraints

in effective drainage and design remedial measures thereof. The previous experience appear to suggest that deep pumping in SGW areas is not very effective due to large capital costs, rapid deterioration of strainers, high operating costs, problems of effluent disposal and lack of farmers' interest in tubewell operation.

There is a need to explore and adopt new technologies for cost-effective and sustainable drainage interventions. Low-cost sub-surface pipe (tile) drains and skimming top layers of comparatively fresh ground-water lenses hold promise, and need to be developed through site-specific action research. High water allowances and inefficient irrigation practices leading to excessive losses and drainage problems need careful review. The concept of integrated water management, along with selective canal lining, is identified to be the most feasible and sustainable option in addressing the twin menace of water-logging and salinity.

Biological drainage is a relatively new concept, which also offers considerable potential as an alternative measure where the drainage cost is high and the disposal of saline effluent poses economic and environmental concerns. The biological treatment includes the plantation of certain categories of plant species that are tolerant of the above conditions. The biological approach will make the lands productive by lowering the water table. Biological drainage is cost-effective, requires little maintenance, provides a renewable source, and is environment - friendly.

Regular desilting of the surface drainage network and improving the outfall conditions is another priority area that requires urgent attention for maintaining the productivity of irrigated agriculture. The surface drains are the backbone of any drainage system, because they are the outlets for all the drainage effluent. In the Indus Plains, low velocities and sedimentation occurs, coupled with the problems of sloughing and side slope erosion. Another major problem of maintenance in open surface drains is the weed growth that increases the channel roughness and decreases the cross-sectional area. Both of these factors decrease the drain capacity and increases flow depth, resulting in flooding of the adjoining areas. There is a need to identify effective and efficient methodologies for the maintenance of drains.

It has been experienced that the outfall conditions for main and branch drains are not favourable, particularly in the provinces of the Punjab and Sindh. To avoid stagnation / spillage of water and also to have a desirable control over the water table, relocation of outfall / proper outfall design and pumpage at the outfall points may be considered.

5.3 Management Interventions

The management interventions represent the most important attribute that can transform and optimize irrigation management under the given set of physical infrastructure. There has been a growing consciousness across the globe that structural measures alone, howsoever elaborate, cannot significantly improve the irrigation performance. In many cases, management interventions have to precede the structural measures in implementing the reforms agenda in order to identify the real structural constraints that need to be addressed. The identified measures

include improving system operation and maintenance, demand side management, effective management information system, and organizational improvements.

5.3.1 Improving System Operation

As already brought out, the operation of an irrigation scheme is as important as its design in determining the level of its performance. The irrigation system operation, though technically quite straight-forward, is one of the most complex management exercises. This is due to the interaction of social, political, economic and technical factors, with the daunting task of real-time management of a dynamic resource. Planning for operation includes estimating future water supply; estimating water demand; and matching supply and demand for optimizing utilization of the available resources. Implementation of the operational plans requires controlling flow and level of water to suit the needs; maintaining water levels and discharges at, or below, safe levels to avoid overtopping; monitoring of the operation through routine supervision, surprise checks and effective communication with farmers; and making the necessary adjustments in the operational plans.

Improved operations of an irrigation canal has the primary objective of providing assured and equitable canal supplies to enable the farmers to improve the quality and the quantity of crop yields, while ensuring economic and environmental sustainability on the farm. At the main canal level the secondary objectives may include improved service to the next lower level; reduced maintenance due to structural improvements; less fluctuation of the water level, or removal of silt at the intake structure; reduced, or more efficient, utilization of labor; reduction of other costs, such as alleviation of the drainage problems; improved safety of the operation, both for the operators and in the form of less canal breaches and physical damage to facilities; and protection of the environment.

The first step in the operation process is to conduct a field survey of required essential structural improvements for flow control and water measurement (i.e. repairing damaged structures or installing new flow measuring devices). The main activities that require attention includes:

- re-defining operational criteria / standards;
- improving regulation practices;
- information-sharing and public awareness campaigns regarding expected canal flow patterns, authorized outlet discharges, expected shortages, and canal closures, etc.;
- regular monitoring and evaluation programs;
- updating the system profile to accommodate the physical changes;
- introducing adequate control structures and mechanism;
- co-ordination with police / civil administration to check water theft;
- development of contingency plans and activation of canal escapes to respond to emergency situations; and
- participatory management through farmers organizations.

5.3.2 Planned Maintenance

Maintenance is defined as the set of physical activities required to keep the system functioning to a standard acceptable to the users of the system. Routine maintenance is necessary for any system or structure to achieve its design life. The first step in the maintenance process is to conduct a detailed field survey that lists all maintenance needs along each main canal, branch, distributary and minor. The survey requires careful inspection, taking notes on each maintenance need, i.e. removal of silt, repair of canal bank, repair of damaged structure, etc.. The maintenance plan needs to be prepared for each irrigation canal identifying the maintenance needs within a reasonable period, preferably 3 to 5 years. This plan should contain essential items of maintenance and costs involved; inventory of required maintenance; priority maintenance needs; and maintenance equipment/manpower requirements.

In order to improve maintenance planning standards, the following steps need to be taken:

- proper planning of maintenance activities in the form of Annual O&M Work Plans;
- re-defining maintenance criteria/standards;
- appropriate scheduling of maintenance works;
- institutionalizing a system of participatory consultations/involvement in the entire maintenance cycle;
- defining maintenance priorities;
- adequate and timely budget allocation to the implementing units;
- adequate supervision and quality control; and
- independent inspection system for accountability.

5.3.3 Demand Side Management

Until such time that the structural measures are implemented to address the system and supply constraints, the irrigation agency and farmers will have to live with, and operate in, an environment of water scarcity. The water shortages can be managed by better planning and optimal allocation of water. This, however, would require quite intensive action research, appropriate economic incentives and farmer extension services to put the concept to practice.

The Demand Side Management Plan may include the following alternatives:

- staggering of cultivation to reduce peak water requirements;
- growing water-efficient crops in order to optimize allocation of scarce water resources;
- agriculture practices to optimize water use;
- excluding areas covered by saline, poor or marginal soils;
- allocation of water to preferential crops during sensitive stages of growth; and
- rationalizing water rates, power tariffs and economic policies for encouraging efficient water use:

5.3.4 An Effective Management Information System

The systematic monitoring and evaluation is very essential for supporting and guiding management decisions. This activity has to be conducted on a regular and continuing basis. The main features of M&E system and Decision Support Framework also require periodic review in order to meet the growing needs of irrigated agriculture and to make these responsive to the dynamic external environment. The major improvements in this behalf include:

- review the existing M&E arrangements and revive its implementation;
- enhance monitoring capability by installing control structures;
- effective control over data collection, analysis and its interpretation;
- refine the reporting systems, with emphasis on processing the data to convert it into useful information for the management;
- introduce a modern information system and performance assessment techniques; and
- close review of the performance of various field units by the top management with reference to the agreed/identified objectives, targets and performance indicators.

5.3.5 Use of Modern Tools and State-of-the-Art Techniques

The present state-of-the-art technologies for computer applications in simulation of canal flow, regulation, distribution of irrigation supplies within the irrigation network and optimization of resource use, need to be developed and calibrated through a process of monitoring and validation of the model predictions. This would require close coordination and interface among the researchers, computer programmers/users and irrigation managers/field staff. There is also an urgent need to train the agency staff to enhance computer skills and development of Irrigation Management Information Systems.

Some of the most common and interesting applications of micro-computers in irrigation management are in the realms of data storage and retrieval, data processing and analysis, simulation, and geographical information system (GIS). For planning and scheduling of irrigation water, a lot of data processing and analysis is involved. Micro-computers can greatly facilitate data analysis and processing for supporting management decisions. Computers can also be very useful to simulate events that would be dangerous, difficult or costly to attempt in real life. Packages, that can simulate flow behaviour in canals are available, providing opportunities to study various operation scenarios. This can be in the form of predicting operational constraints, evaluating performance, providing useful information for making management decisions, and training, etc.. Shahid, et, al. (1994) and Shafiq & Latif (1990) have reported interesting and useful applications of simulation techniques for system operation, optimizing the use of limited maintenance budget and formulating good rotational programs, etc..

The mini-and micro-computers with increased power of data storage / processing offer tremendous opportunities to achieve significant improvements in the effectiveness of Irrigation

Management Information System. In the Irrigation and Power Department, Punjab, a number of micro-computers are being used for word processing, data base management, along with the use of spreadsheets for analysis and design purposes at Secretariat level, and in some of the Zonal Offices. However, at present the operation staff has very limited access to these modern tools and utilization of even the available computers in irrigation management and advance applications is minimal. The information processing is in the form of a simple batch system, all input data are processed at one point in time to produce the desired output. The input data are collected and used to update the files periodically, but access to the real time data and linkages among various field units is totally missing.

There are a number of software developed by the Consultants and research organizations like IIMI, that are working on the development of IMIS to improve the Irrigation Management System. Analytical and Simulation Tools, which have been used in Pakistan, are Equilibrium Software (EQ), CFLOW (Water / sediment balance model) and SIC (Simulating Irrigation Channels). WAPDA is also using various versions of the "Indus Basin Model" for irrigation and drainage sector studies. The model can be used to address critical issues of efficiency in water allocations and permits rapid evaluation of alternative interventions, such as improving water use efficiency. The Consultants for the Flood Protection Sector Project (M/S NESPAK) are also developing a comprehensive hydro-meteorological model for prediction of flood peaks at rim stations and for flood forecasting at downstream barrages. In addition, a variety of software tools are available for an effective GIS involving spatial and attribute database, map digitization, database management, image processing and decision support systems. Remotely sensed data is useful to a broad range of disciplines. This offers tremendous opportunities for optimizing resource allocation and improving irrigation management (Haq and Hasnain, 1998).

5.3.6 Improving Communication Systems

A reliable and efficient communication system is the key to the success of an irrigation management information system. The information on monitoring and evaluation of the system is to be communicated to the managers/decision-makers well in time to enable them to take operational control decisions for urgent action. The existing communication system in the Punjab Province is grossly inadequate and needs massive improvements for supporting implementation of an effective IMIS.

In order to implement an effective and efficient Irrigation Management Information System, improvement and modernization of the existing communication network is of vital importance. The necessary improvement measures can be prioritized to match the available finances. The improvement options may include expanding public telephone circuits to important subordinate offices / locations, providing a fax transmission facility up to the XEN level, developing exclusive microwave links or renting microwave channels from railways, repairs to the existing telegraph system and its operation through the private sector, extending HF radios to cover the remote area, and use of local communication systems for canal divisions / circles.

5.4 Organizational Improvements

The most significant measures for organizational improvements comprise managing external influences, reorganization of irrigation agencies, effective performance monitoring, stability of tenure, restructuring audit system, exclusive legal staff, and improved communication. The salient features of the proposed measures are described hereunder.

5.4.1 Managing External Influences

That irrigation institutions are only part of the total institutional framework of any society is recognized. The proposals for organizational improvements of the irrigation agency have to be considered in the broader perspective of the socio-economic and political conditions, as well as the prevailing law and order situation. The management objectives, therefore, need to be carefully defined, such that these are attainable in the prevailing external environment. A detailed review needs to be carried out to assess the extent, causes, and effects of `external influences'. The external influences can be visualized as `uncontrolled authority without responsibility'. Efforts should be made to control these pressures in a realistic manner. Where unavoidable, the possibility of managing them may be considered in order to prevent the system from its ill-effects. One proposal in this regard is to tag responsibility with the (unavoidable) authority of `external pressures' through appropriate amendments in the rules and procedures.

5.4.2 Reorganization of Irrigation Agency

Re-organization of the irrigation agency based on proper management study of the work load analysis needs to be undertaken. This should include effective organizational structure, clear lines of command, and appropriate decentralization for matching responsibility with authority. In this way, the staff utilization can be optimized and the agency oriented towards meeting the present-day requirements in an effective and efficient manner.

5.4.3 Institutionalizing the Planning Process

Clear procedures for planning of all the functions (operation, maintenance, budgeting, training and administration, etc.) need to be established and implemented in order to improve the system performance. Application of advance management techniques, like strategic / operational planning and use of modern computer software, have considerable potential in this field.

5.4.4 Accountability through an Independent Inspection System

The concept of accountability is essential for reposing confidence in the system of development and O&M spending. The experience of an independent inspection system, implemented on foreign- aided projects and recently on O&M / flood restoration works through supervisory consultants, has proved to be quite useful in improving the quality of construction. The proposition is that application of this system should also be continued for development and

maintenance works. A word of caution here is that for the system to be effective and efficient, the selection of consultants has to be carefully made in the light of their past performance and experience.

5.4.5 Stability of Tenure

Stability of tenure is very crucial for effective and efficient irrigation management. Therefore, it is proposed that this aspect may be given due importance by the policy makers and the respective competent authorities. A comprehensive policy needs to be evolved and followed for postings and transfers. In this regard, it may be desirable to institutionalize a system for staff consultations, career planning, and job fitness, etc.. The transfers should generally be banned during the tenure, except when on grounds of inefficiency/indiscipline.

5.4.6 Updating Manuals

Updating the manuals and compilation of rules and procedures into a single Code is essential for improving irrigation agency performance, as well as management control at different levels. The manuals requiring revision include the Manual of Irrigation Practice, Irrigation Manual of Orders, PWD Code, Revenue Manual and Accounts Code. In addition, a general O&M Manual and specific O&M Manuals for various irrigation components / systems also requires to be developed for guidance to the staff.

5.4.7 Reforming the Audit System

The present Audit system needs to be reviewed in order to make it more performance-oriented. A proposal is that the accounting responsibilities may be transferred to the Audit and Accounts Department at the canal division level (Pre-Audit System, or equivalent). This would relieve the mid-level managers from stressful and time-consuming accounting work and subsequent defence of audit paras.

5.4.8 Exclusive Legal Staff

Exclusive staff needs to be posted for handling the legal/court cases. This would save a lot of time for Executive Engineers and Sub-divisional Officers. Thus they would be in a better position to concentrate on critical irrigation management activities.

5.4.9 Appropriate Personnel Policies

Appropriate and responsive personnel policies, including career planning opportunities and training, are needed for good management. Good performance should be rewarded, and staff with poor performance face its consequences. The duties and responsibilities, as well as performance indicators at all staff levels, need to be clearly defined. A system of performance monitoring also needs to be put in place.

5.4.10 Improved Communication

Communication within the agency, as well as with other organizations/departments and the farmers, need to be institutionalized and improved. This would greatly help in effective coordination/liaison and in providing better irrigation services. Information-sharing and awareness-raising of various stakeholders can facilitate improved management, provided the irrigation agency can demonstrate its commitment to purpose and transparency of transactions and resource utilization.

5.5 Financial Measures

The major financial interventions need to focus on adequate funding for maintenance works, reducing deficits and optimizing budget utilization, alternative arrangements for financing the O&M expenditures of drainage and flood works, improving the existing system of water rates assessment / collection, and identifying new avenues for enhancing the revenue generation. A well-conceived package of the above financial measures can effectively address the financial issues that confront the irrigation agency, and can also prove to be quite instrumental in making the system self-sustainable by progressively bridging the budget deficit.

5.5.1 Adequate Maintenance Funding

Adequate O&M funding is an essential pre-requisite for the proper upkeep of the irrigation infrastructure to allow it to operate in an efficient manner. The suggested measures in this regard include:

- developing/reviewing the proposed engineering standards and maintenance yardsticks to establish realistic annual budgets;
- institutionalizing a system of automatic revision of yardsticks in response to inflation;
- establishing performance indicators for budget monitoring against annually planned maintenance;
- decentralizing budget allocation and spending authority up to the division level; and
- Evolving participatory approaches for fund raising/maintenance through self-help basis at the local level.

5.5.2 Reducing Deficits and Optimizing Utilization

The main recommendations in this regard include the following:

- reducing the establishment costs based on the organizational study and proper work load analysis;
- Phased shifting of drainage/flood protection responsibilities to the beneficiaries;
- enhancing the effectiveness of resource utilization by putting in place a system of maintenance planning / prioritization, improved supervision, independent third party inspections, and close monitoring of implementation of works;
- improving the contracting practices, work scheduling / implementation, and quality control measures by the contractors; and
- staff training and performance monitoring of the agency staff.

5.5.3 Financing Drainage Facilities

The drainage facilities benefit agriculture by providing a favourable environment for crop growth. Due to timely drainage, it may be possible to cultivate maximum area, as a part of it may not be possible otherwise. The assessment of water rates on such an area will off-set a portion of the expenditure on the drainage. Conceptually, it is difficult to isolate the O&M costs of drainage systems. Drainage comprises two components; surface and sub-surface drainage. There are about 4800 miles of drainage channels, while SCARP tubewells provide sub-surface drainage relief. Whereas, it is possible to identify the beneficiaries of surface drainage facilities, the beneficiary of sub-surface drainage systems is the nation at large and the systems also provide protection to infrastructure like roads, railways, etc.. The Government of Punjab is currently charging double water charges in those SCARP areas that are located in FGW zones. The extra single water rate, virtually, is the drainage cess being charged by the Government of the Punjab. No cess has, however, been imposed for surface drainage.

The main considerations in respect of financing of drainage facilities are:

a) identification of various beneficiaries;
b) extent of use by each beneficiary group;
c) whether beneficiaries that can be specifically identified should be charged separately for drainage, either as a direct service charge, or as a drainage cess tagged on to the *abiana* charge; and
d) whether the cost of maintaining drainage systems should be recovered from all farms, including those that have not been specifically provided with such a facility.

Surface Drainage. The surface drains, while working as seepage drains, have a limited area of influence, and is only effective in about a kilometer-wide strip on either side. But the main advantage is when these work as storm water drains. During the rainy season these provide the only mode of quick and effective evacuation of storm water from the catchment areas, which are inundated to dangerous levels. The natural drainage lines are mostly obstructed due to the construction of industries, townships, roads, etc., in violation of government orders issued from time to time. The drainage activity is carried out by both, Provincial and Federal agencies, but in all cases the projects, after completion, are handed over to the PIDs for operation and maintenance.

A study by the Consultants (ACE et al, 1994) reviewed/analyzed the above issues by conducting case studies and concluded that :

- the main beneficiaries that can be exclusively identified include the farmers and industrial / municipal users;
- a drainage charge be levied on the direct beneficiaries, such as industrial units and municipal users, for disposal of effluent commensurate with the quantity of fluid input, so as to recover about Rs 11,000 per cusec of effluent annually (1993 price level);
- In order to recover the O&M expenditure on the surface drainage from irrigators, it would be appropriate to merge it with the O&M of canals and recover the same as part of the water rate. Such an increase would be to the order of Rs 5 to 6 per acre at the present O&M level; and
- no cess may be imposed on village *abadies,* as the majority of residents of these villages own agricultural land and are already paying water charges.

The above proposal offers a good starting point for financing the O&M costs of the surface drainage network. The proposals can be further reviewed and modified in the light of the current O&M expenditures and implementation experience of the proposed arrangements.

Sub Surface Drainage. The government is currently implementing a program of dis-investment of public tubewells in FGW areas. The farmers are being motivated, through a set of incentives, to install private / community tubewells to replace the SCARP tubewells. The provincial government will, therefore, be progressively relieved of most of the O&M expenses relating to vertical drainage in FGW areas. As such, the levy of drainage cess in this case may not be indicated for the time being. The situation may be reviewed subsequently, say after five years, to monitor the implementation progress of SCARP transitioning and to consider measures for financing the operating expenses of the facilities still operating in the public sector.

The saline/drainage tubewells will, however, continue to be maintained in the public sector even after transitioning fresh groundwater tubewells. As in the case of surface drainage, the sub-surface drainage benefits are also accruing to agriculture, communication infrastructure,

habitation centers, and industries, etc.. The problem of waterlogging and salinity is a sequel to the advent of the canal system and not a creation of irrigators. The imposition of drainage cess on farmers, therefore, may not have adequate justification. In view of the difficulty to identify the beneficiaries of the sub-surface drainage and the fact that both, the farming and the non-farming communities derive benefits from drainage, it is suggested that these expenditures should be financed from the general tax receipts of the province.

5.5.4 Financing Flood Works

The flood protection works can be categorized in the following three broad groups :

a) . embankments and spurs serving as river training works and protection of canal system

b) multipurpose bunds protecting the canal system as well as other areas

c) bunds constructed specifically for protection of towns, cities, "abadies" or other infrastructure

The following pattern for financing the O&M Cost of the existing facilities is proposed :

- category (a) works are integral part of the Irrigation System. As such, their maintenance cost is and should be met as part of the O&M of irrigation system.

- the O&M of category (b) embankments may be shared equally by PID and other beneficiaries. The 50% share of other beneficiaries in case of public sector infrastructure is proposed to be met out of the general provincial receipts and in the case of private sector beneficiaries from their own resources, the exact contribution depending on case to case basis.

- category (c) "bunds" the agencies sponsoring their construction and the beneficiaries of the facilities should bear the O&M cost.

For new flood protection infrastructure; an objective, rational and coherent selection / financing criteria may be developed. The conceptual prioritized framework given below has already been agreed in principle by the government.

i) Protection of Irrigation Infrastructure
ii) Protection of Cities / Population Centers / Lands where :
   - Economic Criteria is met
   - O&M Cost is Financed by the Communities
iii) Schemes on Social Criteria provided Communities undertake responsibility for their maintenance

5.5.5 Improving the Revenue Assessment / Collection System

In this context, the main issues include under-assessment of cropped area, un-authorized modifications in the demand statement un-due remissions and shortfall in collections etc. The following measures are suggested for improving the assessment / collection system :

- strict observance of codal provisions and departmental instructions by the revenue establishment
- comprehensive checking of abiana assessment work and close / constant watch by the higher echelons [Zilladars, Deputy Collectors, Sub Divisional Canal Officers (SDCOs) and Divisional Canal Officers (DCOs)]
- particular emphasis on booking of the cropped areas under Zaid Rabi and Zaid Kharif
- rigid check / control in remission claims
- implementation of effective monitoring systems (e.g. outlet efficiency diagrams) to identify areas with potential under-booking
- conducting well-designed special checks by various tiers of senior officers
- effective check on changing the crop category
- greater emphasis on correctness of Khatuni entries / figures (demand statement).
- improving the abiana collections by Board of Revenue, explore new options / systems for improving collections
- close monitoring of canal system / division / village-wise collections and constant follow-up in problem areas. Revenue collection monitoring system should be reviewed in Irrigation Agency/Civil Administration.
- effective involvement of farmers in abiana assessment / collections
- Comprehensive study to review/evaluate various options for charging water rates.

5.5.6 Potential Sources to Enhance Generating Revenue

The potential sources to enhance the revenues of irrigation agencies may include the following:

- rationalization of assessment mode and water rates;
- toll tax on canal bridges / barrages;
- higher penalties for water theft / misuse;

- lease of canal lands / buildings;
- permit fee for use of canal roads;
- control of misuse of water for reclamation and appropriate pricing mechanisms for reclamation supplies;
- rationalized tariff for bulk supply of irrigation water for industrial and municipal use;
- fishing rights at barrages, headworks and canals; and
- development of barrages / headworks / rest houses as recreational spots on a commercial basis.

The Consultants (ACE et al, 1994) had estimated a revenue generation potential of over Rs 200 million (at the 1993 price level) from the above additional sources. These additional revenue sources need to be carefully reviewed / evaluated in order to enhance the revenue generation capacity of the Punjab Irrigation Agency.

5.6 Institutional Reforms

5.6.1 The Perspective

The need for improving irrigation management has been figuring high in the agenda of most national and international agencies in the recent past. This was triggered by the declining irrigation performance despite sizeable investments in the rehabilitation of irrigation infrastructure. The international financing agencies, therefore, changed their strategy by arguing that institutional issues constrain the overall irrigation management in Pakistan. That the worsening situation can only be addressed by implementing broad-based institutional reforms in the irrigation agencies is being maintained. Initiated by a World Bank proposal in 1993 to privatize and commercialize the water service, the reforms agenda has been the topic of an open, comprehensive and discrete public discussion. This public discussion and dialogue, benefiting from the views of all the major stakeholders (farmers, political leadership, policy-makers, and irrigation / agriculture agencies), had been very worthwhile in a clearer definition of irrigation issues and in identification of alternative strategies for designing the conceptual framework of institutional reforms. Despite micro-level divergence on the extent and contours of the reforms, the pubic debate appeared to indicate general consensus on gradual and phased implementation of irrigation reforms through participatory management, without changing the current water allocation framework. This model was considered to be more responsive and implementable in the context of the local environment, as it provided for farmers participation and obviated the risk of system disruption.

After extensive and thorough debate on the pattern, extent and feasibility of the institutional reforms in the irrigation sector, the following set of institutional changes was agreed upon in a high level meeting that was chaired by the President of Pakistan, and attended by the Prime Minister and the four Provincial Chief Ministers during August 1995:

- The existing Provincial Irrigation Departments (PIDs) would be converted into autonomous authorities to be known as Provincial Irrigation and Drainage Authorities (PIDAs). Ordinances to this effect were promulgated by the Provincial Governments in January 1997, which were subsequently legislated with some amendments as Acts by the Provincial Assemblies during mid-1997.

- One of the existing circles of each PID would be transitioned to financially self-accounting Area Water Board (AWB) on a pilot basis. Further transitioning of AWBs would be planned in view of the performance of the pilot AWB. Developing AWBs on the canal command basis is expected to allow integrated management and flexibility, as well as decentralization and a basis for comparison of cost of delivery services.

- Formation of farmer-controlled FOs would be promoted on a pilot basis. These formations would play an increasing role in the operation and maintenance of distributaries and minors. Based upon results of such pilot projects, a workable model would be evolved for adoption on the countrywide basis.

5.6.2 Salient Features of Institutional Reforms

The Punjab Irrigation and Drainage Authority (PIDA) Bill 1997 was passed by the Provincial Assembly of the Punjab on June 27, 1997, and assented to by the Governor of the Punjab on June 29, 1997. The main objectives of the establishment of PIDA, as set out in the Preamble of the Act, are reproduced hereunder:

> *"Whereas, it is expedient to establish the Punjab Irrigation and Drainage Authority to implement the strategy of the Government of Punjab for streamlining the Irrigation and Drainage System; to replace the existing administrative set up and procedures with more responsive, efficient and transparent arrangements; to achieve economical and effective operation and maintenance of the irrigation, drainage and flood control system in the Province; to make the irrigation and drainage network sustainable on a long-term basis and introduce participation of beneficiaries in the operation and management thereof"*

The main provisions of the PIDA Act are presented below :

iv) The Authority shall be a body corporate (Section 2(2)).

v) The Minister for Irrigation and Power shall be the Chairman of the Authority. The

Authority members will be notified by the Government, such that not less than six members shall be farmers and the number of non-farmer members shall not exceed the farmer members (Section 3).

vi) Subject to the control and guidance of the Authority, the management of the affairs of the Authority shall be carried out by the Board of Management appointed by the Authority with the prior approval of the Government. The Board would comprise a Managing Director (MD) and three General Managers (GMs). The MD and GMs shall have technical backgrounds and practical experience in the profession relevant to their job description (Section 4).

vii) The Authority shall carry out all functions of the Irrigation Wing of the Punjab Irrigation Department. The powers and duties of the PIDA have been set out in Section 5 of the Act.

viii) All employees of the Irrigation Wing of Irrigation and Power Department, except such employees as may be specified by the Government in this behalf, shall become the employees of the PIDA (Section 11).

ix) An Authority Fund shall be established for financing the activities of the PIDA (Section 12).

x) The Government may establish Area Water Boards (AWBs) and Farmers Organizations (FOs) and assign to them such functions as it may deem fit. The Authority shall, within one year of its establishment, devise and implement pilot programs and policies to form an AWB and FOs on a pilot basis in accordance with the relevant Bye-Laws and Regulations framed by the Authority (Section 14).

xi) The Rules shall be framed by the Government (Section 16).

xii) The Regulations shall be made by the Authority (Section 17).

5.6.3 Major Functions of the PIDA

The major functions of the Authority would include the following:

- to perform all duties and functions of the Irrigation Wing of the I&P Department;
- to plan, design, construct, operate and maintain the irrigation, drainage and flood control infrastructure located within its territorial jurisdiction;
- to improve effective and efficient utilization of irrigation water and its disposal;
- to introduce the concept of participatory management through the pilot AWB and FOs.

Also, to adopt and implement policies aimed at promoting formation, growth and development of FOs and monitoring of its performance;

- measures for reducing O&M expenditure and improving maintenance planning;
- measures to improve assessment and collection of water rates and drainage cess; and
- to make the Authority financially self-sustaining with regard to the O&M cost of canal irrigation and drainage within a period of 7 to 10 years.

5.6.4 Composition of Authority and AWBs

The composition of the notified Authority and the proposed Area Water Boards in the Punjab Province is given in Table 5.1.

Table 5.1 Composition of Authority and AWBs in the Punjab Province.

Description	Designation	No.	Status
A. Authority			
Minister, I&P	Chairman	1	Ex-officio
Chairman P&D	Member	1	-do-
Secretary Finance	Member	1	-do-
Secretary I&P	Member	1	-do-
Managing Director, PIDA	Member	1	-do-
Farmers Representatives	Members	6	Farmers
B. AWB			
Farmer Representative	Chairman*	1	Farmer
Representative of Authority	Member	1	Ex-officio
Technocrats in Water Management and Finance	Members	2	-do-
MD of AWB	Member	1	-do-
Government Representative	Member	1	-do-
Representatives of FOs	Members	8**	Farmers

Note: * Chairman to be elected from amongst the members of the FOs
** Three members from tail portions of distributaries and minors

5.6.5 Current Implementation Status

After promulgation of the PIDA Act, the following actions have been undertaken for implementation of institutional reforms:

i) notification for establishment of the Authority;

ii) notification for constitution of the Authority and nomination of the ex-officio and farmers' members;

iii) notification for the appointment of the Secretary of Irrigation as Managing Director, PIDA, during the initial interim period;

iv) notification for continuity of all the existing rules, regulations, procedures, and financial/legal arrangements until such time that the PIDA becomes operative and makes its own rules, regulations and financial / legal instruments;

v) the Authority has held two meetings, wherein initial actions for a reform agenda, hiring of core staff, and identification of one canal circle as a pilot AWB were discussed;

vi) the engagement of a chartered accountant and a legal expert for the PIDA is under process;

vii) the hiring of institutional reformers consultants and external auditors for PIDA is under process;

viii) the General manager (Transition Management has been appointed;

ix) LCC (East) Circle has been notified as pilot AWB.

The implementation of institutional reforms and transitioning of the PID into the PIDA would involve a long and complex evolutionary process that would require a number of studies and a lot of input by the professionals and experts. For this purpose, EOIs have been invited for the institutional reforms and financial systems consultants. These consultants would be financed through the institutional reforms component of the National Drainage Program (NDP-I) and would formulate proposals for transforming the PIDA into a functional entity. Extracts from the draft terms of reference for the institutional reforms consultancy are given in Annex 5. The major areas / issues requiring attention/resolution include:

- the organizational structure of the PIDA and a pilot AWB;
- the rules, regulations and bye-laws of the PIDA, a pilot AWB and FOs;

- establishment of Authority Fund and financial procedures of the PIDA, an AWB and FOs;
- business and financial plans;
- the transition arrangements;
- change management; and
- the monitoring arrangements for evaluating the performance of the pilot AWB and FOs.

As mentioned above, the implementation of institutional reforms will be phased over a long time period and would, therefore, call for commitment by all the key players, close monitoring of implementation progress and course correction by drawing on the learning experience. That the process involves the creation of new institutions in the rural areas of Punjab needs to be appreciated along with the issues of sustainability and replicability that appear to pose quite a few challenges, which will have to be addressed in a professional, dispassionate and efficient manner.

5.7 Participatory Irrigation Management

5.7.1 General

Participatory Irrigation Management (PIM) refers to the association of farmers in the operation and management of irrigation systems. The intensity of participatory management may range from minimal user involvement to the transfer of nearly all management functions. The main objective of PIM is to improve irrigation management by providing a better irrigation service to the farmers, ensure physical sustainability of the irrigation infrastructure, and to promote a sense of partnership between the farmers and Government Agencies. There are various aspects of PIM that include planning, design, construction, operation and maintenance, financing, and policy matters. Similarly, PIM can be implemented at various levels according to the environment, technical complexities of the irrigation system and needs of the society at large. These levels include quaternary, tertiary, secondary / main, and project / sector, where PIM may be practiced. The examples of project level participatory management can be found in the United States, France and Japan, where irrigation users have largely replaced the state management. At the lower end of the spectrum, the state continues to dominate most aspects of irrigation down to tertiary or even quaternary levels, as in the case of Morocco, India, and Pakistan, etc. (World Bank, 1997).

The farmers' participation in irrigation management can have a profound impact on irrigation management. The main reported advantages of PIM include: management efficiency, transparency, accountability, cost saving, higher fee collection rates, and a sense of ownership. On the other hand, the concerns about PIM include the difficulty of organizing farmers,

particularly in the larger systems, lack of technical / professional expertise with farmers, risk of manipulation by influential farmers, and the issues related to development of new institutions and their sustainability.

In order to successfully implement participatory management, there has to be a conducive environment and enabling framework in position. The process of formulating a strategy that fits specific features of the country needs to be evolved in the context of the local environment. Towards this end, there are some common pre-requisites that include creating an enabling environment; the legal framework; and a gradual evolutionary process.

5.7.2 Creating an Enabling Environment

For participation to work, the government, being the major stakeholder in most national irrigation sectors, must be willing and interested. At least three sections of the government must be willing to support PIM; political leadership, administrative leadership and irrigation agency leadership. The second important stakeholder that must also be brought into the discussions of PIM policies at the earliest stage should be the farmers themselves. Farmers are most profoundly impacted by the changes in irrigation management. The representation of the farmer community overlaps with governmental stakeholders in the form of political leaders who represent farming constituencies. These political forces who can speak on behalf of both, the government and farmers, can be particularly important in both designing and promoting PIM reforms.

A danger in designing and implementing PIM programs is the lack of attention to farmers' interest and support. Improvement in services and potential for income enhancement are better motivators for user organizations. Farmers' incentives cannot be assumed, but rather, must be assessed through field interviews and discussions with a representative sample of the community concerned. Farmers' involvement in designing a management model for PIM that builds on sustainable incentives is a critical, and often neglected, step in the overall PIM implementation process.

Public discussion of problems faced by water users in the existing set-up, where the water supply is unreliable or inequitable, could be useful to stimulate interest among the agencies. There are many ways of stimulating such interest. The media can help in reporting the outcome of these events and highlight key issues in the debate. For instance, addressing tail shortages, cost recovery and financial sustainability are bound to be popular topics for discussions with water users (World Bank, 1997).

5.7.3 The Legal Framework for PIM

The legal framework for the establishment of FOs, and for enabling them to operate and maintain parts of the irrigation system, consists basically of three sets of legal instruments, namely, the enabling law, the bylaws of the FOs, and the transfer agreement between the irrigation agency and the FOs.

For PIM to be established as a legal entity, there has to be a law authorizing its establishment. This law could be a comprehensive one that deals with all aspects related to water, including the establishment of an authority like the PIDA Act in Pakistan. The enabling law could also be special rules and regulations dealing specifically with the authority and deriving their functions from a basic law.

The law establishing the authority would usually include provisions indicating that the authority to be established is a legal entity. Such an enabling law would also address the relationship between the authority and the irrigation agency, and between the Authority and local entities / FOs; the duties and obligations of the irrigation agency, and those of the authority/FOs; the structure of water rates, and other fees. The enabling law may also lay down some of the main issues to be addressed in the transfer agreement.

Whether established under a separate law or under an umbrella enabling law, the Authority would normally be required to prepare and agree on its bylaws before it can be registered as a legal entity. The issues that such bylaws need to address include objectives of a WUA, membership criteria, and internal management, operation and maintenance, assessment and collection of water charges, rights and obligations of the members, procedures for amending the bylaws, and the establishment of FOs, etc..

The transfer agreement is the agreement between the FOs and the irrigation agency in which the irrigation agency agrees to transfer some of the responsibilities for operation and maintenance of certain parts of the irrigation system, including the collection and remitting of water charges; and the FOs agrees to carry out such responsibilities. The issues that such a transfer agreement would need to address include the area and irrigation system to be transferred, interim joint management, responsibilities of FOs and the period/termination of the transfer agreement, etc. (World Bank, 1997).

5.7.4 Gradual Evolutionary Process

The design of an implementation strategy involves planning for the start-up, pilot areas and expansion phases of a PIM Program. This is a very crucial stage and needs to be planned thoughtfully in view of the prospects and constraints prevailing in the particular system.

Start-Up. To begin with, management responsibility for PIM may be assigned at the strategic level. A steering committee could be formed comprising key officials of the concerned departments / agencies, farmers' representatives and political leaders. This group should approve the PIM program (its goals, strategies, specific work program, and budget) on an annual basis. At the operations level, responsibility for PIM could be assigned to a senior manager of the irrigation agency. This senior manager would need a group of interested staff from various levels to help him implement the program. The revenue staff of the irrigation agency and staff of the OFWM directorate can play an important role in this behalf, as they have close interface with the rural population and also have quite an intimate knowledge of the local conditions.

Piloting. PIM is usually not a new concept as participatory management is already practiced at various levels. For example, water management downstream of the outlet is administered in a participatory mode in Pakistan. Nevertheless, what is usually new is the effort to implement PIM in all stages of the project cycle and system management; from planning and design to construction, and from O&M to the collection of water charges.

The objectives of piloting are to learn from experiences on a small scale in order that a manageable irrigation system, or sub-system, can be the focus of implementation, monitoring and learning. The implication is that the pilot projects should cover a range of conditions and be carefully monitored so that the necessary changes can be introduced in the PIM model. The selection of pilots also requires careful consideration. The criteria for pilots should include the selection of a representative area; replicability of the effort, both in terms of physical interventions as well as back-up support; and the sustainability of the PIM model. That subjective results of heavily-financed and closely-supported pilots are used to build up success stories is not uncommon. In this context, Vermillion (1997) has observed that the reported positive impacts of management transfer programs may be partly a result of unrepresentative sites, or the possibility that many authors are promoters of the reforms. Therefore, it is imperative that the pilots should be truly representative and replicable, and should also be backed up with independent evaluation of their performance over a sufficiently long time period (Haq 1995).

Expansion. At the end of the pilot phase, policy makers and managers would have derived lessons regarding the scope for user participation in the water distribution, operation and maintenance fundings, water charges, and sustainability of the system. They would also be wiser about current government policies and procedures that help, or hinder, effective participation. The period before the large-scale expansion phase presents an opportunity to bring about changes in existing laws, policies, financing arrangements and procedures, as the need may be. Without this intervention, an expanded program could run into severe problems. What was possible in a controlled, small-scale setting during the pilot phase, may not be forthcoming during the expanded large scale phase. The expansion of PIM, therefore, needs to be evolved carefully, while closely monitoring the progress and impacts of participatory management.

5.7.5 The PIM Model for Pakistan

The concept of PIM has evolved over time and all the major stakeholders consider the participatory approach to have a considerable potential for improving irrigation management in Pakistan. There are various PIM models that have been implemented in different countries. This global experience is useful in indicating the available options. Vermillion (1997), however, cautions to apply more systematic research methods with enough commonality to permit conclusions about impacts, and specify conditions under which participatory approaches could be expected to succeed, or not. The model for Pakistan, therefore, needs to be evolved in the context of the local setting, complexities and constraints of the irrigation system, and monitoring results of similar past interventions and pilots under progress.

The Participatory Irrigation Management can be best achieved by following a gradual and phased approach, both with reference to the level of management and the management functions. This model for PIM appears to be more realistic and implementable in the context of Pakistan's social set-up and constraints of the irrigation system. Starting with encouraging the formation of FOs to learn by operating through a joint management mode, they can progressively organize / orientate and train themselves to take up higher level management functions. This model for PIM implementation has been recommended with minor differences by a number of writers [Haq (1995); Gill and Zahid (1996); Usman Akram (1996), Shafqat and Ashraf (1996)]. The proposed PIM model is presented in Table 5.2.

Table 5.2 The Phased PIM Model for Pakistan.

Phase*	Description	The Proposed Roles of WUAs/WUFs	Duration**
Phase-I	The Organizing Phase	• Establishing WUAs/WUFs • Training Agency Staff / WUFs • System management by agency staff • Farmers in consultation / oversee role	One Year
Phase-II	The Setting in Phase	• Farmers to manage internal distribution of water and conflict resolution • Training of WUAs/WUFs • Collection of water charges by WUAs/WUFs • Increased role of farmers in Operation and Maintenance Plans	One Year
Phase-III	Joint Management Phase	• Joint Assessment of water charges • Joint O&M of Distys / Minors • Groundwater management • Secondary drains O&M	Two Years
Phase-IV	Farmers Management at Disty / Minor Level	• Independent Management of O&M of distys / minors • Assessment and Collection of Water Charges • Groundwater Management and Development • Rehabilitation and Modernization • Environmental Sustainability	-

Note: * Some of the authors propose to combine Phases I and II.
** The duration is indicative. Moving to the next phase would depend on the monitoring results of the previous phase.

Currently, PIM pilots are being implemented along the Bhukan Distributary and Bahaderwah

Minor by the OFWM Directorate under the Fordwah Eastern Sadiqia (South) Project. The International Irrigation Management Institute (IIMI) is also conducting PIM pilots at the Hakra 4-R Distributary in the Bahawalnagar area. In the above pilots, Federations of Water Users Associations have been established for minors / distributary reaches containing groups of 10-20 outlets. This approach for the formation of WUFs is considered more workable for organizing farmers to take up minor / distributary level management through effective farmers participation [Gill and Zahid, (1996); Bandaragoda et al (1997)]. The pilot WUFs are presently negotiating with the Irrigation Agency to identify the irrigation management functions that can be undertaken by them. In the backdrop of the existing legal framework, the indications are that these pilot WUFs would initially operate through the joint Irrigation Management mode. As the legal framework for pilot Area Water Boards and Farmers Organizations is developed under the PIDA Act, and the FOs formulate their bylaws, they will be able to progressively undertake more management responsibilities independently.

The following activities and proposals are identified for more effective and expeditious implementation of participatory programs in Pakistan:

- keep the users intimately involved at all levels and give them ample / real opportunities to agree, or disagree, and to suggest amendments;

- try to build on the existing community structure gradually; ensure that the institutional changes are compatible with the local setting and implementable in the context of the socio-political environment and management capabilities of the farming community;

- develop a well-defined implementation mechanism, along with enabling legislation, appropriate bylaws and an effective regulatory framework;

- training the WUA/WUF and the Agency staff in order to enable them to appreciate their new roles and to efficiently perform the designated functions;

- setting up of appropriate financial controls and accountability mechanisms; this is particularly relevant in the backdrop of low literacy rates, lack of FOs experience and concerns of financial mismanagement related to local bodies and cooperatives in the past; and

- the pilot projects must be designed cautiously and the pilot design should ensure representatives, replicability and sustainability. An independent monitoring and evaluation mechanism needs to be set-up in order to learn from the implementation of pilot projects and to make necessary adjustments in the overall plans.

There are a number of challenges that confront the implementation of management reforms and participatory programs in Pakistan. These include management complexities of distributing water shortages and addressing the problem of inequitable water distribution in an extremely large and

contiguous network. The sharing of a scarce resource with conflicting interests of upstream and downstream users, coupled with socio-political divides in a feudal-led society, might present a unique and bewildering dimension for participatory management. These challenges have been identified here not for distraction or disappointment, but as a note of caution that should reinforce the need for realistic planning, constant political support, and whole-hearted commitment to reforming the irrigation management for the common good of the rural population and subsistence farmers. Needless, therefore, is to emphasize that the success of participatory approaches would greatly hinge on the overall vision, bold initiatives and ability to make adjustments in the PIM models in the light of field experiences without philosophical bias.

5.8 Reorganization of Water Sector Institutions

Sequel to the enactment of the PIDA Act for the implementation of irrigation management reforms, all the water sector activities have been placed under the umbrella of the Punjab Irrigation and Drainage Authority for integrated development planning and management. The activities include water acquisition, conveyance, distribution and farm level management. The charter of duties of the PIDA also include formulation and implementation of policies in the water sector with a view to continuously improve and achieve effective, economical and efficient utilization and preservation of water resources by the water users on a sustainable basis. In addition, the PIDA has been made responsible for formulation, adoption and implementation of policies aimed at formation, growth and development of Area Water Boards and Farmers Organizations, and monitoring the results thereof to ensure an orderly and systematic induction of these entities into the operations of the Authority.

In order to implement policies for integrated water management, there is a need to reorganize water sector institutions at various levels, particularly the water management at the farm level and the organization of WUAs / FOs. The issue is under consideration of the Provincial Government, and a series of meetings have already been held for evolving an appropriate framework. The following set of policy interventions are identified in this regard:

- Sequel to implementation of institutional reforms and promulgation of the PIDA Act, all matters relating to water management (water acquisition, conveyance, distribution and farm level management) would rest with the Punjab Irrigation and Drainage Authority (PIDA).

- For the interim period, until such time that the PIDA becomes fully functional, the agencies currently performing the On-Farm, as well as Off-Farm, activities, may continue to perform their functions on behalf of the PIDA. Suitable terms and conditions in this regard would be mutually agreed upon between the PIDA and the concerned agencies.

- At the Pilot Area Water Board (AWB) level, the On-Farm Water Management set up may merge with the PIDA for implementation of pilot programs.

- Once the rules and regulations are framed under the PIDA Act, all the Farmers Organization / Water Users Federations (FOs / WUFs) would be established under relevant provisions of the PIDA Act.

- Close coordination and interfacing of the PIDA / Irrigation Department / OFWM Directorate would be ensured during the interim transition period in all matters regarding the evolution of the PIDA rules and regulations, management study and organizational structure, etc.. Provision may be made in the relevant legislation / institutional setup for the final integration of all water-related functions by the PIDA.

5.9 Prioritization of Improvement Measures

In order to meet the growing requirements of the increasing population and to sustain agricultural development, the need for improving irrigation management is overwhelming. There is an urgent need to frame appropriate strategies and to take effective steps for its implementation. For remedial measures to be really effective and long-lasting, a package approach needs to be pursued, integrating both, the structural as well as management interventions. The structural measures are considered essential for addressing the root cause of the problem, i.e., system and supply constraints in meeting the increased water demand.

Implementation of the structural measures, though necessary for any medium to long-term strategy for improved irrigation management, may not be possible for immediate completion due to time and financial constraints. The structural measures will, therefore, have to be prioritized and phased out. In view thereof, the management interventions assume added significance, particularly in the context of the immediate to short-term plans. A prioritized package of interventions recommended for implementation by various agencies/user groups, as part of an immediate to short-term plan for reforming irrigation management, is presented below:

Political Leadership and Federal/Provincial Governments

- Top leadership commitment towards the implementation and monitoring of institutional reforms and participatory irrigation management models.

- Urgent measures for restoring the rule of law in the society and managerial discipline in irrigation management.

- Adequate maintenance funding.

- Re-defining investment and surface water allocation policies for optimization of resource use.

- Prioritization of urgent structural measures and arrangements for its implementation.

Next >>

- Rationalize pricing / marketing systems for agricultural inputs and outputs.

- Evolving holistic strategies for reforms and providing a conducive environment for enhancing the productivity of the irrigated agriculture.

Punjab Irrigation Department/PIDA

- Expeditious planning and implementation of institutional reforms/participatory management programs.

- Develop a system of information sharing and awareness-raising of farmers at all levels.

- Clear definition of goals and objectives in view of the system and supply constraints. Clearly inform the Government and the Users about these constraints and attainable objectives.

- Planned programs for enhancing farmers participation in irrigation management at all levels.

- Implement programs for farmers training in matters relating to irrigation/financial management.

- Restoration of technical and managerial discipline.

- Implementation of priority structural interventions.

- Planned and more effective operation and maintenance of the irrigation facilities.

- Systematic monitoring and evaluation and setting up an effective MIS.

- Institutionalize a system of third-party inspections for enhancing the quality of works and for ensuring transparency in transactions.

- Better Co-ordination with Agriculture Department and other agencies for improving irrigation management.

- Review of system design in order to identify and address the constraints.

Agriculture Department

- Effective coordination with the PIDA in implementing institutional reforms and in formulating water allocation / canal operation plans.
- Improving the agriculture Extension and Research Components to enhance the productivity.
- Training and educating the farmers for managing water shortages in the existing system by optimizing water utilization.

Farmers

- Organize User groups / FOs for more effective participation in irrigation management.
- Plan to gradually take over the local level irrigation functions.
- Jointly check illegal water abstractions and provide feedback about the system management.
- Develop a system of information-sharing and awareness-raising at all levels.
- Implement programs for farmers training in matters relating to irrigation/financial management.
- Plan cropping patterns, sowing dates, use of fertilizers and other farming operations according to the expected availability of irrigation water, in consultation with the Agriculture Extension Services and Irrigation Agency staff.
- Improve irrigation application efficiencies by land levelling and better on-farm practices.
- Manage water shortages by allocating water to preferential crops and / or crops in the sensitive growth stage.

REFERENCES

Abernethy C.L. 1989. Performance Criteria for Irrigation Systems. Conference on Irrigation Theory and Practice. Southampton University, UK.

ACE et al. 1994. Reducing Government Liability, Effective Performance of Irrigation Departments and Use of Abiana for Increasing Farm Output. Final Report. Associated Consulting Engineers (Pvt.) Ltd. ZCL, PDC and Systems (Pvt.) Ltd. Lahore.

Akhtar M. 1989. Charging for Irrigation Water : Review of Present Practices and Methods. M.Sc. Dissertation. Institute of Irrigation Studies. University of Southampton, UK.

Amir M and A.A. Abidi. 1993. Priority Institutional Reforms in Irrigation Sector to Improve Productivity of Irrigated Agriculture. paper presented at the Seminar on Policy Issues for Enhancing Agricultural Productivity in Pakistan.

Bandaragoda D.J. and GR Firdousi. 1992. Institutional Factors Affecting Irrigation Performance in Pakistan : Research and Policy Priorities. IIMI Country Paper No. 4. International Irrigation Management Institute.

Bandaragoda D.J. 1993. The Role of Research-Supported Irrigation Policy in Sustainable Irrigated Agriculture: An Interpretive Precis of the Case of Pakistan. IIMI Country Paper - Pakistan-No. 6. International Irrigation Management Institute.

Bandaragoda, D.J. and S.U.Rehman. 1995. Warabandi in Pakistan's Canal irrigation System : Widening Gap between Theory and Practice. Country Paper No. 7. International Irrigation Management Institute.

Bandaragoda D.J., Mehmood U.H, Mirza Z.A, Cheema M.A and Waheed-uz-Zaman. 1997. Organizing Water Users for Distributary Management : Preliminary Results from a Pilot Study in Hakra 4-R Distributary of Eastern Sadiqia Canal System of Pakistan's Punjab Province. IIMI Report R-25. April 1997. IIMI, Lahore.

Bureau of Statistics. 1995. Punjab Development Statistics. Government of the Punjab.

Chambers R. 1988. Managing Canal Irrigation: Practical Analysis from South Asia. Cambridge University Press. U.K.

Dogar T.M. 1976. Public Works Accounts and Audit. Dogar Sons, Lahore.

FAO. 1982. Organization, Operation and Maintenance of Irrigation Schemes. Irrigation and Drainage Paper No.40 FAO, Rome.

FAO. 1991. Improved Irrigation System Performance for Sustainable Agriculture. Proceedings of the Regional Workshop held in Bangkok, 22 - 26 October, 1990.

Farooq K. 1987. Administrative History of the Punjab Irrigation Department. Diamond Jubilee Special Publication, Pakistan Engineering Congress, Lahore.

Farooq, K. 1996. Punjab Irrigation Department : That Was. Engineering News, 66th Convention Issue. Lahore.

Gill M. and A.S. Zahid. 1996. A Case Study on the Participatory Irrigation Management Component of Fordwah Eastern Sadiqia Project. Proceedings of the National Seminar on PIM. August 11 - 18, 1996. Lahore.

GOP. 1961. A Manual of Irrigation Practice. Second Edition. Public Works Department, Irrigation Branch. Government Printing Press, Lahore.

GOP. 1961. Public Works Department Code (PWD Code). Government Printing Press, Lahore.

GOP. 1962. Revenue Manual. Public Works Department Punjab, Irrigation Branch. Government Printing Press, Lahore.

GOP. 1969. Manual of Orders Issued by the Punjab Government for the guidance of Officers of Irrigation Branch. Government Printing Press, Lahore.

GOP. 1976. Accounts Code Vol. III. Edited and Updated by Hamid Ali. The Ideal Publishers, Lahore.

GOP. 1987. Budget Manual. Finance Department. Government Printing Press, Lahore.

GOP. 1990. Delegation of Financial Powers Rules. Government of Punjab, Finance Department. Government Printing Press, Lahore.

GOP. 1990. Rules of Business. SGA&ID Department. Government Printing Press, Lahore.

GOP. 1997. Punjab Irrigation and Drainage Authority Act. Government Printing Press, Lahore.

Hafizullah M, Mushtaq A and W Vehmeyer. 1996. Introduction of an Information System for Facilitating Canal Operations. Proc. of National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. Vol. II. IIMI Pakistan.

Haq A.U. 1995a. Improving Irrigation System Performance: Major Issues and Options. Pakistan Journal of Water Resources, June 1995. PCRWR, Islamabad.

Haq A.U. 1995. Current and Planned PIM Programs in Punjab. Proceedings of Participatory Irrigation Management Seminar. October 1-4,1995. Bhurban, Pakistan.

Haq A.U. 1997. Indus Basin Irrigation Management: Issues and Options. Paper Presented in the Government Engineering Academy. Lahore.

Haq A.U. Shahid B.A. and A.S. Shakir. 1997. Indus Basin Water Resources: Sustainability Concerns and Optimization Strategies. Proceedings of the International Symposium `Water for the 21st Century : Demand, Supply, Development and Socio-Environmental Issues. Centre of Excellence in Water Resources Engineering, Lahore.

Haq A.U. and B.A. Shahid. 1997. Public, Private or Participatory? Reforming Irrigation Management in Pakistan. ICID Journal Vol. 46/Number 1/April, 1997.

Haq A.U. and M. Hasnain Khan. 1998. Irrigation Management Information System : The Framework and Implementation Strategies for Pakistan. Proceedings of Pakistan Engineering Congress, Lahore.

Hassan M.U., Hamid A and DJ Bandaragoda. 1998. Transition From Local Level Management to State Regulation: Formalization of Water Allocation Rules in Pakistan. Report No. R-60. Pakistan National Program. International Irrigation Management Institute.

Jahania C.M.H. 1986. Canal and Drainage Act, 1873 (As amended in 1975). Jahania Law Publishers, Multan.

JICA. 1997. The Study on the Lining of Distributaries and Minors in Punjab in the Islamic Republic of Pakistan. Feasibility Report. Nippon Koei Co. Ltd. and Nippon Giken Inc.

Kinje J.W. and E.J. Vankder Velde. 1990. Salinity in Punjab Watercourse commands and Irrigation Systems Operation : The Imperative Case for Improving Irrigation Management in Pakistan. In Advancements in IIMI's Research 1989-91. Colombo: IIMI.

Kuper M and P Strosser. 1992. The Appropriateness of Canal Water Supplies : The Response of Farmers - A Case Study in the Fordwah Eastern Sadiqia Area, Punjab, Pakistan. IIMI Pakistan Division Discussion Paper No. 6. IIMI, Lahore.

Malhotra, S.P. 1982. The Warabandi and its infrastructure. Publication No. 157. Central Board of Irrigation and Power, India.

Mazhar Ali et al. 1981. Punjab Irrigation and Power Department: Objectives, Policies, Organization Review and Recommendations Report of the Committee of Irrigation Engineers and Professors of University of Engineering and Technology, Lahore.

Mellor et al. 1994. Institutional Reforms to Accelerate Irrigated Agriculture. Main Report Vol. I. John Mellor Associates Inc. Washington D.C. and Asianics Agro-Dev. International (Pvt) Ltd. Islamabad.

Mohtadullah K, Rehman C.A. and C.M. Munir. 1993. Water for the 21st Century. A Pakistan National Conservation Strategy Sector Paper No. 3. Environment and Urban Affairs Division, Government of Pakistan and IUCN.

Mohtadullah K. 1997. Water Resources Development and Utilization in Pakistan : Potentials and Challenges. Proceedings of the International Symposium on Water for the 21st Century : Demand, Supply, Development and Socio-Environmental issues. Centre of Excellence in Water Resources Engineering, Lahore.

Murray-Rust D.H. and W.B. Snellen. 1993. Irrigation System Performance Assessment and Diagnosis. IIMI, ILRI and IIHEE. International Irrigation Management Institute, Colombo, Sri Lanka.

Muzamil, H.Q. 1986. Irrigation Service Fees in Sindh Province. Paper presented in the Regional Seminar on Irrigation Service Fees. Manila, July 1986.

Nasir, S.A.D. 1993. The Canal and Drainage Laws in Pakistan. Mansoor Book House, Lahore.

Nazar C.M. 1986. Study on Irrigation Service Fees in the Punjab, Pakistan. Paper Presented in the Regional Seminar on Irrigation Service Fees Manila, July 1986.

Nazir A and GR Chaudhry. 1988. Irrigated Agriculture of Pakistan 61-B/2, Gulberg-III, Lahore.

NESPAK et al. 1995. National Drainage Program. Feasibility Study Report. National Engineering Services Pakistan (Pvt) Ltd. and Mott McDonald Int.

NESPAK et al. 1995. Second Irrigation and Drainage : Sukh Beas / Lower Bari Doab Canal Project. Feasibility Study Report. National Engineering Services Pakistan (Pvt) Ltd. Agrar-UND-Hydrotechnik GMBH Essen, Germany and National Development Consultants, Lahore.

Nur-ud-Din A and Nazir Ahmed. 1990. Water Management Strategies for Optimizing Productivity. Proc. Pakistan Engineering Congress, Lahore.

PERI. 1992. Evaluation of SCARP Transition Pilot Project. Project Evaluation Report. Punjab Economic Research Institute, Lahore.

Perry. C. 1996. Quantification and Measurement of a Minimum Set of Indicators of the Performance of Irrigation System. January 1996. IIMI Research Report. Colombo, Sri Lanka.

PID Punjab. 1994. Recommendations by Land Utilization and Irrigation Sub-Committee. Punjab Commission on Agriculture.

PRC/CHECCHI. 1986. Recommendations for Improved Operation and Maintenance of Rehabilitated Canal Systems. Report by Consultants for ISM Activities, USAID.
PWD. 1963. Hundred Years of PWD. West Pakistan Public Works Department and Pakistan Engineering Congress, Lahore.

RAP 1979. Revised Action Program for Irrigated Agriculture, Vol. I. Master Planning and Review Division, WAPDA, Lahore.

Robbins, S.P. 1991. Management. 3rd ed. Prentice Hall International Inc.

Rydzewski J.R. 1987. Irrigation Development Planning. John Wiley and Sons Ltd.

Shafi C.M. 1994. Irrigation Development in Punjab. Individual Paper, Government Engineering Academy, Lahore.

Shafi CM and Z. Habib. 1996. Scheduling of Water Delivery in the Irrigation System of Indus Basin, Pakistan. Proceedings of the Third International Network Meeting on Information Technology for Irrigation System. Malaysia, June 1996.

Shafique, M and M. Latif. 1990. A Model for Efficient Distribution of Irrigation Supplies Among Distributaries. Proceedings of Pakistan Engineering Congress, Lahore.

Shafqat M and C.M. Ashraf. 1996. Participatory Management in Irrigation System. Proc. of Seminar on Sustainable Development of Irrigation Schemes. March 20, 1996. Islamabad.

Shahid B.A., Kuper M and EJ Vander Velde. 1992. Improving Canal System Management : An Intervention to Calibrate Control Structures in Punjab, Pakistan. IIMI Pakistan.

Shahid B.A. et al. 1994. Improving Performance of Punjab Irrigation System. Syndicate Report. Government Engineering Academy, Lahore.

Singh, K.K. 1981. Warabandi for Irrigated Agriculture in India. Publication No. 146. Central Board of Irrigation and Power, India.

Small L and M. Svendson. 1992. A Framework for Assessing Irrigation Performance. Working Papers on Irrigation Performance. International Food Policy Research Institute, Washington D.C.

Tanton T.W. and R.F. Stoner. 1992. World Food Production : The Past, the Present and the Future. Proceedings of the Conference on Priorities for water Resources, Allocation and Management. Southampton U.K., July 1992. Overseas Development Administration.

UCL. 1985. Preliminary Management Study of Punjab Irrigation Department. Study Report under ISM Project. United Consultants Limited. Lahore.

Upton M. 1994. Spreading the Benefits of Irrigation. ICID Journal 1994. Vol. 43, No. 1.

Usman A. 1995. Irrigation Water Pricing Structure in Pakistan. Pakistan Journal of Water Resources Vol. 1, No. 1, June 1995. Pakistan Council of Research in Water Resources, Islamabad.

Usman Akram. 1996. Participatory Irrigation Management in Punjab. Proceedings of the National Seminar on PIM. August 11- 18, 1996. Lahore.

Vander Velde E.J. and R.L. Johnson. 1992. Tubewells in Pakistan Distributary Cancel Commands : Lager Distributary, Lower Chenab Canal System, Punjab. IIMI Paper No. 21, Colombo, Sri Lanka. IIMI.

Vander Velde E.J. and M. Svendsen. 1993. Goal and objectives of Irrigation in Pakistan : A Prelude to Assessing Irrigation Performance. Proceedings of IPR at Colombo, Sri Lanka, December 1993. International Irrigation Management Institute.

Vermillion D.L. 1997. Impacts of Irrigation Management Transfer: A Review of the Evidence. IIMI Research Report No. 11. IIMI, Colombo, Sri Lanka.

Wahah A.F. Shaikh. 1992. Tubewell (Vertical) Drainage. Proc. 5 ICID International Drainage Workshop, Lahore.

WAPDA. 1987. History of Irrigation in Indus Basin. Planning and Investigation Organization, Planning Division, WAPDA.

World Bank. 1988. Second Irrigation Systems Rehabilitation Project. SAR No. 6991-Pak.

World Bank. 1994. Irrigation and Drainage : Issue and Options. Report No. 11884 - Pak.

World Bank 1996. Pakistan - National Drainage Program Project. Staff Appraisal Report No. 15310-Pak.

World Bank. 1997. Participatory Irrigation Management. Handbook of Economic Development Institute. Washington D.C.

WSIPS. 1990. Water Sector Investment Planning Study. Federal Planning Cell. Lahore, GO Pakistan, UNDP, WAPDA & World Bank.

Zuberi, M.H. 1997. Environmental Control and Industrial Waste Disposal. Lecture Notes. Governing Engineering Academy, Lahore - Pakistan.

CHRONOLOGICAL SEQUENCE OF CANAL CONSTRUCTION IN PUNJAB

Canal	Diversion Site	River	Year	Discharge Capacity (000 Cfs)	CCA (M.Acres)
1. Central Bari Doab	Madhopur* UCC/BRBD	Ravi* / Chenab	1859	2.5	0.649
2. Sidhnai	Sidhnai	Ravi	1886	4.0	0.869
3. Lower Chenab	Khanki	Chenab	1892	11.7	3.03
4. Lower Jhelum	Rasul	Jhelum	1901	5.3	1.500
5. Upper Chenab	Marala	Chenab	1912	16.5	1.441
6. Lower Bari Doab	Balloki	Ravi	1913	9.0	1.670
7. Upper Jhelum	Mangla	Jhelum	1915	8.7	0.544
8. Eastern Sadiqia	Suleimanki	Sutlej	1926	5.8	0.969
9. Pakpattan	Suleimanki	Sutlej	1927	5.2	1.049
10. Fordwah	Suleimanki	Sutlej	1927	3.4	0.426
11. Qaimpur	Islam	Sutlej	1927	0.5	0.043
12. Bahawal	Mailsi/Bahawal	Sutlej/SMB Link	1927	4.4	0.605
13.Upper Depalpur	Ferozepur* UCC/BRBD	Sutlej* / Chenab	1928	2.4	0.360
14. Lower Depalpur	Ferozepur* / BS Link	Sutlej* / Ravi	1928	4.0	0.615
15. Mailsi	Islam/Sidhnai	Sutlej*/ Ravi	1928	4.9	0.615
16. Panjnad	Panjnad	Sutlej	1929	10.4	1.348
17. Abbasia	Panjnad	Sutlej	1929	1.3	0.154
18. Rangpur	Trimmu	Chenab	1939	2.7	0.344
19. Haveli	Trimmu	Chenab	1939	5.2	0.179
20. Thal	Kalabagh	Indus	1947	7.5	1.641
21. MR Link(Int)	Marala	Chenab	1956	1.4	0.158
22. DG Khan	Taunsa	Indus	1958	8.3	0.909
23. Muzaffargarh	Taunsa	Indus	1958	8.9	0.809

Note : * abandoned after partition.

INDUS BASIN REPLACEMENT WORKS
(INDUS WATERS TREATY CONSEQUENTIAL WORKS)

I. DAMS

Dam	River	Year of Completion	Height (Ft.)	Live Storage Capacity (MAF)
Mangla	Jhelum	1967	380	5.34
Tarbela	Indus	1975	485	9.40

II. BARRAGES

Barrage	River	Year of Completion	Length (Ft)	Capacity (000 Cfs)
Chashma	Indus	1971	3,556	950
Rasul	Jhelum	1967	3,209	850
Marala	Chenab	1968	4,475	1,100
Qadirabad	Chenab	1967	3,373	900
Sidhnai	Ravi	1965	712	150
Mailsi Syphon	Sutlej	1965	1,601	429
Trimmu (Remodelling)	Chenab	1965	3,025	650
Balloki (Remodelling)	Ravi	1965	1,646	225

III. NEW LINK CANALS

Link Canal	Rivers	Year of Completion	Length (Miles)	Capacity (000 Cfs)
Chashma - Jhelum Link	Indus - Jhelum	1970	63	21.7
Taunsa - Panjnad Link	Indus - Chenab	1970	38	12.0
Rasul - Qadirabad Link	Jhelum - Chenab	1967	30	19.0
Qadirabad - Balloki Link	Chenab - Ravi	1967	80	18.6
Balloki - Suleimanki Link	Ravi - Sutlej	1968	54	18.5
Trimmu - Sidhnai Link	Chenab - Ravi	1965	46	11.0
Sidhnai - Mailsi - Bahawal Link	Ravi - Sutlej	1965	62	10.1

APPORTIONMENT OF INDUS WATERS TO THE FOUR PROVINCES (WATER ACCORD 1991) (Karachi dated March 16, 1991)

As a follow-up to the meeting of the Chief Ministers at Lahore on March 03, 1991, a meeting of the representatives of the four Provinces was held at Lahore on March 04, 1991. Another meeting was held at Karachi on March 16, 1991. The representatives of the Provinces agreed on the following points :

1) There was an agreement that the issue relating to Apportionment of the Waters of the Indus River System should be settled as quickly as possible.

2) In the light of the accepted water distribution principles the following apportionment was agreed to :

Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)
Punjab	37.07	18.87	55.94
Sindh*	33.94	14.82	48.76
NWFP Civil Canals**	3.48 1.80	2.30 1.20	5.78 3.00
Baluchistan	2.85	1.02	3.87
Total :-	**77.34** **+** **1.80**	**37.01** **+** **1.20**	**114.35** **+** **3.00**

Note: * Including already sanctioned Urban and Industrial uses for Metropolitan Karachi
** Ungauged Civil Canals above the rim stations.

3. NWFP/Balochistan projects which are under execution have been provided their authorized quota of water as existing uses.

4. Balance river supplies (including flood supplies and future storages) shall be distributed as below :

Punjab	Sindh	Balochistan	NWFP	Total
37%	37%	12%	14%	100%

5. Industrial and Urban Water supplies for Metropolitan City, for which there were sanctioned allocations, will be accorded priority.

6. The need for storages wherever feasible on the Indus and other rivers was admitted and recognized by the participants for planned future agricultural development.

7. The need for certain minimum escapage to sea below Kotri to check sea intrusion was recognized. Sindh held the view that the optimum level was 10 MAF, which was discussed at length, while other studies indicated lower / higher figures. It was, therefore, decided that further studies would be undertaken to establish the minimal escapage needs downstream Kotri.

8. There would be no restrictions on the Provinces to undertake new projects within their agreed shares.

9. No restrictions are placed on small schemes not exceeding 5000 acres above elevation of 1200 ft. SPD.

10. No restrictions are placed on developing irrigation uses in the Kurram / Gomal / Kohat basins, so long as these do not adversely affect the existing uses on these rivers.

11. There are no restrictions on Balochistan, to develop the water resources of the Indus right bank tributaries, flowing through its areas.

12. The requirements of LBOD will be met out of the flood supplies in accordance with the agreed sharing formula.

13. For the implementation of this accord, the need to establish an Indus River System Authority was recognized and accepted. It would have headquarters at Lahore and would have representation from all the four provinces.

14. a) The system-wise allocation will be worked out separately, on ten daily basis and will be attached with this agreement as part and parcel of it.

    b) The record of actual average system uses for the period 1977-82, would form the guideline for developing a future regulation pattern. These ten daily uses would be adjusted pro-rata to correspond to the indicated seasonal allocations of the different canal systems and would form the basis for sharing shortages and surpluses on all Pakistan basis.

    c) The existing reservoirs would be operated with priority for the irrigation uses of the Provinces.

    d) The provinces will have the freedom within their allocations to modify system-wise and period-wise uses.

    e) All efforts would be made to avoid wastages. Any surpluses may be used by another province, but this would not establish any rights to such uses.

The Punjab Gazette

PUBLISHED BY AUTHORITY

LAHORE WEDNESDAY JULY 02, 1998

PROVINCIAL ASSEMBLY OF THE PUNJAB

NOTIFICATION

July 02, 1997

No. Legis-2(10)/97/91. The Punjab Irrigation and Drainage Authority Bill 1997, having been passed by the Provincial Assembly of the Punjab on June 27, 1997 and assented to by the Governor of the Punjab on June 29, 1997, is hereby published as an Act of the Provincial Assembly of the Punjab

THE PUNJAB IRRIGATION AND DRAINAGE AUTHORITY ACT 1997
ACT XI OF 1997

[First published after having received the assent of the Governor of the Punjab, in the Gazette of the Punjab (Extraordinary) dated July 02, 1997]

An

Act

to provide for the establishment of the Punjab Irrigation and Drainage Authority.

Preamble. Whereas, it is expedient to establish the Punjab Irrigation and Drainage Authority to implement the strategy of the Government of Punjab for streamlining the Irrigation and Drainage System; to replace the existing administrative set up and procedures with more responsive, efficient and transparent arrangements; to achieve economical and effective operation and maintenance of the irrigation, drainage and flood control system in the Province; to make the irrigation and drainage network sustainable on a long term basis and introduce participation of beneficiaries in the operation and management thereof;

It is hereby enacted as follows ----

1. **Short title and commencement.**---(1) This Act may be called the Punjab Irrigation and Drainage Authority Act 1997.

(2) It shall come into force at once.

2. **Constitution of the Authority.**---- (1) There shall be established an Authority to be known as the Punjab Irrigation and Drainage Authority.

(2) The Authority shall be a body corporate having perpetual succession and a common seal with power to acquire, hold and dispose of property and shall by the said name sue and be sued.

3. Composition of the Authority.---(1) The Authority shall consist of such number of members as may be notified by the Government.

(2) The Minister for Irrigation and Power shall be the Chairman of the Authority.

(3) Not less than six members shall be farmers and the number of non-farmer members shall not exceed the number of the farmer members.

(4) In the absence of the Chairman in a meeting the members present in the meeting may elect a member from amongst themselves to act as Chairman of the meeting.

4. Board of Management.---(1) Subject to the control and guidance of the Authority the management of the affairs of the Authority shall be carried out by the Board of Management appointed by the Authority with the prior approval of the Government and comprising a Managing Director and three General Managers.

(2) The Managing Director and the General Managers shall have technical background and practical experience in the profession relevant to their job description.

5. Powers and duties of the Authority.-- The Authority shall have the following powers and duties-

(1) To receive irrigation supplies at the barrages falling within the province and from the inter-provincial or link canals and deliver the same in agreed quantities to the various water users and Area Water Boards in the Province.

(2) To ensure conveyance of drainage effluent to the outfall in coordination with Area Water Boards and Farmers Organizations as the case may be.

(3) To exercise all the powers under the Canal and Drainage Act 1873, the Soil Reclamation Act 1952 and any other law for the time being in force relating to the subject matter of these Acts.

(4) To fix the rates in consultation with the Government for the supply of irrigation water and of the drainage cess payable for the disposal of the drainage effluent.

(5) To levy appropriate surcharge for late payments and recover arrears from defaulters under the Land Revenue Act provided that in case the Government declares a remission, waiver, re-scheduling or suspension of payment of any of the dues of the Authority, the same shall be debited to the account of the Government who shall simultaneously notify how the Authority shall be compensated for the loss thereby caused to the Authority or any other entity established under this Act.

(6) To formulate and implement policies in the water resources sector with a view to continuously improve and achieve effective, economical and efficient utilization, preservation and improvement of such water resources by the water users of the Province on a sustainable basis.

(7) To formulate and implement policy guidelines and procedures for the proper and efficient exercise of powers available under this Act by the various entities and their Directors and employees and to prescribe training requirements and programs which may be conducted by the various entities under this Act in this behalf.

(8) To conduct any inquiries and hear any complaints and adjudicate on any dispute or differences of opinion between the Authority and different entities established under this Act and any individual and the said entities in accordance with the principles of natural justice relevant thereto and to faithfully and punctually implement such decisions as per letter and spirit thereof.

(9) To prescribe and adhere to the procedures for the filing of documentation regarding water allocation in the Province and all concessions, licenses and leases granted by any entity under this Act and to ensure availability thereof to the general public for inspection and taking of copies thereof.

(10) To establish criteria and procedures for granting, modifying, reassigning, renewing, suspending or revoking any concessions, licenses or subleases granted by the Authority to any other entity or person and for the management of the infrastructure in the event of suspension or revocation of a concession, license or sublease.

(11) To operate and maintain the irrigation tube-wells, drainage, storage reservoirs and flood control infrastructure in the Province including hill torrent control and development works for irrigation of adjoining lands including watershed management practices in catchment areas.

(12) To plan, design, construct and improve the irrigation, drainage, storage reservoirs and flood control system with a view to ensure optimal utilization of the water resources of the province on an equitable and efficient basis.

(13) To maintain all relevant and necessary records, registers and data banks as may be relevant or necessary for the effective performance of any or all of its powers and duties.

(14) To issue such directions and take all such steps as may reasonably be necessary for the prevention and removal of encroachments and unauthorized construction along or on the properties of the Authority.

(15) To prescribe rates, fees and other charges to be payable in respect of various types of services which the Authority may be required to render or provide under this Act.

(16) To operate and maintain the equipment, machinery and stores of the Authority effectively, efficiently and in a business like manner.

(17) To undertake anti-erosion operations including conservation of forests and re-afforestation and with a view to achieve this purpose, to restrict or prohibit by general or special order the clearing or breaking up of land in the catchment areas of any rivers, hill torrents and other streams.

(18) To undertake any work, incur any expenditure, procure machinery, plant and stores required for use by the Authority and to negotiate, execute, adopt and ratify all such contracts as may be considered necessary or expedient.

(19) To acquire and dispose of any land, property or machinery or equipment or any other interest in or regarding any land or property.

(20) To direct that any work required to be carried out by a person in connection with training of rivers, hill torrents and any other streams or undertaking of anti-erosion measures including conservation of forests and re-afforestation but remaining undone shall, after reasonable notice to such person and due consideration of any objections raised by him in this regard, be undertaken by the Authority and determine the cost to be borne by such person, or after notice and due enquiry, by any other person who may be held by the Authority to be liable for the same.

(21) To utilize the Authority Fund to meet the cost and expenses incurred on account of and in connection with the due performance of the various functions of the Authority under this Act including the payment of salaries and other remuneration to the management and employees of the Authority.

(22) To formulate, implement and continuously review and improve the policies and procedures relevant to the management of finances and maintenance of the accounts of the Authority as well as for the inventory and assets valuation and disposal and for the recruitment, promotion, retirement (upon attainment of age of superannuation or otherwise) and earlier conclusion of employment of the employees of the Authority.

(23) To formulate financial policies aimed at ensuring that the finances of the Authority are managed in a consistent, conservative and diligent manner as to protect its assets including providing for their maintenance and periodic replacement as necessary, preserve its capital and reserves and promptly service its debts and obligations.

(24) To formulate, adopt and implement policies aimed at promoting, formation, growth and

development of Area Water Boards, Farmers Organizations and compilation and faithful monitoring of the results thereof as per the requirements prescribed under this Act and to ensure orderly and systematic induction thereof into the operations of the Authority.

(25) To prepare or cause to be prepared and regularly update or cause to be updated Staffing, Operational and Financial Plans.

(26) To prepare and implement policies with a view to ensure that the staffing levels within the Authority and other entities under this Act conform with the corresponding levels indicated in the Staffing, Operational and Financial Plans prepared and updated as above.

(27) To formulate and implement policies with a view to ensure that the Authority and other entities as the case may be under this Act become fully operative as self supporting and financially self sustaining entities, to the extent of full recovery of O&M cost of canals and subsidiary drains within a period of 7 to 10 years.

(28) To formulate, implement and regularly update policies, studies and research programs with a view to development and management of water resources, solve and eliminate and prevent waterlogging and salinity, and to develop irrigated agriculture in the Province.

(29) To conduct studies with a view to regularly analyze and evaluate the impact of the operations and policies of the Authority on the ecology and environment within the Province with a view to establish the various available options for the minimization of the adverse impact of such operations and policies, if any, and to adopt the optimal options for further action.

(30) To coordinate and regulate the measures being undertaken or required to be undertaken in the Province for recording and gauging surface waters, monitoring of groundwater table and quality of water and the compilation of data relevant thereto and in this regard to establish and regularly maintain proper liaison with similar work being undertaken in other provinces.

(31) To cause studies, surveys, experiments, technical investigations and research to be conducted in connection with or regarding the functions and duties of the Authority or of any other entity under this Act.

(32) To publish or cause to be published various policies, details, data and information relevant to the affairs of the Authority on a regular basis and to ensure reasonable access of the public to the same.

6. Right of Entry --- (1) The Managing Director, or any other person authorized by him in writing, may, after reasonable prior notice to that effect, enter upon and survey any land, erect pillars for the determination of intended lines of work, make borings and excavations and do all other Acts which may be necessary for the preparation and implementation of any scheme under any provision of this Act.

(2) If the affected land does not vest in the Authority, the power conferred by the above sub-section shall be exercised in such manner as to cause the least interference with and damage to such land and the rights of the owner thereof.

(3) When any person enters into or upon any land pursuant to sub-section (1) above, he shall, at the time of such entry or as soon thereafter as may be practicable but in no case later than 60 days from the date of such entry, pay or tender payment for all necessary damage likely to be caused on account of any operations proposed to be carried out or carried out under sub-section (1) above.

(4) In case of any dispute, the same shall be referred to the Collector / Deputy Commissioner of the district who shall decide the same within a maximum period of 60 days from the date of such reference.

7. Arrangement with local bodies or other agency.---(1) As soon as any scheme has been

completed by the Authority or at a later date, the Authority may arrange by a written agreement with a Local Body or other agency within whose jurisdiction any particular area covered by the scheme lies, to take over and maintain any of the works comprising such scheme in the said area.

(2) The Government shall have the power to direct the Authority to hand over any schemes completed by the latter to any agency of the Government or a Local Body or take over such schemes completed by any agency.

(3) In any such case, the authority shall be entitled to receive the expenditure incurred on such schemes.

8. Control over Provincial Water Resources.--- Subject to the Indus Water Treaty (1960) and Water Apportionment Accord (1991), the Authority shall have control over all the rivers, canals, drains streams, hill torrents, public springs, natural lakes, reservoirs (except such reservoirs as are under the control of WAPDA) and underground water resources within the Province to give effect to schemes to be prepared under this Act in relation to public purposes.

9. Appointment of Officers, Servants etc.--- The Authority may employ such officers and servants, or appoint such experts or consultants as it may consider necessary for the performance of its functions, on such terms and conditions as it may deem fit.

10. Delegation of powers to Managing Director etc.--- The Authority may, by general or special order, delegate to the Managing Director, a Member of the Board of Management or officer or servant of the Authority any of its powers, duties or functions, under this Act subject to such conditions as it may deem fit to impose.

11. Persons serving in the Provincial Irrigation and Power Department.--- (1) All employees of the Irrigation Wing of the Provincial Irrigation and Power Department except such employees as may be specified by the Government in this behalf shall, subject to any other provisions contained herein, on coming in force of this Act, become the employees of the Authority.

(2) Employees under sub-section (1) shall serve the Authority on such terms and conditions as may be prescribed by rules and regulations of the Authority but in any case not less favourable than their existing terms and conditions of service.

(3) The Authority shall, through adoption of policies of hiring freeze, reassignment, non-replacement of employees retiring upon attainment of age of superannuation and providing incentives for early retirement, bring the number of its employees in conformity with the corresponding numbers indicated in the relevant Staffing, Operational and Financial Plans.

(4) The government shall contribute to the pension, gratuity and final payment of provident fund of the employees of the Provincial Irrigation & Power Department who become the employees of the Authority under sub-section (1) as per the relevant Rules.

12. Authority Fund.-- There shall be a fund to be known as the "Punjab Irrigation and Drainage Authority Fund" vested in the Authority to which shall be credited all sums received by the Authority.

13. Budget, audit and accounts.-- The budget of the Authority shall be approved and its accounts shall be maintained and audited in such manner as may be prescribed.

14. Establishment of Area Water Boards, etc.-- (1) The Government may establish Area Water Boards and Farmers' Organizations and assign to them such functions as it may deem fit:

Provided that the Area Water Boards shall comprise not less than eight members who shall be

representative of the farmers three out of whom shall be from the tail reaches of canals; the Chairman of the Area Water Boards shall be a representative of the farmers and the number of non-farmer members of the Boards shall not exceed the farmer members.

(2) The Authority shall, within one year of its establishment, devise and implement pilot programs, policies and take steps thereunder to ensure that an Area Water Board covering selected canal command and Farmers Organizations at the minor and distributary level are formed in a phased manner in accordance with the relevant Bye-Laws and Regulations framed by the Authority.

(3) The pilot Area Water Board and Farmers Organizations shall be vested with such functions and power as would be required to enable them to become financially self-sustaining and self-sufficient to the extent of recovering complete O&M charges for maintaining canals and subsidiary drains within a maximum period of ten (10) years in the case of Area Water Board and seven (7) years for Farmers Organizations from the respective dates of their formation.

(4) The process of setting up of further Area Water Boards and Farmers Organizations will depend upon the successful functioning or the pilot project.

15. Transfer of rights and liabilities.---Upon coming into force of this Act all assets and liabilities and all rights and obligations of the irrigation Wing of Provincial Irrigation and Power Department shall stand transferred to the Authority, on such terms and conditions, particularly as regards use and disposal of the said assets as may be prescribed by the Government.

16. Rules.--- The Government may, by notification, make rules for carrying out the purposes of this Act.

17. Regulations.--- The Authority may by notification make regulations not inconsistent with the provisions of this Act and the rules made thereunder for the administration and management of the affairs of the Authority.

18. Removal of difficulties.---If any difficulty arises in giving effect to any of he provisions of this Act the Government may make such orders, not inconsistent with the provisions of this Act as may appear to it to be necessary for the purpose of removing the difficulty.

19. Repeal.--- The Punjab Irrigation and Drainage Authority Ordinance (XX of 1997) is hereby repealed.

DR. SYED ABUL HASSAN NAJMEE
Secretary

EXTRACTS FROM DRAFT TERMS OF REFERENCE FOR PIDA INSTITUTIONAL REFORMS CONSULTANCY

I. OBJECTIVES AND SCOPE OF THE SERVICES

The objectives of the Services are to assist the Government of Punjab to successfully implement its institutional reform program. The Consultants will provide a `process change-management Consultancy' over a period of about 6 years to assist the Government of Punjab/PIDA to establish and operate vibrant, autonomous, efficient, service-oriented, financially-viable public utility organizations (PIDA and several AWBs), operating on sound business principles; and to transfer management of the irrigation and drainage system below minor/distributary level to FOs, which would be established under a social mobilization/organization process but operate on sound business principles. The reforms would be carried out in a phased and consultative manner.

The Consultants would assist the Government of Punjab / PIDA and the various entities in the whole spectrum of activities associated with the reform process, specifically in working with the various officials: (i) in carrying out the several preparatory or planning studies required at various stages of the change process; and (ii) more importantly, in implementing the change strategy. The Consultants will provide required professional expertise and operational assistance to the Government of Punjab and the various entities for the several activities associated with the reform process; and will act as catalysts, facilitators and advisors in the reform process.

Institutions Covered: The focus of most of the work outlined below will initially be on the PIDA, the first AWB (or AWBs) and pilot FOs. This will be subsequently extended to other AWBs and FOs when these are established and operational. In many cases, the work done for the PIDA itself would form the basis for replication in the AWBs, with some modifications taking into account the specific requirements of the AWBs, with the size and nature of the AWBs' operations. Given that the FOs would be relatively small entities, it is expected that the systems in FOs would be relatively simple. However, the coverage would be comprehensive and cover all aspects, which are required for operation and sound business principles. The experience on the first AWB and FOs would provide the basis for replication (and possible improvement) in other AWB and FOs. Based on the experience of the first AWB and FOs, the Consultants would assist in the development of a `standard AWB package' and a `standard FO package' covering most of the aspects outlined below, which could be adapted and replicated in all future AWBs and FOs. The Consultants would also provide required assistance to any subsequent AWBs and FOs, in the form of replicating and adapting the `standard package'.

Activities: The Consultants will assist the Government of Punjab and specifically the various entities (PIDA, AWBs and FOs) in a range of process activities required in the institutional reform process. This will include the following aspects:

a) Organizational Vision and Strategy
b) Business Planning
c) Legal Framework
d) Business Policies
e) Internal Policies and Procedures
f) Organization Structure and Staffing
g) Human Resources Development
h) Improving Operational Efficiency
i) Information Systems
j) Finance and Accounting
k) Policy and Regulation
l) Technical and Engineering Aspects
m) Transitioning (establishment of AWBs and FOs)
n) Change Management
o) Monitoring and Evaluation of the Reform Program

Each of these aspects is elaborated below. The depth of coverage of each of the issues would vary by entity. For example, the FOs, many of the issues may not be required to be covered in as much depth as for the PIDA, keeping in view the simple nature of operations of the FOs and the need to avoid complexity.

Organizational Vision and Strategy: The Consultants would assist the various entities in developing an organizational vision and the strategy to achieve the vision. This would include aspects such as formulation of (i) Organizational Mission Statement; (ii) Organizational Values Statement; and (iii) Organizational Strategy. Similarly, Mission Statements, Values Statements and Strategies would be formulated for Sub-Organizational Units, if necessary.

The Mission, Values and Strategy would take into account that the entities (PIDA and AWBS) are publicly-owned development agencies, as well as public utilities which should be operated on sound business principles. The strategy would also include development of institutional capacity to proactively and efficiently deal with the various demands on a public entity. The strategy would demonstrate focus and selectivity in the entities' operational areas taking into account the respective entities' comparative advantage and core competencies.

Business Planning: The Consultants would assist the various entities in preparing Business Plans for their operations. The Business Plans would be based on the organizational vision and strategy. The Business Plans are expected to be prepared at least annually, as three-year Rolling Business Plans, and would inter-alia cover aspects such as operations (including operation and maintenance, revenue assessment and collection, water resource management planning etc.), capital investments, staffing, human resources development, information systems, finances including subsidies, performance targets, and implementation of the institutional reforms program. The Business Plans would include projections of standard financial statements (Income and Expenditure Statements, Balance Sheets, Cash Flow Statements, and Ratio Analysis).

Legal and Regulatory Framework: The basic legal framework for the reforms has been established through the enactment of the PIDA Act, 1997. The Consultants would assist the Government of Punjab in identifying and implementing improvements and refinements in the legal framework with reference to various Acts in force, which are necessary for implementing

the reforms. The refinements and improvements may be identified during the preparatory studies or based on the lessons of experience. To the maximum extent possible, changes to the legal framework would be only in those aspects which require the concurrence of the Provincial Government, and which need to be issued in the form of Rules, etc; and would not be in aspects which are part of the `Business Policies' of the entities and the `Internal Policies and Procedures' of the entities. The Consultants' assistance would include providing legal expertise, drafting assistance, and process assistance through liaison, etc.

Business Policies: The Consultants would assist the various entities in formulation, adoption and implementation of Business Policies, which govern the operations of the entities. The Business Policies would outline the policies regarding the operation of the entity vis-à-vis its customers, suppliers and other business partners. In some cases, the Business Policies may need to be covered as part of the Legal Framework. The main principle underlying the formulation of the Business Policies would be to ensure that these are fair, transparent, clear and simple, value adding and feasible. The `Business Policy Document' would be available as a public document.

Internal Policies and Procedures: The Consultants would assist the various entities in formulation, adoption and implementation of internal policies and procedures. The main principle underlying the formulation of these policies and procedures would be to move away from an operating culture based on complex rigid `rules and regulations' (which are common in a Government Department) to a set of clear, simple, transparent, user-friendly, and value-adding `policies and procedures' which would be continuously updated as necessary. The internal policies and procedures would be in line with the organization structures, and wold take into account the need for substantial delegation of authority and responsibility while focussing on accountability. The `Internal Policies and Procedures' would cover the entire gamut of policies and procedures required for the internal activities of the entities, and which are within the scope of powers of the entity itself (i.e. the Authority or Board of Directors or management of the entity). In many cases, the 'Internal Policies and procedures' may overlap with the `Business Policies' and may be published as one document. Broad areas of coverage in the internal policies and procedures wold include corporate governance, administrative / operational policies and procedures, and approval / updating procedures.

Organization Structure and Staffing: The Consultants would assist the various entities in designing and implementing appropriate organization structures and staffing plans. The organization structure and staffing would be in line with the overall Mission, Values and strategy of the entity including the organizational integration of entire water sector by the merger of other provincial administered entities into PIDA; and would reflect the need to bring about a change in the overall organization operating culture and thinking. Broad areas of coverage include:

a) designing and implementing an appropriate organization structure.
b) preparing job description and job/skill profiles for various key positions;
c) preparing staffing plans for the various entities, including phasing over time. The staffing plans should be need-based and should take into account the roles and functions of the entity, the changes in these over time (as the transitioning process takes place), and the new modes of operations being considered; and
d) formulation a strategy for `right-sizing' the various entities. The strategy should propose measures for reductions in all cases where the entities are currently

overstaffed. Measures to be considered would include continuation of the hiring freeze, attrition (after retirement, resignation, etc.), redeployment after appropriate training, transfers, reassignment to other organizations, transfer to surplus pool of Provincial Government, voluntary termination, etc. An important aspect to be covered is the development and implementation of an appropriate incentive package or `Voluntary Termination Program'.

Human Resource Strategy and Policies: The human resource base is the most important asset of the various entities. The Consultants would assist the various entities in developing and implementing comprehensive human resource strategies and policies to effectively harness the opportunities for professional growth; encourage learning, accountability and teamwork; and treat staff fairly.

Improving Operational Effectiveness: A key objective of the reform program is for the various entities to become more cost-effective and efficient (thereby reducing O&M costs and the `cost recovery' base), while protecting and improving the quality of client services. The Consultants would assist the various entities in developing measures to improve cost-effectiveness and efficiency. Key measures would include: (i) introducing and integrating scientific operational management techniques, tools and technology into the operations of the entities; (ii) introducing a program of Total Quality Management (TQM) in the various entities; (iii) contracting for O&M and various `non-core' services; (iv) modernization' (v) improving and simplifying procedures and processes; (vi) ensuring efficiency in procurement and contract administration (including appointment and supervision of Consultants); and (vii) reducing administrative costs, establishment and other overheads (to move more resources to works and direct O&M expenditure). An important aspect would be to bring about a change in the `operations management culture' to one based on scientific and modern operational management tools.

Information Systems (IS): A major requirement to enable the entities to carry out their operations in an efficient and effective manner is the introduction of comprehensive Information Systems (IS), taking advantage of modern technology. The Consultants would assist the various entities in developing and implementing comprehensive IS covering all aspects of the entities' operations (including procurement and contract administration; human resources; water service operations including operation of the various canals and drains, operation and maintenance, etc; revenue assessment, billing and collection; finance; accounting; water resources planning; project monitoring; administration; etc.). The Consultants would initially prepare an `IS Strategy' which would outline the scope, coverage, requirements, and phasing of the Information Systems.

Communications / Information Module: An important aspect to be covered early on during the implementation of the IS is a Communication / Information Module, which would enable the rapid flow / exchange of information in the entities using modern communication technologies (e.g., Internet, Web Technology, etc.). This would include aspects such as the creation of internal and external web sites (which would substantially enable information dissemination both within and outside the entity); development of an internal communication system using Electronic Mail; providing a system which would enable access to global information using Web technology; and such related aspects.

Finance and Accounting: The Consultants would assist the various entities to develop satisfactory financial and accounting policies and systems, commensurate with the size and scope of their operations, which would: (i) promote efficiency and effectiveness in the entities; and (ii) enable measurement and timely reporting of the financial performance, efficiency and effectiveness of the entities and their various constituent operating units. The Consultants would assist the entities' to develop financial and accounting policies, procedures and systems, including the necessary computerization; and most importantly, provide substantial hands-on implementation assistance and on-the-job training to ensure that the improved systems are operational and sustainable

Finance Studies: The Consultants would assist the various entities in carrying out a study on *"Revenue Options of PIDA, AWBs, and FOs"*, with the objective of identifying sources of revenues and funds both for capital expenditure activities and for revenue activities. The study would look into more efficient (any "buoyant") options for charging and collecting Abiana, and expanding the revenue base of the entities (such as generating revenue from selling water to and draining effluent for urban and industrial users, and how to charge for many of their services which fall within the domain of public goods, specifically off-farm drainage, and flood control, etc.) The study would also explore the possibilities of combining water charges for surface and subsurface water. The Consultants would also assist the various entities in carrying out a study on *"Long-Term Financing Options for Irrigation and Drainage"*, which could define the long-term requirements for investment and O&M financing for irrigation and drainage (which has so far been substantially financed by the public sector), and options for financing the requirements through various mechanisms that would make sense for the public sector (e.g. special financial instruments, special purpose or dedicated taxes, or guarantees) and the private sector.

Policy and Regulation: The Consultants would assist the various entities in carrying out the necessary technical and engineering studies required for the management transfer to AWBs and FOs. This would include aspects such as:

a) preparing an inventory of the irrigation drainage System, flood protection infrastructure, including the location / type of projects carried out for physical system improvement in the project area;
b) assessing the adequacy of irrigation and drainage infrastructure in the FO areas, identifying physical improvements required, and preparing an estimate of costs;
c) establishing the basis on which allocations of supplies at each point in the system would be determined, and proposing structural, legislative and institutional arrangements to facilitate fair distribution;
d) preparing a water allocation model which will facilitate fair distribution of any shortages / surpluses;
e) identifying methods to improve transparency and accounting of water allocation at various points in the system (barrage, branch canals, minors, distributaries, watercourse outlets, and rotational turns).

Transition Program: The Consultants would assist the Government of Punjab and the various entities in preparing and implementing a transition strategy for establishment of AWBs and FOs; and management transfer of the irrigation and drainage system to the AWBs and FOs. Indicative list of aspects to be covered include the following:

a) delineating the physical boundaries of the each AWB, and each FO taking into account hydraulic features of the irrigation schemes, social aspects, and economies of scale which apply;
b) outlining the rights and obligations of PIDA, AWBs, and FOs;
c) formally registering the FOs with the appropriate authority;
d) facilitating the involvement of users and the farming community at large in formulating the transfer program through special mobilization, its objectives and process, including identifying a communication and participation program to effectively communicate the new institutional structure to beneficiaries, and further their interest in forming FOs, obtain feedback from stakeholders on the new legal and institutional arrangements, including arrangements for program implementation,
e) organizing farmers into FOs, and conducting or overseeing elections of office bearers;
f) formalizing "Titles of Leasehold" for the infrastructure to AWBs and FOs.
g) carrying out inventories of facilities, machinery and equipment, including lists of assets to be transferred and assessments of the need for additional facilities, equipment and / or repair of existing equipment;
h) preparing instruction manuals and operational handbooks for AWBs and FOs; plans for rehabilitating or modernizing the infrastructure; the related financial plans and policies to ensure financial viability; and detailed programs / schedules for the transfer;
i) determining technical and training needs of AWBs and FOs;
j) carrying out the physical and legal transfer of the system, infrastructure, machinery and equipment to the physical and legal transfer of the system, infrastructure, machinery and equipment to the PIDA, AWBs, and FOs;
k) preparing and implementing Business Plans;
l) providing necessary assistance in aspects such as water management (water recording, budgeting and allocation, etc), assessment, billing and collection of abiana / revenue; identification of functions to be contracted out, etc.; and
m) preparing and implementing a monitoring and evaluation program.

Change Management: The change process itself needs to be actively and well managed, and carried out in a consultative and participatory manner. The Consultants would assist the Government of Punjab / PIDA in managing the change process, including ensuring that the lessons from global experience in institutional change management are reflected in the design and implementation of the institutional reforms.

Monitoring and Evaluation: The Consultants would assist the Government of Punjab and the various entities in monitoring and evaluation of the reform program. This would include: (i) defining indicators; (ii) defining progressive service standards and performance targets to be achieved (with time frame); (iii) establishing measurement mechanisms (including client surveys, independent standard certifications - such as ISO standards for quality management, etc); and (iv) monitoring, evaluation and reporting.

II. OUTPUTS

Given the process nature of the assignment, certain outputs such as organizational / staffing structure and preparatory arrangements for setting up of the pilot Areas Water Board (AWB),

legal framework for FOs, and modalities / rules for setting up and operation of Authority funds would be completed on priority within the first six months of the signing of consultancy contract. The Consultants would also identify specific and time-bound critical path schedules for these and various other activities mentioned in the TOR. The completion of other tasks / plans / documents for operationalization of the new institutions would be developed within next one year in a phased manner. The next phase would focus on subsequent implementation of institutional reforms and refining the enabling framework in keeping with the experience gained.

IIMI-PAKISTAN PUBLICATIONS

CONSULTANCY REPORTS

S.No.	Title	Author	Year
C-1	Consultancy inputs for the preparation of project inception report on social organization in irrigation management	P. Ganewatte P. Pradhan	Jan 1995
C-2	Regional Salinity - Sodicity Issues in Punjab, Pakistan Consultancy Report	Dr. James W. Biggar	Apr 1996
C-3	Study of Water and Salt Balances for Eight Sample Watercourse Commands in Chishtian Sub-division, Punjab, Pakistan - Consultancy Report	E.G. van Wayjen	June 1996
C-4	Unsteady Flow Simulation of Pehur High-Level Canal Including Automatic Downstream Water Level Control Gates - Consultancy Report	Dr. Kobkiat Pongput	June 1996
C-5	Distributary Level Water Users Associations in Pilot Projects for Farmer-Managed Irrigated Agriculture, Punjab and Sindh Provinces, Pakistan	Dr. P. Pradhan	Sept 1996
C-6	Water Users Organization Program in IIMI's Pilot Projects in the Punjab and Sindh Provinces, Pakistan	Piyasena Ganewatte	Oct 1996
C-7	Soil Salinity and Sodicity in Relation to Irrigation Water Quality, Soil Type and Farmer Management - Consultancy Report	J.C. van Dam M. Aslam	Apr 1997
C-8	Maintenance of Water Management Systems for Irrigation in Pakistan: A Study Report	MM Pakistan (pvt) Ltd	Apr 1997
C-9	Salinization of the Irrigated Soils in the Punjab (Pakistan)	Serge Marlet	Aug 1997
C-10	Case Study on Agriculture Department of Punjab Province	Mushtaq Ahmad Gill Khurram Mushtaq	Sep 1998
C-11	Legal Framework for Irrigation Management in Punjab and Sindh	Prof. Dr. Dil Muhammad	Sep 1998
C-12	Case Study of the Punjab Irrigation Department	Asrar ul Haq	Sep 1998