PD-AAR-507
ISN 40836

FINAL REPORT IRRIGATION SYSTEMS MANAGEMENT RESEARCH DESIGN

68

Submitted to USAID/Pakistan

under provisions of

contract number 391-0467-C-00-4028-00

Prepared by the University of Idaho 001451

in Collaboration with

Washington State University and 001262

Development Alternatives, Inc. 000435

000141
S

November, 1984

University of Idaho

F I N A L R E P O R T

I R R I G A T I O N S Y S T E M S M A N A G E M E N T R E S E A R C H D E S I G N

Submitted to USAID/Pakistan

Under Provisions of

Contract Number 391-0467-C-00-4028-00

Prepared by

The University of Idaho

in collaboration with

Washington State University

and

Development Alternatives, Inc.

November 1984

PREFACE

This report proposes a water management research program for Pakistan. It is organized into three sections. The body of the report and thirteen supporting annexes are contained in this binder. The annexes include a core set of research projects which would be implemented under the program. Vitae for potential members of the implementation team are contained in a separate binder.

The report was prepared by a Research Definition Team which consisted of: Dr. Charles E. Brockway, Dr. Gilbert L. Corey, Dr. Ronald V. Curtis, Dr. Delbert W. Fitzsimmons, Ms. Paulette George, Dr. Joel R. Hamilton, Dr. W. Doral Kemper and Ms. Gleanne G. Wray from the University of Idaho; Dr. Larry G. King from Washington State University; and Dr. Peter Reiss and Dr. James M. Wolf from Development Alternatives, Inc.

The Research Definition Team wishes to acknowledge collaboration of Pakistani and USAID officials during the design of this program. The assistance and support given to the team were outstanding.

TABLE OF CONTENTS

PAGE

List of Tables and Figures.....iii
List of Acronyms and Abbreviations.....iv

I. EXECUTIVE SUMMARY

A. Introduction.....1
B. Goal and Purpose.....1
C. Findings and Recommendations.....1
D. Program Overview.....3

1. Research.....3
2. Institution Building.....4

E. Implementation Overview.....5
F. Program Costs.....5

II. INTRODUCTION

A. Overview of Scope of Work.....7
B. Approach of the Research Definition Team.....8

III. BACKGROUND

A. Irrigated Agriculture in Pakistan.....12
B. Need for Water Management Research.....13
C. The U.S. Experience in Conducting Water Management Research.....14

IV. FINDINGS AND RECOMMENDATIONS

A. Water Management Research in Pakistan.....18
B. Institutional Base for Water Management Research.....20

1. Mona Reclamation Experimental Project.....22
2. Lower Indus Management and Reclamation Project.....23

C. Current and Alternative Approaches to Water Management Research.....23
D. Professional Development.....26
E. Conclusions.....27

V. DESCRIPTION OF THE WATER MANAGEMENT RESEARCH PROGRAM

A. Introduction.....28
B. Goal and Purpose.....28
C. Program Overview.....28
D. Components.....29

1. Research.....29

a. Program Areas.....29
b. Research Projects.....30
c. Potential Research.....31
d. Estimated Costs.....33

2. Institution Building.....35

a. Research Management.....35
b. Competitive Grants Program.....42
c. Training.....47

VI. IMPLEMENTATION PLAN

A. Strategy.....54
B. Schedule.....55

1. Pre-Implementation.....55
2. Mobilization.....55
3. First-Year Work Plan - Research Projects.....56
4. First-Year Work Plan - Competitive Grants Program.....61
5. First-Year Work Plan - Information System Management.....62
6. Short-Term Technical Assistance.....63
7. Training.....63
8. Commodity Procurement.....65

C. Arrangements with Pakistani Institutions.....66
D. Program Management.....70

1. Institutional Coordination and Support.....70
2. U.S. Management Responsibilities.....73
3. In-Country Management Responsibilities.....73
4. Reports.....75
5. Evaluations.....75

E. Budget.....76

VII. ANNEXES

A. Scope of Work.....86
B. Proposed Research Projects.....94

1. Integrated Watercourse Management.....95
2. Surface Drainage and Water Table Control.....103
3. Public and Private Tubewells.....110
4. Irrigation Systems Outside the Indus Basin.....117
5. Encouraging Water User Involvement in Better Management.....129
6. Development of Groundwater-Surface Water Models.....143
7. Farm Water Management.....152
8. Beyond Watercourse Improvement.....169

C. Institutional Profiles.....176

Pakistan Agricultural Research Council (PARC).....179
Irrigation Drainage and Flood Control Research Council (IDFCRC).....181
Drainage and Reclamation Institute of Pakistan (DRIP).....183
Water and Power Development Authority (WAPDA).....185
Mona Reclamation Experimental Project (MREP).....187
Lower Indus Water Management & Reclamation Research Project (LIM).....189
On-Farm Water Management Program (OFWM).....191
Provincial Irrigation Departments (PIDs).....193
Provincial Agricultural Research Institutes.....195
University of Agriculture, Faisalabad (UAF).....196
Sind Agricultural University, Tando Jam.....198
Northwest Frontier Province Agricultural University (NWFP AU).....200
Punjab Engineering Academy, Lahore.....202
Northwest Frontier Province University of Engineering and Technology, (NWFP UET), Peshawar.....203
WAPDA Academy in Tarbela.....204
Quaid-i-Azam University, Department of Anthropology.....206
Center for Excellence in Water Resources Engineering.....207
Applied Economics Reseach Center, University of Karachi (AERC).....208
Pakistan Institute of Development Economics (PIDE).....210

D. Assessment of Mona and LIM.....211
E. Commodities List.....238
F. Long and Short-Term Team Composition.....242
G. Linkages with Other Technical Assistance Teams....257

H. Research Management.....265

A. Report by Dr. Tom Armor.....265
B. Report by Dr. Clark Ballard.....274

I. Establishing An Information System for Research Support on the ISM Project.....278
J. List of Persons Interviewed.....304
K. Foreign Agricultural Research Grant Program.....317
L. Proposed Training at the Snake River Conservation Research Center at Kimberly, Idaho.....354

LIST OF TABLES AND FIGURES

PAGE

A. Table

No.	Title	
1.	Summary of Estimated Program Costs	6
2.	Estimated Research Costs	34
3.	Research Management Estimated Costs	43
4.	Information Systems Estimated Costs	44
5.	Competitive Grants Estimated Costs	48
6.	Estimated Training Requirements	52
7.	Training Estimated Costs	53
8.	Institutional Involvements	69
9.	Summary of Estimated Program Costs	77
10.	Long-Term Technical Assistance Estimated Costs	78
11.	In-Country Support Estimated Costs	79
12.	Campus Support Estimated Costs	80
13.	Cost Estimate Worksheet, Long-Term Technical Assistance	81
14.	Cost Estimate Worksheet, Short-Term Technical Assistance	82
15.	Cost Estimate Worksheet, In-Country Program Support	83
16.	Cost Estimate Worksheet, Campus Support	84
17.	Cost Estimate Worksheet, Training	85

B. Figures

No.		
1.	Management Structure for Water Management Research Program	71

LIST OF ACRONYMS AND ABBREVIATIONS

AARI	Ayub Agricultural Research Institute
ACOP	Alluvial Channel Observation Project
ADB	Asian Development Bank
AERC	Applied Economics Research Center, University of Karachi
AID	Agency for International Development
AIT	Asian Institute of Technology
ARD	Agriculture and Regional Development
ASCE	American Society of Civil Engineers
AZRI	Arid Zone Research Institute
BALAD	Baluchistan Area Development Project
BMIADP	Baluchistan Minor Irrigation and Agricultural Development Project
CE	Chief Engineer
CEWR	Center for Excellence in Water Resources Engineering
CID	Consortium for International Development
CIDA	Canadian International Development Agency
COP	Chief-of-Party
CSI	College of Southern Idaho
CSU	Colorado State University
CWM	Command Water Management
DAI	Development Alternatives, Inc.
DRIP	Drainage and Reclamation Institute of Pakistan
FAO	Food and Agriculture Organization of the United Nations
FERRO	Far Eastern Regional Research Office

FSRE	Farming Systems Research and Extension
FWM	Farm Water Management
GOB	Government of Baluchistan
GOP	Government of Pakistan
IBRD	International Bank for Reconstruction and Development (World Bank)
ICID	International Commission on Irrigation and Drainage
IDFCRC	Irrigation, Drainage and Flood Control Research Council
IFAD	International Fund for Agriculture Development
IIMI	International Irrigation Management Institute
ISM/E	Irrigation Systems Management/Engineering
ISM/EM	Irrigation Systems Management/Equipment Maintenance
ISM/P&M	Irrigation Systems Management/Planning & Management
ISM/R	Irrigation Systems Management/Research
ISR	Irrigation Systems Rehabilitation Project, World Bank
IWM	Integrated Watercourse Management
JRO	Junior Research Officer
LBOD	Left Bank Outfall Drain
LIM	Lower Indus Water Management and Reclamation Research Project
MART	Management of Agricultural Research and Technology
M & E	Monitoring and Evaluation
MREP	Mona Reclamation Experimental Project
NARC	National Agricultural Research Center
NESPAK	National Engineering Services (Pakistan) Limited
NWFP	North West Frontier Province

NWFP AU	North West Frontier Province Agriculture University
NWFP UET	North West Frontier Province University of Engineering and Technology
OFWM	On Farm Water Management Program
OJT	On-the-job-training
O & M	Operations and Maintenance
PAD	Provincial Agriculture Department
PARC	Pakistan Agricultural Research Council
PI	Principal Investigator
PID	Provincial Irrigation Department
PIDE	Pakistan Institute of Development Economics
POL	Petroleum, Oil, Lubricants
SAR	Staff Appraisal Report (World Bank)
SCARP	Salinity Control and Reclamation Project
SCS	Soil Conservation Service
SE	Superintending Engineer
SMS	Subject Matter Specialist
SFCRP	Special Foreign Currency Research Program
SRCRC	Snake River Conservation Research Center
SRO	Senior Research Officer
TA	Technical Assistance
TDY	Temporary Duty
TIPAN	Transformation and Integration of the Provincial Agricultural Network
TOEFL	Teaching English as a Foreign Language
UAF	University of Agriculture, Faisalabad
UI	University of Idaho
UPLB	University of the Philippines, Los Banos

USAID	United States Agency for International Development
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USDA-ARS	U.S. Department of Agriculture-Agricultural Research Service
USGS	United States Geological Survey
WAPDA	Water and Power Development Authority
WSU	Washington State University
XEN	Executive Engineer

I. EXECUTIVE SUMMARY

A. Introduction

A research program in water management is essential to support Pakistan's irrigated agriculture. Arguments for this program include:

1. the dependence of Pakistani agriculture on irrigation;

2. the relative low levels of irrigated agricultural productivity in Pakistan;

3. the large GOP support, with donor assistance, for irrigation.

Proposed is a four-year effort that will address current research needs while providing research direction for a longer time. The focus of the Program will be on increasing the capacity of GOP professionals and institutions to conduct research in water management.

The proposed Program is a component part of a major GOP effort, the Irrigation Systems Management (ISM) Project, that is designed to upgrade major portions of Pakistan's irrigation systems and to strengthen the capacity of the organizations charged with operations and maintenance of those systems. ISM is co-financed by USAID and the World Bank.

The University of Idaho with Washington State University and Development Alternatives, Inc. joined with Government of Pakistan and U.S. Agency for International Development officials in a collaborative examination of the state of water management research in Pakistan.

B. Goal and Purpose

The goal of the program is to increase the effective use of water through research to increase agricultural production, productivity, and farmer income. The purpose is to improve the capability of scientists and institutions to conduct irrigation research. Technical expertise and research management skills will be developed so that a foundation for a well organized, well managed, and integrated research program is firmly established.

C. Findings and Recommendations

Key findings and recommendations pertaining to water management research are summarized below:

1. Findings

a. There is a substantial body of water management research information together with operational experience covering a full range of topics that provides a foundation on which to build a water management research program.

b. Pakistan has a wealth of research institutions. Research priorities are developed in isolation and, as a result, water management research is not well focused nor integrated.

c. Commodity oriented research is the norm. Little off-the-experiment-station water management research work is performed.

d. Research, extension, and training functions are institutionally separated which affects the quality of the research, its degree of dissemination and the professional development of the research worker and manager.

e. The number of Pakistani scientists engaged in water management research is inadequate to mount an effective program. Additionally, research management skills are not well developed.

f. The library system to support scientific research in water management is inadequate.

g. The Water and Power Development Authority (WAPDA), through the units under the Water Wing, has established the base for an expanded program. Inter-institutional agreements with the Pakistan Agricultural Research Council (PARC) and the Irrigation Drainage and Flood Control Research Council (IDFCRC) are a means to create a comprehensive water management research network.

h. The Mona Reclamation Experimental Project has had some success in carrying out multi-disciplinary research on farmers' fields. This work stands out in contrast to experiment station research conducted under controlled conditions.

2. Recommendations:

a. Research requirements must be well defined to assure that specific research projects serve as building blocks for related and future research. Each researcher must have a clear sense of how their work relates to a better understanding of the entire system.

b. Formal degree training in selected fields is required. Additionally, building worker competence and managerial expertise is critical for long-term success in research.

c. There is a need to research discrete parts of a priority water management research agenda such as crop response to high water table conditions, or irrigation application methods; there is more pressing need to examine the interactions within an entire irrigation system. To do this it is essential for researchers to extend their investigations beyond the bounds of experiment stations so that institutions and farmers become part of the research task to examine implementation constraints.

d. Until GOP support for Mona and the Lower Indus Water Management Research and Reclamation Project (LIM) is stabilized, USAID should provide operational core support through the Water Management Research Program. The annual level of support should be made contingent upon the GOP increasing their support. The total provided through the Water Management Research Program should not exceed $800,000.

e. The research programs at Mona and LIM should focus on water management and less on agronomic research that could be done cooperatively by other institutions.

f. The Lower Indus region represents a set of agro-climatic and economic conditions which are different from those of Northern Punjab. Water management technologies must be developed for this region. The proposed headquarters for LIM should be changed from Tando Adam to Hyderabad, to take advantage of existing facilities and to have ready access to cooperative research programs with other institutions. No funds should be provided by AID for construction of new facilities.

g. WAPDA, because of its strong base in water-related studies, and its proven operational ability is recommended to lead the Water Management Research Program. IDFCRC is recommended to lead a program to provide library and documentation support needed for a self-sustaining research program. It is recommended that close collaboration with PARC be forged to provide coverage of irrigation agronomy; PARC should develop and lead a National Coordinated Program in water management. Through IDFCRC and PARC, other researchers and institutions should receive financial support to carry out Program activities, e.g., the University of Agriculture at Faisalabad, the Drainage and Reclamation Institute of Pakistan, and Quaid-i-Azam University.

D. Program Overview

The Program is designed with two mutually reinforcing components: targeted research and specific actions to strengthen the institutional base of professional expertise.

1. Research

Research projects address key problems that were determined in consultation with administrative and research staff of Pakistani institutions. The research component consists of eight research projects grouped into three research program

areas. Pakistani researchers will be supported by a team of long- and short-term research advisors. The research program areas and projects include:

Farm Water and Watercourse Management

1. Farm Water Management
2. Beyond Watercourse Improvement
3. Encouraging Water User Involvement in Better Water Management

Water Supply and Delivery Systems

1. Irrigation Systems Outside the Indus Basin
2. Integrated Watercourse Management

Drainage and Conjunctive Use

1. Surface Drainage and Water Table Control
2. Development of Groundwater - Surface Water Models
3. Public and Private Tubewell Performance

Each project offers research outputs, or added understanding of a specific problem. Each project will also address policy issues that constrain or encourage the diffusion of technology. Individual projects offer researchers experience in planning, implementation, analysis, and management. Also presented are a number of potential research projects.

2. Institution Building

Institution-building activities consist of research management, information management, a competitive research grants program, and training.

Development of management skills for the research effort is considered as important as development of research results. Research management deals with the development and management of research projects and programs, the interchange of ideas and information between researchers, and the extension of results to "next users".

The research management activities were designed to provide researchers with an opportunity for training and "hands-on" experience in areas outside their narrow technical specialization. Thus, training in administration, personnel management, communications, budgeting, and financial management are addressed both as discrete topics and as integral parts of each research project.

Support for the IDFCRC documentation center is programmed. The center will track and disseminate information on research work in progress and establish means for information sharing among libraries. IDFCRC will also be the lead institution for a Competitive Grants Program. This is a mechanism to expand the scope of the initial core projects and draw scientists from other institutions into water management research.

Training is an investment in the long-term objective of upgrading Pakistani capability to carry out effective and sustained research programs. The Program provides support for formal and informal training. Typically, formal training would call for students to take graduate coursework in the U.S. and then return to Pakistan for completion of thesis or dissertation research. Informal training includes several techniques such as a) seminars and workshops, b) in-service training, c) internships at U.S. research centers, d) scientist/faculty exchanges, and e) observation tours.

E. Implementation Overview

The execution of the proposed Program is designed to build as much as possible on existing research programs. The proposed projects are closely related to existing PC-1s. No new institutions are proposed. The process of implementation will allow a coordinating mechanism to evolve among key institutions.

A small core team of resident scientists is proposed with arrival dates determined by progress during a mobilization period. This team, supplemented by short-term advisors, will begin the initial process of building the network through close collaboration with Pakistani scientists and administrators in the implementation of the components of the Program.

The four-year Program is proposed to start April 1, 1985. Work plans will be developed annually. The cycle of these annual plans will run from September to August, coinciding with the beginning of the agricultural year.

F. Program Costs

The total estimated costs of this program are summarized in Table 1.

TABLE 1.

SUMMARY OF ESTIMATED PROGRAM COSTS
TOTAL COSTS IN DOLLARS

ACTIVITY	FY85	FY86	FY87	FY88	FY89	TOTAL
1. LONG-TERM TECHNICAL ASSISTANCE	278,163	689,913	721,476	777,384	386,155	2,853,091
2. IN-COUNTRY SUPPORT	414,026	291,170	277,778	287,719	148,926	1,419,619
3. CAMPUS SUPPORT	61,676	127,538	135,981	142,780	74,951	542,926
Subtotal	753,865	1,108,621	1,135,235	1,207,883	610,032	4,815,636
4. RESEARCH MANAGEMENT	51,205	88,041	45,375	54,313	46,750	285,684
a. INFORMATION SYSTEM	276,632	94,903	92,648	53,625	53,625	571,433
5. COMPETITIVE GRANTS	35,393	174,653	490,545	356,895		1,057,486
6. TRAINING	140,520	1,127,456	1,500,785	689,491	123,387	3,581,639
Subtotal	503,750	1,485,053	2,129,353	1,154,324	223,762	5,496,242
7. RESEARCH PROJECTS						
a. Integrated Watercourse Management	162,594	245,850	199,815	205,370	62,191	875,820
b. Surface Drainage	123,342	81,111	110,481	118,621	64,075	497,630
c. Tubewell Performance	98,371	106,288	127,449	113,121	46,406	491,635
d. Irrigation Outside Indus	147,062	120,876	131,863	134,778	101,228	635,807
e. Encouraging Water Users	60,356	152,873	119,268	42,020	20,873	395,390
f. Groundwater Models	249,087	175,134	90,537	94,084	87,629	696,471
g. Farm Water Management	252,006	118,291	106,521	110,646	46,681	634,145
h. Beyond Watercourse	99,153	197,471	200,399	114,187	46,551	657,761
i. Unspecified Research Reserve (including unspecified equipment)		400,000	650,000	550,000	100,000	1,700,000
Subtotal	1,191,971	1,597,894	1,736,333	1,482,827	575,634	6,584,659
8. MONA/LIM CORE SUPPORT	125,000	250,000	250,000	175,000	0	800,000
GRAND TOTAL	2,574,586	4,441,568	5,250,921	4,020,034	1,409,428	17,696,537

FINAL REPORT

II. INTRODUCTION

A. Overview of Scope of Work

This report addresses one component part of a larger GOP Irrigation Systems Management (ISM) Project which is co-financed by USAID and the World Bank (IBRD). A detailed scope of work that outlines the larger project and the water management research component of this project is included as an annex.

The larger USAID-financed ISM project is designed to assist the Government of Pakistan (GOP) and the four provincial irrigation departments (PIDs) to plan, design, rehabilitate, operate and maintain the country's irrigation system so that reliable and equitable water supplies are available to the irrigated agriculture sector. The overall project consists of four distinct but complementary and interrelated components:

1. rehabilitation work intended to assist the GOP to rehabilitate and maintain 14,000 km of canals and 3,500 km of surface drains, and to strengthen the human and equipment capability of institutions to design, manage, operate and maintain the entire irrigation system.

2. institutional improvement to improve the institutional capability of irrigation agencies by providing construction and maintenance equipment, improving maintenance workshops, improving canal design and civil works capability, and providing management training and improved management information systems.

3. planning, policy implementation, and research consisting of two subcomponents: a planning and policy implementation subcomponent that will enable the PIDs to improve their planning and implementation of new projects, and a research subcomponent that will strengthen Pakistani capability in hydraulic research and water management research. (It is the water management portion of this subcomponent which is the subject of this report.)

4. command water management, intended as a pilot effort to integrate the management of irrigation water at all levels within a canal command.

Within the research portion of the ISM Project, the water management research priorities include developing methods for identification and monitoring available water resources, including groundwater, and on-site tests to improve the quantity and quality of water available for agricultural production. The Research Definition Team was instructed to consider research in areas such as:

1. examination and refinement of on-farm water management techniques such as those developed at the Mona Reclamation Experimental Project and the Lower Indus Water Management and Reclamation Project,

2. research into performance and water quality aspects of tubewells,

3. computer models of irrigation water availability and utilization,

4. standard design procedures for small diversion structures in the Northwest Frontier Province (NWFP),

5. potential for on-farm, groundwater, or other local water storage schemes,

6. analysis of the socio-economic environment governing final water use.

The Research Definition Team was directed to:

1. review and evaluate proposed research programs and then recommend which research activities should be included in the project,

2. prepare a detailed life of project research plan,

3. develop profiles of the Pakistani institutions involved in water management research, including recommendations for institution-building activities, and institutional collaboration on the proposed research,

4. compile a detailed commodity list,

5. define training requirements for Pakistani research personnel,

6. define long-term team composition, and short-term consultant requirements, and

7. define anticipated working relationships between the proposed project and other ISM and On-Farm Water Management (OFWM) advisor teams.

B. Approach of the Research Design Team

The Research Definition Team was made up of representatives of the University of Idaho (UI), Washington State University (WSU), and Development Alternatives, Inc. (DAI). The definition of research requirements and formulation of the proposed program was a collaborative effort by U.S.-based scientists and GOP and USAID officials.

The working arrangements among the U.S. institutions are based on a history of collaborators. The campuses of UI and WSU, which are only nine miles apart, share and collaborate in many educational and research programs. The UI and DAI joined forces in establishing a Postharvest Institute for Perishables on the Idaho

campus in 1980. Both UI and WSU have been involved in the design, development, and continued research on large irrigation systems within the two states; the Columbia Basin of Washington State and the Snake River system in Southern Idaho. The University of Idaho and Washington State University have well-established and operational degree and non-degree training capabilities in all disciplines associated with water management. DAI has a proven record for quality work in international development including major research projects in the field of agricultural and rural development and management of expatriate teams abroad. These three institutions have people on their staff, some of whom were members of the Research Definition Team, who will form the core staff for implementation of this program. The three institutions also have the capacity to contract with additional specialist personnel as needed.

The Research Definition Team used a three-step approach in designing the program described in this report. The steps included:

1. Step 1 which provided the team an initial overview of the irrigation management conditions and research needs in Pakistan. This step began with a three-day predeparture orientation and planning workshop at the UI campus. This workshop was devoted to clarification and refinement of individual statements of work, review of irrigation improvement programs in Pakistan and the role of the water research component, a brief review of historical and cultural influences as related to water management in Pakistan, discussion of Pakistani institutions involved with the ISM project, and other team building exercises. The team arrived in Pakistan in late July, 1984, for a stay of approximately one month. During this period the team:

a. began discussions with AID and GOP officials to ascertain the goals and objectives of current GOP water management improvement programs, research priorities, institutions which might participate in the research programs, and needs for institution-building activities,

b. reviewed the scope of the ISM project and began discussions with other component technical advisory teams,

c. collected and reviewed information on past and present research work, including the Revised Action Program, work performed with Colorado State University, WAPDA managed research efforts, and evaluations of the On-Farm Water Management program,

d. visited representative areas for research to help the team to better relate the research objectives of the GOP to specific field conditions, and

e. formulated a draft of a recommended research program, developed recommendations for specific research projects, identified potential collaborators, and developed proposed project time schedules and budgets.

2. Step 2 allowed the Research Definition Team to return to the U.S. to continue the development of the research program in collaboration with other US based staff. This period also allowed for GOP and USAID officials to travel to the U.S. to visit research facilities, meet with UI, WSU and DAI professional staff, interact with institutional staff that will support the research program, examine irrigated and dryland water management practices in Idaho, Washington, and California, and visit with the relevant departments to define training requirements. Meetings were held between the Research Definition Team members, GOP and USAID officials, and others to discuss and solicit suggestions on the proposed research program, and the proposed methodologies.

3. Step 3 was was devoted to further development of the research program and preparation of this report. It was carried out in Pakistan and involved considerable additional consultation with Pakistani researchers, research organizations, and other donor agencies regarding research needs and priorities, and Pakistani institutional capabilities and limitations. The specifics of each proposed research project were also finalized. During this step extensive collaboration and review by Islamabad-based USAID staff helped shape the final form of this document.

It is important to note that the research proposal in this report builds on the past irrigation-related work that has gone on in Pakistan. Two of the most important components of these past research efforts are work at the Mona Reclamation Experimental Project, and the water management research efforts of Colorado State University. Mona was created by the Water and Power Development Authority in 1965 to address water management problems associated with the Salinity Control and Reclamation Project (SCARP). From this beginning, Mona has proceeded to do some of the most significant irrigation water management research in Pakistan, including work which led to the establishment of the On-Farm Water Management program for watercourse improvement. Since the late 1960's, Colorado State University has provided important leadership, training, and technical support for Pakistani water management research, including fruitful collaboration with the Mona project. While a great many difficult research and institution-building tasks remain, these CSU and WAPDA efforts have made significant contributions to knowledge and provide the information base from which this project proposes to begin.

The Research Definition Team proposes a four-year program of research and institution-building. The research proposed is important work by itself. If this aspect of the program is successful and productive, it will add substantially to knowledge about irrigation systems and water management in Pakistan. If these results are successfully transmitted to intended users (other researchers, irrigation system operators, extension workers, policy makers, or farmers), this program could have a substantial impact on Pakistan's agricultural productivity. However, the most important intended impact of this program is the benefit to Pakistani institutions involved with water manage-

ment research. By training scientific staff, and guiding them through the experience of formulating, conducting and administering research programs, the four-year program can begin the longer process of developing a sound management research program in Pakistan which is responsive to national goals.

III. BACKGROUND

A. Irrigated Agriculture in Pakistan

Agriculture is the largest sector of Pakistan's economy, accounting for 70 percent of its export earnings, 55 percent of its labor force, and 29 percent of its Gross Domestic Product. While agriculture's share of the Pakistani economy has fallen in recent years, due to the faster growth of other sectors, agriculture has continued to grow in absolute terms. Recent growth of the agricultural sector (4 percent per year during the period 1978 - 1982) has been good, but less than hoped for, given Pakistan's population growth rate of about 3 percent per year.

Pakistan has an abundance of agricultural resources (adequate water, good soils, favorable climate), yet in spite of the recent growth of agriculture, productivity remains low. The available land and water resources of the Indus Basin are not being used either fully or effectively. This great river basin that forms the core of Pakistan's agriculture has been estimated to have a productive potential of 100 million tons of food grain annually, but it produces only 20 million tons. Ineffective use of land and water results in less than the potential cropped area and reduced yields. The national average yields for all crops are far below yields obtained in experiment station trials, and also substantially below yields now being obtained by progressive Pakistani farmers.

Rainfall over the Indus Basin averages less than 500 millimetres, in some areas substantially less. Consequently, nearly 90 percent of Pakistan's agricultural production comes from irrigated fields. Of about 175 billion cubic metres of water available in the Indus River system annually, about 113 billion cubic meters is diverted into the canal systems of the Punjab and the Sind (the provinces which contain over 95 percent of Pakistan's irrigated area). Water available to farmers consists of slightly over 80 billion cubic metres of canal deliveries to the head of the watercourse, and about 32 billion cubic metres from groundwater. Tarbela and Mangla Dams in the headwaters of the system provide an effective storage capacity of 18 billion cubic metres, and allow some control over timing of water delivery, reducing monsoon flooding, and augmenting rabi and late kharif water supplies.

Pakistan's irrigation canal system (the largest contiguous system in the world) now covers over 14 million hectares, not all of which receive water every year. The total length of the canal system is about 61,000 kilometers (km), with watercourses, farm channels, and field ditches running another 1.6 million km. The system consists of 42 canal commands, with 89,000 watercourses. The physical structure and institutional organization of the Indus canal system is a legacy from the British Engineers and administrators who designed and constructed much of the system.

The system was initially designed to operate with a minimum of operator intervention -- a conscious decision which was based on the huge unwieldy size of the system, the initial lack of storage and control capability, a lack of communication among components of the system, and a lack of trained operational and administrative personnel. While recent structural improvements may have lessened the operational rigidity of the Indus irrigation system, this lack of flexibility for matching water deliveries to crop needs is still one of the constraining realities of the system.

Irrigation system design in the Indus Basin has often ignored the need for adequate drainage, or found adequate drainage difficult or impossible to provide. This has in many cases resulted in severe problems of waterlogging and salinity. A response to this problem has been the construction of almost 13,000 public tubewells under the Salinity Control and Reclamation Projects (SCARP) of the GOP. These were intended to both control water table levels and to augment irrigation water supplies in cases where the water quality is high enough to be used for such purposes. This effort has been supplemented by about 200,000 farmer-owned tubewells, constructed mainly to provide irrigation water but with water table control benefits.

B. Need for Water Management Research

The economic development of Pakistan depends on improving the growth performance of its irrigated agricultural sector. The GOP is committed to the idea that research is an essential mechanism for achieving this needed growth.

On achieving independence in 1947, Pakistan found itself with little left of the research infrastructure that had existed in undivided India. From these beginnings, Pakistan has built an agricultural research network that has 65 research institutes, and 162 stations, sub-stations, centers, and laboratories engaged in agricultural research. This proliferation of agricultural research organizations in Pakistan is an indication of a problem -- in Pakistan as elsewhere, agricultural research has evolved along specific narrow lines where programs, institutions, budgets, and scientists have become oriented to specific problems or crops. It is difficult to break away from this single factor approach. Modern production practices are highly sensitive to all inputs and good management of inputs leads to high economic return. But the converse is also true -- the promised benefits of new practices are lost with poor management of any of the required inputs.

Nothing in agriculture is more complicated than the management of water for effective crop production, whether water is provided naturally through precipitation or artificially through irrigation. It is logical to assume that irrigation provides better opportunity for improvement because of the potential for more accurate control of the water supply. However, exceptionally poor results from irrigation projects all over the world provide strong evidence that the problems of irrigation management are

highly complex and not well understood.

One reason is that research on water management is often not done well. Agricultural researchers, organized in professional disciplines and located in crop-oriented institutes are not challenged to venture outside of their fields -- they are encouraged by their institutional setting to continue their focus on single-factor research. It is not surprising to find that most research in irrigation management tends to focus on one or two single aspects of the totality of irrigation operations: witness the volume of literature on consumptive use of water by all kinds of crops and the paucity of information regarding methods of scheduling water delivery through long conveyance systems to small farms. Single-factor research is needed and has and will continue to produce useful knowledge. However there has to be a way to integrate research on parts of the irrigation system (single factor research) to provide knowledge on the sum of the parts which form the totality of an irrigation system.

Understanding irrigation management requires an understanding of many factors. Control of the timing and quantity of water supply is critical for crop production and this control is subject to many physical, biological, procedural, legal and social factors acting and interacting to influence that control. Study of a part of any one of these factors can lead to better understanding, better water use, and increased production. But a greater potential lies untouched without an integrated study of all factors.

C. The U.S. Experience in Conducting Water Management Research

Such integrated research is highly complicated and cuts across several disciplines. An individual researcher interested in water management must sometimes leave his own field and enter new ones without having adequate training or access to skilled scientists. This is not a problem unique to Pakistan. It is faced in every society that depends heavily on irrigation for agricultural production. The straightforward solution is to create an institution with all the requisite skills housed under one roof. This solution is not only expensive, but it circumvents existing talent available in sister institutions working on integral factors related to water management. One must look for other approaches. In the United States, for example, a system of integrated water management research has evolved which most would agree is not perfect. It does, however, result in effective research that is implemented by operational agencies and farmers with clear payoff in terms of agricultural production.

Several U.S. federal institutions deal with water management and there is no one federal institution that is paramount or exclusively dedicated to water management research. In addition, individual states have created agencies responsible for water management within their respective borders. Within these federal and state institutions reside the scientists that conduct water

management research. The scientists and institutions do not work in isolation. There has evolved a system of networking that allows and stimulates cooperative research programs whereby individual federal and state scientists collaborate on research topics important for water management.

The most important mechanism that has evolved in the United States to foster this collaboration is the program approach to research. In most U.S. research, not just research on water management, research goals are stipulated by a funding agency and institutions and scientists compete for funds to carry out research within guidelines defined by program objectives. Research proposals are submitted to the agency and a peer-review process is used to select the best for funding. This approach forces researchers to be responsive to research priorities developed by public bodies. It is important to note that career advancement by scientists in federal and state agencies is largely determined by the quality and quantity of published research, rather than seniority. Thus there is a strong incentive for scientists to compete for research funds as many research organizations do not have sufficient internal funds to support the operational requirements of their research staff.

The networking system also calls on scientists to help formulate funding agency priorities, and ultimately to help select the projects to be funded. Recognized researchers serve on multi-agency committees to define research goals, objectives, and criteria for selection of research projects. Similar peer-review committees often are used to review the adequacy of proposals, assess the capability of applicant scientists and institutions and recommend which proposals get funded.

Research programs are not solely funded by government research agencies. Funding for agricultural research in the U.S. also comes from public operational agencies, from private foundations, and from private industry. This mix of sources of financial support is then reflected in the research programs undertaken by scientists.

Program definition and funding are not the only tools used to foster collaboration. Heavy emphasis is placed on seminars, workshops, and professional meetings to achieve coordination and build linkages among scientists from several organizations and disciplines. These meetings enable scientists to keep abreast of changes in their own professions as well as to interchange ideas with scientists from related disciplines working on similar problems in water management.

There are continual attempts to build linkages with operational organizations in water management. One example of this was the need for improved irrigation scheduling in several western states. The Agricultural Research Service of the USDA proposed and funded an initial research program. Scientists from several western universities joined with ARS scientists to carry out this basic research. A federal operational agency, the Bureau of

Reclamation, then used the research results, in conjunction with state agricultural extension staff, to develop scheduling programs for individual irrigation districts. Thus the linkage from research to farmers required program interaction between scientists and operational agencies.

This brief description of the water management research system in the U.S. can serve as one model that might be used for developing a similar system in Pakistan. It is certainly not a blueprint for a Pakistani program since there are important differences between conditions in the U.S. and Pakistan. One very important difference is that research and extension in individual states are part of the university system and are closely tied to teaching. This is not true in Pakistan.

A second important difference is that in Pakistan the government is responsible for water delivery to a chak. It is also a "retailer" of the water and assesses farmers for water deliveries. In the U.S., the government is a "wholesaler" of the water, making contracted deliveries to water districts that are farmer-controlled. These institutional differences generate different research needs since research must also address the institutions that operate the systems.

There are, however, close institutional parallels between Pakistan and the U.S. The United States Department of Agriculture, the Agricultural Research Service, and the Bureau of Reclamation have their counterparts in Pakistan in the Ministry of Agriculture, Food and Cooperatives; the Ministry of Water and Power; the Irrigation, Drainage and Flood Control Research Council; the Pakistan Agriculture Research Council; and the Water and Power Development Authority. Provincial agricultural universities and research institutes have their counterparts in the individual state universities. The provincial irrigation departments are likewise found in the individual states but with different names and often narrower mandates for operation. In the western U.S., fairly small farmer-controlled irrigation districts perform many of the functions performed by Pakistani irrigation departments. Likewise, agricultural extension services in Pakistan have their counterparts in the extension services of the individual states.

The need to improve research in water management in Pakistan is clear, but how to satisfy this need is not. It is easy to point out that a viable research program must have at least two prerequisites -- good projects and good researchers. Good researchers are the product of good training, and good projects result from a basic understanding of the problems. The first logical step in developing a lasting research program is to learn as much as possible about how the system functions. This knowledge can be used to develop relevant and researchable projects, and those involved will have learned a great deal about integrated research and will be better able to delineate their own training needs. At the same time the institutions which house this trained individuals will have received the benefits of their training, and

the useful institution-building experience of participating in the conceptualization and design of the projects.

Any program to address the research needs of Pakistani irrigated agriculture must have as a primary objective the development of well-trained and knowledgeable researchers who have a good grasp of the totality of problem. The research/training program suggested here is designed to do integrated interdisciplinary research and at the same time accomplish the institution-building objectives.

IV. FINDINGS AND RECOMMENDATIONS

A. Water Management Research in Pakistan

Several sources can be cited as constituting or contributing to a firm foundation for water management research in Pakistan. The Revelle Report of 1964 described waterlogging and salinity and the steps that might be taken to contain these problems. The CSU-implemented and USAID-sponsored Water Management Research Project during the 1970s contributed to establishment of facilities for water management research at Mona. A series of over fifty published reports stemming from the CSU project constitute a comprehensive and extremely valuable research and information base particularly for water management below the mogha. More comprehensive views of water management research needs are contained in The Report of the Indus Basin Research Assessment Group (1978), and the Revised Action Plan for Irrigated Agriculture (1979). These reports offer agendas for future irrigation research in the context of the entire Indus system. An appreciation of the contents of those reports is essential for design of any agricultural research program constructed for the second half of the 1980s. Tariq Husain's report to IBRD, Potential for Irrigated Agricultural Development in Pakistan (1981), provides valuable basic data pertaining to irrigation system performance and policy-type research needs. Three recent reports to USAID also provide research overview: The Agricultural Research System of Pakistan: The Report of the Minnesota Reconnaissance Team (1982); Strengthening Agricultural Research in Pakistan (1983), and the report by Dean F. Peterson, Long-Range Strategy Options for Water Resources (1984).

The reports listed in the previous paragraph are augmented by thousands of published reports that are concerned with discrete, and often minute, aspects of water management in Pakistan. The Research Definition Team did not have time to review all of these. But it became apparent to the team that much of that research lacked focus as to where it fits in addressing problems of importance in Pakistan irrigation.

Review of the literature cited above under Section IV.A. together with the Research Definition Team's assessment leads to an enumeration of priority water management research components that should be addressed in a comprehensive research program. A new program cannot initially address all of these nor in the order they are listed below. Priority components are the following:

1. water delivery from the mogha to the farm - since large donor-supported projects in On-Farm Water Management are underway, there is a pressing need to evaluate these projects, and to design programs to translate water savings to agricultural production increases and economic benefits to farmers;

2. farm water management - irrigation and synergistic agronomic practices are needed to improve production technology and close the wide gap that exists between irrigated agricultural potential and actual production;

3. water user participation in better water management - what can be done to mobilize farmers, collectively and individually, for more effective participation in water management activities, including activities now performed by government entities;

4. drainage - what can be done to improve on-farm surface drainage and solve the more traditional and long-discussed problems of waterlogging and water table control;

5. conjunctive use of groundwater - this practice can supplement inadequate surface supplies and also serve as a means of water table control;

6. pumps, wells, and SCARP operations - these operations are key to providing water table control, augmentation of inadequate surface water supplies, and flexibility in water delivery scheduling to farmers;

7. main system water management operations - how operation of the main system can be made more flexible and timely to water users;

8. salinity and sodicity - what can be done to limit its extent and to utilize affected lands for agricultural production;

9. watershed management - practices to reduce deterioration of the resource base and beneficially use runoff in catchments and basins for productive purposes are needed;

10. traditional/indigenous irrigation systems - systems unique to Pakistan would require modest levels of technology to improve irrigation in remote, water-scarce areas of the country;

11. policy related to irrigated agriculture - private and public institutions and regulations (markets, water policy, product prices) have a strong influence on farmers' effective use of water and their willingness to adopt new practices;

FINDING:

There is a substantial body of water management research information together with operational experience covering a full range of topics which forms a foundation for a water management research program.

RECOMMENDATION:

A comprehensive research program in water management should be developed which can, in time, address these priority components.

B. Institutional Base for Water Management Research

Three types of institutions are involved in water related research: federal and provincial agencies that are charged with coordination of national research programs and in-house research; universities; federal and provincial line agencies that carry out research and investigations related to operational requirements or in response to requests from other governmental bodies. The most important of the latter category is WAPDA.

The two major federal institutions are the Pakistan Agricultural Research Council (PARC) and the Irrigation Drainage and Flood Control Research Council (IDFCRC). PARC works directly with provincial agricultural research bodies as well as in managing in-house research programs through dependent federal research institutes. The National Agricultural Research Center near Islamabad is an example of the latter.

Water-related research through PARC has not received high priority as yet: a coordinated program in water management has not been established. (A coordinated program is a means to mobilize scientists throughout Pakistan to work together on a particular agricultural commodity or sector.)

IDFCRC has a mandate to coordinate and fund research in several aspects of water management. The single research institute under IDFCRC is the Drainage Research Institute of Pakistan (DRIP) located near Hyderabad.

Except for the Center of Excellence in Water Resources, the role of universities in water management research is extremely limited due to their focus on teaching functions. Professional staff engage in water-related research only on an ad hoc basis. Thus, valuable scientific talent within the teaching community is largely untapped and current research findings are not incorporated into the teaching curriculum.

Lack of active participation by universities in water management research is a serious deficiency. Much of the pool of holders of the Ph.D. reside in the universities and the separation of research from teaching reduces the talent that could contribute to water management research.

WAPDA carries out the most varied water-related research programs in Pakistan. The irrigation/agronomy work at Mona, the beginning program at LIM, groundwater surveys throughout Pakistan, the ACOP

program, and the continuing evaluation work by the Monitoring and Evaluation Unit are examples of the breadth and importance of water related research carried out by WAPDA. There is no other institution in Pakistan that has as many experienced technical staff or as long a history of research and investigations in water as WAPDA.

The lead role played by WAPDA over the past several years has produced the most comprehensive body of water management research in Pakistan. This clearly points to WAPDA as the lead agency for an expanded water management research program. It is also clear that WAPDA has to expand linkages with other research bodies in Pakistan in order to more efficiently and effectively cover non-engineering aspects of water management research. Specifically, incorporation of agricultural research facilities, provincial and federal, through PARC and links to universities through IDFCRC, will provide stronger institutional coordination for water management research.

During Step 3, a review was made of library facilities in several institutions (detail in Annex I). Incomplete collections, sporadic subscriptions to foreign journals, and inadequate cataloguing and dissemination of library materials were found in all cases. Most importantly, a system to capture, catalogue, and reproduce research publications written by Pakistani researchers in water management was non-existent. There is no mechanism for interlibrary lending except on a personal basis.

FINDINGS:

1. Pakistan has a wealth of research institutions that could contribute to a water management research program. WAPDA, through the units under the Water Wing, has established the base for an expanded program. Inter-institutional agreements with PARC and IDFCRC would enable other key institutions to support a new program.

2. The library system to support scientific research in water management is inadequate.

RECOMMENDATIONS:

1. WAPDA, because of its strong base in water-related studies, and its proven operational ability should be the primary counterpart for the water management research program. IDFCRC and PARC should be collaborators in the proposed Program.

2. A Coordinated Program at PARC in topics related to water use would be strongly supportive of the proposed Program.

3. The PC-1 of IDFCRC to provide global library support for water management research should, with modifications, be supported.

1. Mona Reclamation Experimental Project[1]

At Mona, much of the research has moved toward agronomic emphasis and away from engineering and watercourse conveyance work that was the mainstay of the initial work. No other institutions in Pakistan have adequately addressed field engineering questions related to water delivery to the farm. Mona should exploit their comparative advantage in this area. This is not a call to abandon all current research objectives, but rather to seek other institutional collaborators to carry out allied research dealing with plant, soil, and water interactions and to do so on the Mona project.

Modification and reordering of the proposed research projects at Mona lead to necessary elements of the water management research program and should be supported.

FINDING:

1. Mona has had some success in conducting multi-disciplinary action research. The approach of this work stands out in contrast to experiment station research conducted under controlled conditions.

RECOMMENDATIONS:

1. The Mona Reclamation Experimental Project is a key institution for implementation of the Program and should lead the Integrated Watercourse Management and Farm Water Management projects.

2. USAID support for Mona and LIM will be required until the GOP provides support under the Revenue Budget instead of the Development Program. The annual level of support should be made contingent upon the GOP increasing their support to these institutions. The total amount of support provided through the Water Management Research Program should not exceed $800,000.

3. The research program at Mona should focus on water management and less on agronomic research that can be done by other institutions.

4. Certain of the research studies proposed in the Mona PC-1 should form part of the proposed Program.

---

1 The program at Mona and the one proposed at LIM were examined in detail and the review is found in Annex D.)

2. Lower Indus Water Management and Reclamation Project (LIM)

Agro-climatic and economic conditions in Sind are different from Northern Punjab. The area is drier, salinity and sodicity are more widespread, groundwater is more saline, topography is flatter, farm size is larger, and tenancy is more common. It is clear that substantial portions of the water management technology developed at Mona for Punjabi conditions do not fit the needs of the farmers in the lower Indus. As in the case at Mona, LIM should focus on an existing portion of the irrigation system and not be tied to experiment station research.

The proposed headquarters of LIM near Tando Adam is not conducive to effective research. It is isolated and office facilities would have to be constructed. The staff spends valuable time traveling from home-to-site, and the absence of schools creates hardships on families. It would be better to place LIM in Hyderabad, a location typical of lower Sind. Here, office space can be rented and communications are better than at Tando Adam. Most importantly, closer proximity to Jamshiro and Tando Jam Universities in Hyderabad, and to DRIP will facilitate cooperative research programs and add to the research capability of LIM. These institutions have expressed a willingness to work cooperatively with LIM.

RECOMMENDATIONS:

1. The Lower Indus region represents a set of agro-climatic and economic conditions which are different from that of Northern Punjab. Water management technologies should be developed for this region.

2. Funding for LIM will require core support as in the case of Mona, but most operational funds should come from project-specific research activities. No funds should be provided by USAID for new construction.

3. The proposed headquarters for LIM should be changed from Tando Adam to Hyderabad to take advantage of existing facilities and to have ready access to cooperative research programs with other institutions.

C. Current and Alternative Approaches to Water Management Research

Research priorities in water management are developed largely on an institutional basis. For example, WAPDA may focus on engineering aspects of watercourse improvement, IDFCRC on drainage and drip irrigation, and PARC on salinity in agriculture. The result is that while research projects are not necessarily duplicative, there is a large degree of institutional isolation, and results do not serve as building blocks for other institutional programs. The Research Definition Team does not

suggest that all water management research be concentrated in a handful of institutions, but rather that the approach to research be better coordinated so that institutional programs become supportive building blocks that adequately address the priorities described above.

Under the present conditions, even if the pieces of Pakistan's water management research program were put together, the fabric that would emerge would contain significant gaps that are not adequately addressed. As an example, the OFWM program is carrying out watercourse improvement so that farmers receive more water than they received prior to improvement, but in the absence of a research program to suggest ways in which water savings can be translated to increased agricultural production, the full benefits from the various OFWM projects are not being obtained.

In contrast to experiment station research under controlled conditions, water management work conducted by WAPDA at Mona, and by UAF , at Shahkot are modest but important research efforts that deal with functioning irrigation systems. This type of work provides the researcher with an appreciation of the entire range of constraints that the farmer faces. As Peterson has pointed out:

> Here research cannot be done under controlled conditions, rather the behavior of the system defines the conditions and research must be done on actual irrigation systems. Performance, operations and maintenance of watercourses and canals, conjunctive use of fresh and saline groundwater, canal operations, optimal cropping systems, water user involvement, water scheduling and canal operation, need to be considered interactively on real systems. Approaching some of these topics as detailed components has led to misconceptions about what needs to be done to improve irrigation systems. This kind of research is interdisciplinary and inferential, ... (2)

Once researchers move off the experiment station into contact with farmers and irrigation systems, they function not only as researchers but also as extension agents. The information exchange that takes place is bi-directional, researchers offering new technology through demonstrations, and farmers providing insight for refinement of research needs. This approach has come to be known as Farming Systems Research and Extension (FSRE).

---

(2) Peterson, Dean F., Long-Range Strategy Options for Water Resources, Report to USAID, April 1984, p. 78.

When researchers deal with government officials in operating agencies and exchange ideas that can lead to "try-and-see" operational research innovations, this is known as "action research". These approaches to research are not widely applied in Pakistan. Similar to most countries, Pakistan has institutional separations between research, extension and training. In countries where these functions have been merged under a single responsible institution, and where the same individual often has job responsibilities in each function, (the U.S. Land Grant university system) the interaction has been found to be conducive to producing well-directed research programs, extending the research results to the next user, and training researchers.

Except for the coordinated programs of PARC, funding for research is allocated by governmental level (federal and provincial) and by institution. It is common in many research institutions to have a large percentage of funds covering fixed costs (establishment) with little left for operational research requirements. An alternative to this is to provide funds for research through specific programs open to several institutions. This draws the best available talent for specific requirements and assures that research projects are responsive to national priorities.

FINDINGS:

1. Research, extension, and training functions are institutionally separate which affects the quality of the research, its degree of dissemination to the end user, and the professional development of the research worker and manager.

2. Commodity oriented research is the norm with little off-the-experiment-station water management research work performed.

RECOMMENDATIONS:

1. Discrete parts of a priority water management research agenda such as crop response to high water table conditions, or irrigation application methods should be addressed. There is also a pressing need to examine the interactions within an irrigation system.

2. Research requirements must be well-defined to assure that specific research projects serve as building blocks for related and future research. It is important that individual researchers have an understanding of how their work relates to a better understanding of the entire system.

3. It is essential for researchers to move off the experiment stations and to deal with institutions where farmers, operating agencies, and extension services are involved so that implementation constraints can be addressed at the same time.

4. Operational funds for research should be provided through a program approach rather than by strict institutional allocations.

D. Professional Development

Exact numbers of scientists engaged in water management research in Pakistan are difficult to gauge. Data collected for the institutional profiles are only one indicator of a scarcity of trained personnel. Discussions with scientists and administrators confirm that skilled scientific personnel are in short supply. Compounding this is the fact that Ph.D. holders are often placed in administrative positions or engaged in teaching, thus limiting their contribution to research.

Despite the number and diversity of agricultural research institutions in Pakistan, there is general agreement among government officials and foreign donors that research productivity is low and that results are not incorporated into implementation programs. This situation is not unusual. The International Service for National Agricultural Research (1982) identified a number of features of agricultural research programs in developing nations which characterize the situation in Pakistan:

1. weak links exist between policy units of governments and the research system so that the role between agricultural research and national development is not clearly established;

2. more problems are found in national research systems based on human or political issues than on technical matters;

3. many systems do not have well developed plans for their research programs, particularly with regard to manpower needs and other factors of research productivity;

4. staffing and leadership for agricultural research have not kept pace with demand;

5. most systems have fewer scientists than required and the lack of support services often obliges them to spend an undue amount of time on non-research activities;

6. national public service regulations, under which most developing countries' agricultural scientists are employed, often do not provide salary and promotional opportunities needed to keep the best scientists in government research service;

7. many researchers work in relative isolation and are not in close contact with scientists doing similar research;

8. in many systems, research is done with a single focus and problems are not approached with an interdisciplinary perspective;

9. researchers are isolated from the users of the results although close contact would lead to more usable results which might be more quickly applied.

While many of the broader institutional issues are identified elsewhere in this report and incorporated in the design, the issues relating to research management are tied to training requirements. Research personnel have not had the opportunity to experience on-the-job training to learn how to conduct quality research. A review of research proposals indicate weaknesses in formulating research hypotheses, identifying expected results, specifying a clear research plan, and relating proposed research to a problem. Results are not systematically recorded and publications are often limited to a few copies with limited intra-institutional distribution. There are few cases of systematic peer review to assure quality.

FINDING:

The number of Pakistani scientists engaged in water management research is inadequate to mount an effective program. Additionally, research skills beyond formal technical training are not well developed.

RECOMMENDATIONS:

1. Formal degree training to increase technical expertise in specified fields should be incorporated into the research program.

2. An effective program for water management research should not only provide short-term answers to priority research problems, but also should look to the longer term by efforts aimed at building worker competence and managerial expertise.

E. Conclusions

The importance of irrigated agriculture in the Pakistani economy is a persuasive argument for an expanded program in water management research. There exists a research foundation to build upon, the basic institutions are in place, a minimum corps of scientific talent is available, and interest within institutions appears to be high.

What is required is a well-designed research program which will address research content and institution-building, and sufficient time to develop technical skills and managerial competence.

The next section of this report outlines a program which incorporates the findings and recommendations presented above.

V. DESCRIPTION OF THE WATER MANAGEMENT RESEARCH PROGRAM

A. Introduction

The Water Management Research Program recommended here contains two related components: a) a set of priority projects which addresses national objectives and research needs in Pakistan, and b) institution-building activities that focus on research management, a competitive grants program, and training which will provide technical skills and hands-on experience in the definition, design, conduct, and management of research projects. The program is described below. Specific projects are briefly described here and presented in detail in Annex B.

B. Goal and Purpose

The goal of the program is to increase the effective use of water through research to increase agricultural production, productivity, and farmer income. The purpose is to improve the capability of scientists and institutions to conduct irrigation research. Technical expertise and research management skills will be developed so that a foundation for a well organized, well managed, and integrated research program is firmly established.

C. Program Overview

The Water Management Research Program is designed with two interrelated components: research and institution-building. Taken together they provide a framework that will build Pakistani capacity in irrigation research. Building that capacity entails st engthening both individuals and the institutions that have key responsibilities in irrigation research and development.

The research component consists of a series of specific research projects grouped into research areas. The institution-building component consists of research management which encompasses information management and extension of research results, a competitive research grants program, and training. These components are described in detail in Section D.2. of this chapter.

Specific research projects are designed both to provide short-term results and to build research competency. Each individual project offers specific research outputs, or added understanding of a specific problem. Collectively, individual projects within the research program enhance the project purpose by offering GOP researchers "hands-on" experience in research planning, implementation, analysis, and management.

Institution-building components are built into all projects. Training, technology transfer, research management and information management are integral parts of each. Projects address institution-building components in unique ways. The Groundwater-Surface Water Models Project includes Ph.D. and M.S. level training for researchers, technology transfer through the re-

search working group, and research management through a participatory management structure that encourages staff from several agencies to contribute to the whole of the project. The Farm Water Management Project will promote better research management and extension of research results by providing opportunities for research and extension staff to work together in the conduct of farming systems research and extension trials, i.e. research/demonstration work on farmers' fields. This is one way of bridging the gap between research and extension directorates and is a proven method of technology transfer. Similarly, other projects foster institutional development while providing specific research output.

D. Components

1. Research

a. Program Areas

The research projects presented in Annex B are grouped into areas to 1) concentrate substantive program focus on areas of major research needs rather than on individual research projects; 2) promote cohesiveness between projects that might otherwise be treated individually; and 3) improve the management of projects, personnel, and funds. Recognizing that there are strong links and interdependencies among them, the program areas and projects are as follows:

Farm Water and Watercourse Management

1. Farm Water Management
2. Beyond Watercourse Improvement
3. Encouraging Water User Involvement in Better Water Management

Water Supply and Delivery Systems

1. Irrigation Systems Outside the Indus Basin
2. Integrated Watercourse Management

Drainage and Conjunctive Use

1. Surface Drainage and Water Table Control
2. Development of Groundwater - Surface Water Models
3. Public and Private Tubewell Performance

Together with the institution-building activities described in Section D.2., the area grouping and the array of projects constitute an initial program. Implementation would begin by focusing on defined priority areas of important research need, then adding projects and possibly program areas as management of the research program becomes fully operative and as personnel and funds permit.

Thus, neither the program areas nor the listed projects are intended to be all inclusive or final. Rather, the program is designed with flexibility to allow additional research projects and areas to be added. New projects and or new areas will be formally incorporated into the program in the annual work plans.

b. Research Projects

The Farm Water and Watercourse Management area draws upon diverse project inputs - agronomy, engineering, sociology, economics, - all bonded by a common focus, that of improving farmer-controlled agricultural production technology in the area downstream from the mogha. Many people familiar with Pakistan irrigation contend that, because of the inherent limitation of inadequate water supplies imposed by design of the Indus irrigation system, improvement in farmer-controlled water management affords the only flexibility possible in an otherwise inflexible water delivery system. The Farm Water Management project will emphasize the development of improved irrigation and agronomic practices for implementation by the water user. Beyond Watercourse Improvement: The Socioeconomic Impact of Public and Private Investments in Water Management will examine the socioeconomic impact of past improvement programs and conduct research for evaluation purposes to provide guidelines for future interventions. This project will provide basic research required for policy formulation in the water sector. Encouraging Water User Involvement in Better Water Management will look intensively into sociological and institutional factors that are central to increasing farmer participation in better water management.

The mogha is a break point for institutional control of irrigation. The Water Supply and Delivery Systems program area focuses generally upstream of the mogha (main system management), where institutional control rests with government entities such as the Provincial Irrigation Departments or WAPDA. Integrated Watercourse Management will integrate operations above and below the mogha and will seek to examine alternatives within the warabandi system for more effective delivery and utilization of water on farmers' fields. Research parameters will include alternative schedules of the warabandi, chak size, farmer initiatives to modify crop and area patterns to optimize water use, and conjunctive water supplies. This project will directly support government programs in command water management. The research focus of Irrigation Systems Outside the Indus System, will be irrigation systems which may or may not be government operated, but where government assistance to develop and preserve scarce water resources has been the accepted norm.

Efficient management of surface and groundwater supplies to meet irrigation demands and to prevent waterlogging is addressed in the Drainage and Conjunctive Use program area. Proper and timely operations and maintenance (O&M) of tubewells and surface drainage facilities can lessen waterlogging and reclaim unproductive lands while supplementing inadequate surface water supplies. Unanticipated O&M problems with public and private tubewells have reduced their expected useful life and increased the financial burden on both irrigation departments and farmers. Public and Private Tubewell Performance will examine well construction methods, materials, and operational procedures to develop cost effective alternatives. Surface drainage measures available to the individual farmer or farmer groups are costly. Research will be conducted on low-cost methods of and materials for surface drainage adapted to local conditions under the Surface Drainage and Water Table Control project. This will include a socio-technical analysis of what farmers can do for themselves to obtain improved drainage. In Development of Groundwater-Surface Water Models, computer-assisted methods will be developed for evaluation and management of shallow groundwater systems to prevent saline water intrusion, maintain adequate water table elevations, and provide timely supplemental irrigation supplies. Such methods can be valuble tools for operating agencies. Computer data management procedures for hydrologic data such as water level and stream flow measurements are state-of-the-art for efficient water management planning and operation. Development of such methods and procedures is contemplated.

c. Potential Research

In addition to the eight projects which constitute the core of the initial Program, the Research Definition Team considered a series of other potential research topics. For various reasons, primarily the requirement to start with a well-focused and manageable initial research program with priorities indicated by GOP officials, additional topics are not addressed at this time. Other topics could be developed into research proposals during implementation. This flexibility is a major characteristic of the design: introduction of new research projects to deepen and broaden the research program which will permit Pakistani researchers to have responsibility for developing their own research programs and, in the process, develop their skills as research initiators and managers.

Following is a brief summary of water management research topics which were discussed with GOP or USAID officials but which are not proposed for initial funding.

i. Advanced Irrigation Technologies

Advanced irrigation technologies include irrigation techniques such as drip, micro-jet and sprinkler, and use of plastics to conserve water and slow weed growth. Although there is rapidly increasing interest on the part of GOP officials, discussions about an 8000-acre ADB-sponsored drip irriga-

tion project in Baluchistan, and a limited experimental program sponsored principally by IDFCRC and PARC, there has been almost no adoption of these technologies by farmers. The reasons for lack of adoption need to be studied since the technologies are well proven elsewhere. A research project could focus upon developing low cost materials in-country, development of delivery systems or storage which would permit daily on-farm water applications, farmer-irrigation system interaction with respect to maintenance of drip systems, and social and economic constraints to technology adoption.

ii. Command Water Management

Command Water Management (CWM) will be an operational research project with a management focus on agricultural output in an irrigation command. The Program could conduct research in support of the CWM projects in areas such as technology development and/or transfer, or project management related to an irrigation command area. Several of the projects proposed under the Program could be carried out in CWM subproject areas and thus add to the body of knowledge necessary to achieve CWM objectives.

iii. Irrigation Policy

In the core set of projects, socioeconomic research will be conducted on the acceptances by farmers and other end users of water management interventions. This research should be extended to include irrigation policy issues that constrain or encourage the diffusion of the technology since technology adoption is in large part dependent upon the policy framework. Researchable issues include: a) fiscal policy related to O&M requirements; b) water pricing and its impact on water use, crop mix, and production and productivity levels; c) institutional, legal, and economic policy related to formation of drainage districts; d) the impact of chak size on water delivery efficiency and delivery of government services for civil improvements and extension; and e) opportunities for private sector involvement in irrigation system O & M.

iv. Reservoir Operations

There is a need within WAPDA to develop more effective and improved procedures for management of reservoir storage releases, and river and link canal flows. Currently, no computer-based management models are used for short-term operation of the system. Current or planned cooperative efforts with Canadian and Dutch institutions to improve flood and seasonal forecasting procedures and installation of hydromet systems can provide more reliable inputs to a management system. However, increased storage to be provided by Kalabagh Dam will allow better management of the total water supply system, including link canals, only if adequate computer-based procedures are available. A project to address this need should receive priority consideration for future inclusion in the

program.

v. Standard Designs for Small Diversion Structures in Civil Canals

In the Swat Valley and numerous other locations in NWFP and Baluchistan, diversions from rivers to privately owned (civil canals) must be replaced each year as they are washed away during floods. Although the canals are private, responsibility for replacement rests with the irrigation departments. To reduce costs associated with replacement it is in the interest of the PID to develop standard designs for permanent or gabion-type weirs and head regulators which improve upon the rock, gunny bag or killa-bushing systems presently employed. Discussions were held with the PID, NWFP, regarding their interest in obtaining support for research (pilot testing) and training toward development of standard designs. While the PID has interest it is more directed to obtaining support for construction rather than for research into design standardization.

vi. Aerial Photography

An important data collection activity for water-related research -- with application for general agriculture -- is aerial photography or satellite imagery. Ground surveys to measure changes in such variables as saline areas, changing cultivation of major crops, and river changes are too expensive and time consuming. Preliminary discussions with GOP officials towards the end of the design phase indicate some interest.

The listing provided above for future potential projects is by no means complete. Other projects will be considered on their merit even if not expressly mentioned in this report.

d. Estimated Costs

The estimated costs of the research projects are given in Table 2. These include expenses for short-term technical advisors, including travel and per diem, operational expenses directly required for each project, and equipment. Long-term support for the projects, where needed, is costed in the budgets for long-term technical assistance and in-country support (Tables 10 and 11) reflecting that their duties extend beyond a specific project. Salaries of Pakistani principal investigators and overhead expenses of cooperating institutions are not included. Training costs are not charged to each project, but rather are shown in a training budget (Table 7) for the whole program.

TABLE 2.

ESTIMATED RESEARCH PROJECT COSTS
($US DOLLARS)

	FY85	FY86	FY87	FY88	FY89	TOTAL
RESEARCH PROJECTS						
a. Integrated Watercourse Management	162,594	245,850	199,815	205,370	62,191	875,820
b. Surface Drainage	123,342	81,111	110,481	118,621	64,075	497,630
c. Tubewell Performance	98,371	106,288	127,449	113,121	46,406	491,635
d. Irrigation Outside Indus	147,062	120,876	131,863	134,778	101,228	635,807
e. Encouraging Water Users	60,356	152,873	119,268	42,020	20,873	395,390
f. Groundwater Models	249,087	175,134	90,537	94,084	87,629	696,471
g. Farm Water Management	252,006	118,291	106,521	110,646	46,681	634,145
h. Beyond Watercourse	99,153	197,471	200,399	114,187	46,551	657,761
i. Unspecified Research Reserve		300,000	600,000	500,000	100,000	1,500,000
TOTAL	1,191,971	1,497,894	1,686,333	1,432,827	575,634	6,384,659

NOTES

(1) First year costs include vehicles to be purchased by USAID.
(2) Short-term technical assistance person months: 81
(3) Detailed project budgets are attached to each project in Annex B.

2. Institution Building

Three institution-building activities will support an objective of the Program to improve the capacity of research scientists and institutions in Pakistan to conduct water management research. Although some elements of these activities are integral parts of the proposed research projects, they are described here because of their role in creating a research infrastructure so that meaningful water management research will continue beyond the life of the program.

a. Research Management

Research management is a step-wise approach to the resarch process consisting of: (1) conceptualization of a research problem in the context of the Pakistani situation; (2) design of a research proposal which pays particular attention to presentation of the problem and methods of data collection and analysis; (3) management of the effort including team organization and delineation of responsibilities, budgeting, and means of reporting progress; and (4) identification of users and dissemination of results.

Four approaches to the improvement of research management are identified for implementation: staff organization, research project development, research management training, and extension of research results.

i. Staff Organization

The core team will work cooperatively with a large number of Pakistani research institutions and will recruit its local collaborators from their staff. The Program has been designed with a small long-term expatriate team acting primarily as research advisors. Research activities will rely heavily upon Pakistani researchers who will serve as principal investigators working cooperatively with long- and short-term foreign consultants. Local principal investigators and foreign advisors will share responsibility for the design and management of the research staff, budgeting and funding, institutional coordination, and creating links with adminstrators and extension services. The managerial and research responsiblities of the principal investigators will increase during the life of the project.

ii. Research Development

Emphasis will be placed on TA team members working closely with Pakistani investigators in the development of the designated research projects and the competitive grants program. The accountability of the reseachers is an important element in the improvement of managerial skills.

(a) Designing Research Projects

A detailed plan will be developed for all research projects prior to funding. It will include the role of the cooperating institution and the responsibilities of the participating individuals, a proposed schedule of activities including checkpoints to review progress, a description of research applications, and an identification of institutions to support those activities.

(b) Research Progress Reports

Principal investigators will be expected to submit quarterly reports to project management which discuss activities during the period, including administrative problems and possible solutions, deviations from the schedule, budget allocations, training needs, tentative research findings, and collaborative activities with other program activities and research institutions. Issues raised in these reports are likely to be common to many of the projects and will be focal points of team meetings and meetings of the management support group.

(c) Research Program Management

The chairmen of Pakistani research institutions and the chiefs-of-party of research programs, including PARC, IDFCRC, the Water Management Research Program, and MART will meet annually to discuss matters of joint interest in research administration. Issues related to financial and personnel management are expected to be common concerns.

iii. Research Management Training

A series of training activities aimed as increasing the research management skills of GOP participants in Program-supported efforts will be carried out over the life of the project, both in-country and in the United States. Although certain areas for training may now be identified, the exact format, sequencing, and topical focus will be determined on the basis of participant needs learned through project management reviews, research progress reports, and meetings of the management support group.

(a) Management Support Group

A management support group will be established and will be composed of team members, representatives of relevant Pakistani institutions, and the USAID project officer. The Chief of Party will serve as its chairman and will schedule regular meetings. Participation in the group will be a requirement of investigators for support. The group will have the following responsibilities:

(1) review proposed and on-going research projects to coordinate these efforts and keep home institutions informed of project activities;

(2) coordinate its activities with the competitive grants program;

(3) identify opportunities for collaboration between participating institutions, and individuals and where possible assign responsibilities for making such collaboration operational;

(4) assess all activities for practical applications and identify Pakistani institutions through which the extension of research results might be done;

(5) identify special budgeting, funding mechanisms, and staffing opportunities that can increase the effectiveness of the research;

(6) discuss management development needs for each project and provide resources to meet those needs;

(7) identify training requirements;

(8) provide feedback to the Program management from GOP institutions about the conduct of the Program;

(9) prepare a report of the meetings to be distributed to all staff.

(b) <u>In-country Training</u>

Counterpart training will be an integral part of every expatriate advisor's tasks. This training will often be informal, growing out of the relationship between expatriate and local researcher during the course of the individual projects. In addition, training in research management will be provided to participants from all supported projects and to outside researchers as needs are identified. This training is likely to take the form of workshops organized around specific problem areas, such as:

(1) interdisciplinary research management: methods for supporting interdisciplinary research from policy and planning perspectives, budgeting, financial control, team selection and team building, professional and motivational enhancement, role definitions, research design, and project evaluations;

(2) proposal writing and project design: a short course to support the competitive grants program;

(3) microcomputer supported management information systems: use of microcomputers for administrative and management needs, financial management, personnel records, and simple data-based management;

(4) program management: The Program Director will be called upon to offer workshops on management of this program as an example of research and its management;

(5) budgeting and finance management: to support research project development, implementation, and reporting;

(6) information systems: access to literature and other "networking" projects in progress and obligations to make information available to next users.

(c) Training Overseas

Training will include long-term degree training programs in the United States. Experience indicates that many of the returning participants ultimately become research managers. Provisions will be made to give them some managerial training as part of their graduate program. This may involve interning at a training or research institution, taking special university courses, or attending USDA or other management courses. The regular visits of expatriate researchers to Pakistan to work with local investigators on water management research projects are expected to create close relationships. Building on these ties, local researchers will be funded to spend time at research institutions in the United States or elsewhere. They will work with counterparts, cooperating in the research institution's activities. For optimal effectiveness, such visits ought to last at least six months.

iv. Extension of Research Results

The utilization of research results should be an imporant element in any research program. The program has been designed with an awareness that researchers in Pakistan frequently work in isolation and that findings are not disseminated or used. A high priority is the bringing of "next users" into the research process. These include other researchers, administrators, and extension specialists who will build upon the results to reach their own objectives. The aims of this extension of research results are as follows: (1) to provide research-generated information to next users; (2) to increase the likelihood of adoption of research findings by farmers; (3) to enable testing of technologies in a wider set of environments than those where the technologies were initially developed; (4) to improve initial technology development by creating and strengthening feedback loops which provide better program direction for researchers; (5) to stimulate contact between researchers and extension agents and between both these

groups and end users to stimulate institutionalization of relationships conducive to the improved extension of these results.

(a) Information Management

Pakistan's technical libraries have only limited collections in water management which are inadequately catalogued. They do not possess the equipment for standard library services such as copying, management, and distribution of materials. Nor do they have access to information sources in the international scientific community. They appear to mirror the situation of most Pakistani researchers, who are typically isolated and have limited resources. To support the research activities of this program, a permanently housed library collection on water management must be established in Pakistan. It will serve as a major resource in a self-sustaining water management research program. This activity will:

(1) establish a functional research library in water management within IDFCRC which has a government mandate to function as a documentation center for water management;

(2) implement a system to capture and disseminate Pakistani materials related to water management including those generated by this program;

(3) establish a system for the continuing receipt of journals, serials, monographs, and other materials;

(4) develop a functioning linkage among librarians with water management collections in Pakistan;

(5) establish a system linking Pakistani technical librarians with international resources;

(6) develop a functioning nationwide information and referral system related to water management in Pakistan.

Towards those ends, the following actions will be taken:

(1) The pending PC-1 of IDFCRC will be supported to create a collection on water management capable of providing library functions: journal and book dissemination, current awareness services, bibliographies, and interlibrary coordination. Collection and cataloging of Pakistani water management documents should be included in their activities. A microcomputer system will be provided to manage this system and to track work in progress, facilitate linkages between people and institutions, and coordinate training and scheduling activities. Staff will be trained in design and communication skills and in the operation of the equipment.

(2) A joint committee of technical librarians from IDFCRC, WAPDA, the Center of Excellence for Water Resource Engineering, PARC, University of Agriculture at Faisalabad, University of Agriculture at Tando Jam and University of Agriculture at Peshawar will be formed to coordinate collaborative efforts, including interlibrary networking. Based on their participation and interest, equipment may be provided to their libraries to facilitate this information exchange.

(3) Several card duplicators will be purchased and distributed to those agriculture and technical libraries which have important documents for the PARC/AGRIS network, an FAO-supported international agricultural information system.

(b) Training for Next Users

Next users have usually been left out of the research process which makes the results less relevant to them. In Pakistan, next users, such as administrators and extension specialists, do not understand research reports and often do not know how to implement the findings. Moreover, because of traditional divisions of institutional responsibility to develop the research and to disseminate it, the next user has not participated in developing the technology and may have little inclination to accept it as appropriate for the field situations he knows best. Training in the uses of research results for problem identification and project planning, implementation, and evaluation will be provided to these users. WAPDA Academy in Tarbela already trains senior, middle and junior level engineers in management skills and would like to incorporate such training into its program. Formal training will also be provided to extension specialists in workshops. This training will be most effective if it preceeds their involvement in actual research projects.

(c) Exchanges between Researchers and Extension Specialists

Typically, researchers and extension specialists work in separate institutions, even within the same Ministry, and have little to do with each other although they have many common objectives. The Program proposes to overcome this obstacle by encouraging the joint participation of researchers and extension specialists. It is proposed that extension specialists be involved as early as possible in the research process for they have a unique understanding of farm-level problems and constraints. In those projects which are farm-level oriented, extension specialists ought to be research team members. One method could be posting of extension officers at Mona to work with research staff. Conversely, researchers could serve periods in extension units, including the OFWM training centers, where they would be incorporated into the teaching programs and work closely with the extension department in making its curriculum more "problem solving" oriented.

(d) Seminars and Conferences

Seminars will be held at regular intervals that involve primarily "in-house" personnel, both expatriate and local. They will provide an opportunity to Pakistani research workers to present their own or related research work to their peers for information and critique. Travelling seminars involving expatriates in residence, national professionals, and, in some cases, special consultants as instructors will be taken to various centers where research is underway. Subjects will be selected to fit local needs as expressed by participants in meetings of the management support group and in research progress reports. In addition, the program will sponsor national conferences based on its water management research. Papers will be presented by team researchers on ongoing and completed research projects. Government officials and other users will be encouraged to attend.

In Pakistan, researchers are isolated from other researchers and the international scientific community. Much can be learned from participation in international conferences where colleagues meet and papers are given. Researchers will be encouraged to submit papers for project review. Participation will be competitive, based on merit and quality of presentation.

(e) Review Committee for Report Dissemination

In order to keep all research working papers and technical reports at a high level, a review committee will be established. The committee will assess clarity of style and persuasiveness of analysis. Assistance in redrafting the reports will be provided by team members as required. Drafts must be submitted to the committee for review before they are duplicated and distributed. Its members will include some of the core team members and principal investigators.

(f) Collaboration with MART

The Water Management Research Program and the Management of Agricultural Research and Technology (MART) Project share the objective of improving the capability of Pakistani institutions and reseachers to conduct and manage research. MART's activities, scheduled to begin in the second half of 1985, are largely limited to PARC and its associated institutions. The Program also expects to work collaboratively with some of these centers. As such, joint ventures with MART in organizing the following activities will strengthen research networks: (1) training activities where water is a primary concern; (2) workshops on proposal preparation and project management; (3) sponsorship of seminars on research topics; (4) pilot testing of technology transfer arrangements similar to those planned for the Islamabad District; (5) publication of a water research information newsletter; (6) creation

of a review board for funding small water management projects; (7) use of short-term specialists; (8) participation in research program management meetings.

v. Estimated Costs

Most of the funding for the activities included under research management are included in the budgets for individual research projects and the budgets for supporting the long-term team. The exceptions are short-term technical assistance and support for the research management training activities and the information systems development program. The estimated costs of these activities are shown in Tables 3 and 4.

b. Competitive Grants Program

i. Introduction

The research projects initially recommended for implementation cannot cover all topics relevant to water management research. Nor will the projects be able to involve directly the majority of scientists and engineers who could contribute to the scientific base for water management. Accordingly, a competitive research grants program will be established with the following objectives: a) to enable a wider selection of scientists and engineers to contribute to the research program and b) to strengthen the research capacity of institutions by increasing the capability of individual researchers to plan, develop, implement, and manage research programs and to disseminate research results effectively. Grants will be made to personnel of universities, research institutes, and government agencies organized to conduct research. Each grant will be made to an individual researcher through his institution and must be accepted by an authorized representative of the grantee institution. To apply for a grant, the prospective principal investigator must obtain supervisory approval prior to forwarding the application for consideration for funding.

ii. Research Proposals

Proposals may be submitted for research on any aspect of irrigation water management, but proposals most likely to be funded are those which address the priority research areas. Since the main thrust of the competitive grants program is institution-building, a limited number of grants may be awarded for research deemed of lesser priority. In this case, the need to develop the capability of the grantee institution in the specific discipline must be fully documented as necessary to the institution's long-term continued involvement in irrigation water management research.

(a) Research Areas

Research funded under the grants program will cover small, discrete topics rather than large,

TABLE 3.

RESEARCH MANAGEMENT ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		15,870								25,950	
2. FRINGE BENEFITS	2,540		3,990								6,530	
3. WORKSHOPS												
Management support		500		2,000		2,000		2,000		1,000		7,500
Management training		2,000		4,000		6,000		5,000		2,500		19,500
4. CONFERENCES												
In Pakistan		2,000		5,000		5,000		5,000		3,000		20,000
International		5,000		7,500		15,000		22,500		25,000		75,000
5. TRAVEL												
International	6,400		10,080								16,480	
Intl. per diem	800		1,260								2,060	
In Pakistan		1,000		1,575								2,575
Pakistan per diem		3,920		6,180								10,100
6. OPERATING EXPENSE	500	2,500	1,575	5,000		5,000		5,000		2,500	2,075	20,000
7. INDIRECT COSTS (25% of items 1-6)	5,080	4,230	8,194	7,814	0	8,250	0	9,875	0	8,500	13,274	38,669
8. SUBTOTAL	25,400	21,150	40,969	39,069	0	41,250	0	49,375	0	42,500	66,369	193,344
9. CONTINGENCY (10%)	2,540	2,115	4,097	3,907	0	4,125	0	4,938	0	4,250	6,637	19,334
10. TOTAL	27,940	23,265	45,066	42,976	0	45,375	0	54,313	0	46,750	73,006	212,678
11. GRAND TOTAL	51,205		88,041		45,375		54,313		46,750		285,684	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Total short-term technical assistance person months: 5

TABLE 4.

INFORMATION SYSTEMS ESTIMATED COSTS(1)

ITEM	FY 85 DOLLAR COST	FY 85 RUPEE COST	FY 86 DOLLAR COST	FY 86 RUPEE COST	FY 87 DOLLAR COST	FY 87 RUPEE COST	FY 88 DOLLAR COST	FY 88 RUPEE COST	FY 89 DOLLAR COST	FY 89 RUPEE COST	TOTAL DOLLAR COST	TOTAL RUPEE COST
1. SALARY												
Short-term TA	10,080		10,580		11,120						31,780	
2. FRINGE BENEFITS	2,540		2,660		2,800						8,000	
3. LOCAL HIRE												
Prof. staff												
Support staff												
4. TRAVEL												
International	6,400		6,720		7,060						20,180	
Intl. per diem	800		840		880						2,520	
In Pakistan		1,000		1,050		1,100						3,150
Pakistan per diem		3,920		4,120		4,320						12,360
5. OPERATING EXPENSE	1,000	5,000	1,050	18,000	1,100	15,000		15,000		15,000	3,150	68,000
6. INDIRECT COSTS (25% of items 1-3,5,6)	5,205	2,480	5,463	5,793	5,740	5,105	0	3,750	0	3,750	16,408	20,878
7. COMMODITIES	213,059		30,000		30,000		30,000		30,000		333,059	
8. SUBTOTAL	239,084	12,400	57,313	28,963	58,700	25,525	30,000	18,750	30,000	18,750	415,097	104,388
9. CONTINGENCY (10%)	23,908	1,240	5,731	2,896	5,870	2,553	3,000	1,875	3,000	1,875	41,510	10,439
10. TOTAL	262,992	13,640	63,044	31,859	64,570	28,078	33,000	20,625	33,000	20,625	456,606	114,826
11. GRAND TOTAL	276,632		94,903		92,648		53,625		53,625		571,432	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Total short-term technical assistance person months: 6

comprehensive studies. This approach is consistent with the objective of teaching researchers to plan, develop, implement, and manage research and disseminate results effectively. Examples of possible topics for funding by the competitive grants program are on-farm agronomic practices, water management policy issues, standard design procedures for small diversion structures at the headworks of privately-managed canals, socioeconomic impact of new irrigation technologies, and improvements in watercourse structures.

(b) Submission and Approval of Proposals

Research proposals may be submitted at any time, but funds for starting a research grant will be provided at a fixed time each year - the exact time to be determined during implementation. Scientists seeking grant support will first submit a brief preproposal. The preproposal will contain: (1) a research project title, (2) the name of principal investigator and institution, (3) a description of the problem addressed by the proposed research, (4) an analysis of the problem (its extent, how it impedes production, who it affects, etc.), (5) an indication of how the proposed research will contribute to solution of the problem, (6) an explanation of how research results could be used, (7) a tentative schedule, and (8) estimate of cost.

The preproposals will be reviewed by a panel of selected scientists. Based on their review, the preproposal may be rejected, sent back to the proposer for revision, or accepted as potentially fundable. If the project is potentially fundable, the principal investigator will be asked to prepare a formal proposal and grant application. A member of the implementation team (either long-term or TDY) will be asked by the Research Program Specialist to collaborate with the Pakistani proposer to develop the formal proposal and collaborate during the period of the grant. The formal proposal will be received, peer reviewed, and approved or returned to the proposer for revision. All preproposals and grant applications will be sent to the Pakistani institution selected to oversee this grant program during the implementation phase.

The Irrigation Drainage and Flood Control Research Council (IDFCRC) is proposed as the institution responsible for the competitive grants program. Such responsibility would be consistent with an objective of IDFCRC to organize, coordinate and promote research in the various fields of hydraulics, irrigation, drainage, reclamation, tubewells and flood control. Its other objectives include making grants-in-aid for specific schemes to universities and other research institutions in Pakistan, and establishing a library. Thus, the institutional linkages needed for the competitive grants program may already be in place with IDFCRC. The information gathering, cataloguing and dissemination activities of the library will assist the grants program through provision of ready access to details of current and past research

in these areas to the scientific community.

The formal grant applications will be prepared in a style similar to that used for the Foreign Agricultural Research Grant Programs of the International Research Division of USDA (Annex K). The Far Eastern Regional Research Office (FERRO) of USDA funds a grant program through PARC under the Special Foreign Currency Research Program (SFCRP). Cooperative links could be formed between SFCRP and the competitive grants program to the mutual benefit of both in promoting research on irrigation water management in Pakistan.

iii. Reporting Requirements

Reports of research progress will be submitted semi-annually. These reports will be due from all projects on the same date so that workshops involving all grantees can be held. The reports will include technical progress, problems encountered, and plans for next six months. A final report will be required at the end of the grant period. While the reports are required of all grantees, the researchers are encouraged to publish their research results outside the program. They will be encouraged to submit items for the water research information newsletter.

Other requirements for submitting technical and fiscal reports will be patterned after the SFCRP (Annex K).

iv. Research and Funding Duration

Normally projects will be approved for a maximum of two (2) years. Funding will be provided separately for each year of project duration.

v. Estimated Costs

The principal investigator's salary will be paid by his institution, but the grant would provide funds for junior engineers or agriculture officers, junior research assistants, field assistants and laborers in addition to materials, travel, equipment and other operational costs.

A typical grant project is expected to cost about Rs. 350,000 ($25,000) per year. It is expected that, on the average, every five grants will require one TDY scientist (two one-month trips per year) to complement support from the resident team.

The first year of implementation will be spent developing the details of the competitive grants program, soliciting preproposals, reviewing formal proposals and grant applications, conducting workshops, and awarding grants. These activities must begin with the start of the implementation phase. It is anticipated that the first grants will be awarded in the second year of implementation. An estimated 5 grants will be awarded in Year Two, 10 grants in Year Three and 15 grants in Year Four.

The estimated costs of the competitive grants program are presented in Table 5. They include expenses for short-term technical advisors as well as grant funds to be awarded to Pakistani scientists to support their research efforts.

c. Training

i. Introduction

The number of well-trained scientists and engineers involved in water management research is limited in most Pakistani institutions, particularly in certain disciplines. In addition, many researchers who were well-trained at the beginning of their careers have not kept up with technological advances in their areas of specialization. A related problem is that many of these researchers have had little, if any, training in planning, developing and managing research programs. Better trained research personnel are needed at all levels (program director, principal investigator, technician and support staff levels) to make lasting improvements in Pakistan's water management research capabilities. Meeting this objective will require the development and implementation of training programs designed to increase the supply of well-trained research personnel and upgrade present staff in water management-related areas. Provisions have been made in the work proposed in this report to develop and implement training programs needed to do this.

Training is one of the most effective ways of achieving the institution-building goals of this program since it can result in long-term improvements in the capability of Pakistani institutions and researchers to develop and carry out effective research programs.

Development of an effective training program for researchers involved in water management will require that training be closely integrated in the research program. It will, for example, require that members of the implementation team be involved in selecting Pakistani students for training in the U.S. or elsewhere as well as in guiding and supervising their research when they return to Pakistan to complete their theses. For these and reasons mentioned in the following paragraphs, it is strongly recommended that the training proposed be managed as an integral part of the Water Management Research Program.

ii. Training Requirements

Two types of training requirements have been identified by the design team. One is for training the Pakistani personnel required to carry out the research projects. Specific technical areas were identified in several of the proposed research projects and in some of the proposed institution-building activities. Included are requirements for long-term graduate degree training at U.S. institutions as well as requirements for several types of short-term training. For example, the project on Development of Groundwater-Surface Water Models re-

TABLE 5.

COMPETITIVE GRANTS PROGRAM ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		10,580		22,240		23,320				66,220	
2. FRINGE BENEFITS	2,540		2,660		5,600		5,880				16,680	
3. TRAVEL												
International	6,400		6,720		14,120		14,800				42,040	
Intl. per diem	800		840		1,760		1,840				5,240	
In Pakistan		1,000		1,050		2,200		2,320				6,570
Pakistan per diem		3,920		4,120		8,640		9,080				25,760
4. OTHER DIRECT COST	1,000		1,050		2,200		2,320				6,570	
5. INDIRECT COSTS (25% of items 1-4)	5,205	1,230	5,463	1,293	11,480	2,710	12,040	2,850			34,188	8,083
6. RESEARCH GRANTS				125,000		375,000		250,000				750,000
7. SUBTOTAL	26,025	6,150	27,313	131,463	57,400	388,550	60,200	264,250			170,938	790,413
8. CONTINGENCY (10%)	2,603	615	2,731	13,146	5,740	38,855	6,020	26,425			17,094	79,041
11. TOTAL	28,628	6,765	30,044	144,609	63,140	427,405	66,220	290,675			188,031	869,454
12. GRAND TOTAL	35,393		174,653		490,545		356,895				1,057,485	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Total short-term technical assistance person months: 12

quires 2 Ph.D. and 3 M.S. degree programs for successful implementation. Both formal and informal training programs are required to train four sailaba irrigation experts for the proposed Baluchistan research project on Irrigation Systems Outside the Indus Basin. Requirements for training 6 Ph.D., 16 M.S. and 6 non-degree students are identified in the proposed research projects.

There is also a need to provide both formal and informal training opportunities to the broader community of Pakistani personnel involved in water management research. This could include GCP personnel who are developing, implementing and managing water management-related programs as well as university personnel who are involved with educational programs. It is strongly recommended that training opportunities be extended to faculty of educational institutions involved in water-related fields. The future stream of trained manpower for water management programs will come from Pakistani institutions.

iii. Formal Training

Formal training will be needed in a number of disciplines including agricultural economics, agronomy, anthropology, engineering, hydrology, sociology, soil science and water resources. It is anticipated that most of the demand for formal training will be for graduate degree training at U.S. educational institutions. In some cases, there may be a need for students to upgrade their skills by taking formal coursework in non-degree programs. In either case, fellowships and other support will be needed for training at U.S. institutions.

Students going to the U.S. for graduate degrees will take their coursework in the U.S. and then return to Pakistan to complete their thesis or dissertation research. Their research will be done on a sponsored research project and will contribute directly to the objectives of the project. Scheduling their time in the U.S. and their involvement in project research will require careful planning and coordination by the implementation team, particularly when the research involves field-type research. Since many of these students will ultimately become research managers, provisions should be made for them to receive managerial training while in the U.S. either as a part of their coursework or through short courses on management.

vi. Informal Training

Informal training will be one of the main approaches used to upgrade the skills of Pakistani research staff on a continuing basis. Most of this training will related directly to sponsored research activities and will be arranged and coordinated by the implementation team. This will be particularly true for the proposed short-term in-service and internship training programs since they will relate directly to the proposed research project. The types of informal training programs that will be conducted include:

(a) Seminars and workshops which will be held at regular intervals and will involve both local and expatriate personnel. They will provide Pakistani researchers with an opportunity to present their own or related research work to their peers for information or critique.

(b) Short-term (two to six weeks) in-service training in the U.S. and Pakistan on technical topics related to program activities. Example topics might include irrigation system planning, groundwater modeling, and computer use. Annual USDA short courses could be used to provide some of this training.

(c) Short-term (six to twelve months) internships at U.S. research centers such as the Irrigated Agriculture Research and Extension Center at Prosser, Washington or the Snake River Conservation Research Center at Kimberly, Idaho. The Pakistani scientists selected for this type of training will work under the direction of a senior U.S. scientist on an ongoing research project. The emphasis of this training will be on upgrading the research and technical skills of the Pakistani scientists. Upon return to Pakistan, they will be expected to put these skills to use on an active research project. An example of an internship program which would be available at the Snake River Conservation Research Center is presented in Annex L. Similar internships will be available at Prosser, Washington Center and at the Northwest Watershed Research Center in Boise, Idaho.

(d) Scientist/faculty exchanges between Pakistani and U.S. institutions can be done on a limited basis. Mutually agreeable arrangements relative to assignments and time periods would have to be worked out on an ad hoc basis. One source of U.S. participants would be university faculty on sabbatical. U.S. participants in this program will be expected to work on some aspect of water management while in Pakistan. Pakistani participants will be given an opportunity to obtain additional training as needed to upgrade their technical skills in water management-related areas.

(e) Short-term training and observational tours to non-U.S. sites to examine both operational and research programs as they relate to water management problems in Pakistan.

In addition, the implementation team will be involved in providing informal on-the-job training as an integral part of their duties. Training on research program development and management will be provided to support the proposed competitive grants activity. Training on other research-related topics such as research methods, data analysis and computer use will also be provided.

A summary of estimated training requirements is given in Table 6. Included is U.S. and third country training as well as training in Pakistan.

vii. Estimated Costs

The estimated costs for training are shown in Table 7. Included are both U.S. and in-country training costs.

TABLE 6.

Estimated Training Requirements

Type of Training	Length of Training	Estimated Number of Participants
A. U.S. or Third Country Training		
1. Ph.D. Degree	42 months[1]	8
2. M.S. Degree	24 months[2]	32
3. Non-Degree	12 months	16
4. Short-term, In-service	1 month	40
5. Short-term, Internships	6 months	18
6. Science/Faculty Exchanges	12 months	8
B. Pakistan Training		
1. Seminars & Workshops	1-5 days	400
2. Short-term,	1 month	80

[1] Includes 30 months in the U.S. and 12 months in Pakistan.

[2] Includes 18 months in the U.S. and 6 months in Pakistan.

TABLE 7.

TRAINING ESTIMATED COSTS

ITEM	FY 85 DOLLAR COST	FY 85 RUPEE COST	FY 86 DOLLAR COST	FY 86 RUPEE COST	FY 87 DOLLAR COST	FY 87 RUPEE COST	FY 88 DOLLAR COST	FY 88 RUPEE COST	FY 89 DOLLAR COST	FY 89 RUPEE COST	TOTAL DOLLAR COST	TOTAL RUPEE COST
1. TRAINING												
In United States												
long-term	71,400		599,760		791,250		354,600		57,960		1,874,970	
short-term	31,000		260,400		348,840		157,960		30,160		828,360	
In Pakistan		7,500		26,000		28,000		29,000		9,000		99,500
Third country					15,000						15,000	
2. INTERNATIONAL TRAVEL(one-time)		15,970		132,300		174,260		78,000		12,800		413,330
3. INDIRECT COSTS 25% of training in Pakistan		1,875		6,500		7,000		7,250		2,250		24,875
4. SUBTOTAL	102,400	25,345	860,160	164,800	1,155,090	209,260	512,560	114,250	88,120	24,050	2,718,330	537,705
5. CONTINGENCY (10%)	10,240	2,535	86,016	16,480	115,509	20,926	51,256	11,425	8,812	2,405	271,833	53,771
6. TOTAL	112,640	27,880	946,176	181,280	1,270,599	230,186	563,816	125,675	96,932	26,455	2,990,163	591,476
7. GRAND TOTAL	140,520		1,127,456		1,500,785		689,491		123,387		3,581,639	

NOTES:

(1) Rupee costs are shown in dollar equivalents

VI. IMPLEMENTATION PLAN

A. Strategy

It is not surprising that water management needs improvement everywhere or that research programs to delineate solutions are often incomplete and uncoordinated. Successful management techniques and research programs cannot be predetermined for any particular system because of these complexities. Therefore, the strategy of this program is to start conservatively and build on experience until a viable nationwide research effort is in place. Several components are necessary and must be dealt with. Research coordination, planning, implementation, analysis, reporting and dissemination of results are all elements of a complete research program. To improve these, methodologies must be developed and training provided while keeping in view that the basic purpose is to evolve a research system that improves over time.

The system will be built while research and training are being done; the concept being that it is better to let the system evolve in a dynamic process. Considerable effort will be devoted to development and refinement of a coordinated system. Research output will be a by-product of building the research system. Training will involve long-term training, but just as important, is the organized hands-on training provided through the conduct of the research program.

Expert guidance and assistance will be provided to all phases of the Program with long-term and short-term technical assistance. Initially, overall coordination will depend heavily on the contractor. It is planned, however, that this responsibility will eventually shift to a permanent GOP unit.

The Program will be implemented with the arrival of the in-country team as soon as a contract is signed. Initially only two members of the team would arrive since the work plans for the research projects cannot be developed before initiation. These two, with short-term technical assistance, will assist with this development phase. The in-country team would be constituted as follows:

1. Chief-of-Party - arriving at initiation for 48 months
2. Social Scientist - arriving at initiation for 46 months
3. Research Program Specialist - arriving during 4th month for 36 months
4. Hydrologist - arriving during 6th month for 40 months
5. Irrigation Agronomist - arriving during 10th month for 36 months

In total, 104 person-months of short-term technical assistance is planned. This is equivalent to approximately 10 person-months for each activity.

B. Schedule

Program activities will take place over a period of four years. The schedule presented is based on the assumption that a contract will be signed and that implementation can start on April 1, 1985. All dates are keyed to that start-up date. If this date is delayed all dates presented, with the exception of training and work plan preparation, can be shifted accordingly. The long-term training dates are designed to match university calendars and annual work plans will always be prepared in August/September because that is near the end of the fiscal year but, more importantly, it is just prior to the rabi season. A detailed implementation schedule for the first 17 months follows.

1. Pre-Implementation (under existing contract)

Jan. 1-March 31	a. Collaborate with USAID and appropriate GOP agencies in refinement of proposals and development of PC-1s.
	b. Provide short-term TA to WAPDA regarding development of a water data management system. WAPDA is doing this now and have asked for help.
	c. Negotiate long-term agreement between AID and UI.
	d. Finalize selection of long-term team.
	e. Order equipment and vehicles for office support.
	f. Initiate approval for computer purchase.

2. Mobilization

April 1985	Arrival of COP and Social Scientist.
May 1985	In-country office furnished, housing arranged.
May 1985	Office support staff recruited.
June-July 1985	Refinement of PC-1s for all components.

July 1985	Interview and select (with GOP) long-term training candidates for first phase.
July-Aug. 1985	Refinement of first year work plans.
August 1985	Management Specialist arrives.
August 1985	Long-term trainees (first phase) depart.
September 1985	Begin organization of research management by meeting with GOP proposed researchers and managers.
September 1985	Order commodities for program components approved for start-up.
October 1985	Hydrologist/modeler arrives.
January 1986	Irrigation agronomist arrives.

3. First-Year Work Plans - Research Projects

The following plans and schedules were developed as if all projects would be initiated on 1 September 1985. Undoubtedly some projects can be initiated before this date. The Integrated Watercourse Management and Water User Involvement Projects will receive priority attention because the first-to-arrive field party members will be directly involved with them. Several may not be approved until after 1 September 1985. At any rate, the schedule will necessarily be keyed to the actual start-up date for each project. The plans presented here will be refined during the first four-year period.

Integrated Watercourse Management

July-Aug. 1985	Development of water and crop monitoring program with one month short-term TA.
Sept. 1985	Select, with Mona, the research site.
Oct. 1985	Install the monitoring system at the research site. Check and refine methodologies.
Nov. 1985	Start collecting data under monitoring program with the wheat pre-irrigation.

Nov.-Dec.1985	Make thorough reconnaissance survey of the project area. Use data collected to identify major problems. Use as educational exercise for Mona, Irrigation Dept., Monitoring & Evaluation Unit, and UI. Prepare a detailed description of project areas.
Jan.-April 1986	Frequent visits to monitoring crews to check implementation problems. Organize visit at least fortnightly. Work with Ag Extension to inform farmers of the program.
June 1986	Workshop to present summary of monitoring data. Using the data, delineate problems found and describe possible interventions to be tested during following year. Refine monitoring program if needed.
July-Sept. 1986	Continue monitoring program during kharif season.
Aug. 1986	Decide on interventions to be tested.
Sept. 1986	Prepare work plans for next year.
Sept.-Oct. 1986	Install necessary infrastructure for interventions to be tested.

Surface Drainage and Water Table Control

Oct.-Nov. 1985	Review and analyze existing data on SCARP tubewells and assemble information regarding tile drainage in Pakistan.
Nov.-Dec. 1985	Review data at hand and design a program to collect data where voids are apparent.
Jan.-Mar. 1986	Install data collection equipment and initiate the program of collection. Begin to develop the micro-computer models to store data and analyze them with respect to water table response to various drainage methods.

Aug. 1986	Test the developed models with available data and revise models and data collection, if necessary.
Sept. 1986	Prepare plan for field installation of drainage methods. Prepare work plan for next year.

Public and Private Tubewells

Oct.-Nov. 1985	Collect, review and analyze existing data on tubewells. Collect information regarding the problems affecting tubewell performance and useful life. These records are available in various files but need to be assembled for a large number of specific wells.
Dec.-Feb. 1986	Analyze data and records regarding causes of tubewell deterioration. Design a field testing program to test some of the wells reviewed in data collection. Select the wells to be further tested.
March-April 1986	Visit each test-well site and install equipment (facilities for measurement, piezometers. observation wells, etc.)
May-Aug. 1986	Collect data on test wells.
Aug. 1986	Analyze all data and develop a program to field test rehabilitation techniques.
Sept. 1986	Initiate field rehabilitation research program and prepare work plans for the next year.

Irrigation Systems Outside the Indus Basin

Oct. 1985	With Govt. of Baluchistan involvement, select 4 trainees for the project.
Nov. 1985	Reconnaissance survey of small-scale/sailaba systems in Baluchistan with GOB officials, the trainees and TDY specialist.

Dec. 1985	Prepare a report on reconnaissance findings and recommendations for training, and design a data collection system for baseline study of small-scale irrigation.
Jan. 1986	First trainees depart for U.S.
Feb. 1986	Refine survey techniques for baseline study.
Mar.-Aug. 1986	Remaining trainees carry out baseline study. Frequent visits to project area required.
Sept. 1986	Analyze existing data to determine further needs of data collection. Start design of intervention techniques. Prepare work plan for next year.

Encouraging Water User Involvement in Better Water Management

Sept. 1985	Select students at Quaid-i-Azam University.
Oct.-Nov. 1985	Students begin training program.
Nov. 85-Jan. 1986	Design field research programs for students.
Mar.-Apr. 1986	Select watercourse sites for research.
May 1986	Students finish training program and initiate field research program.
May-Sept. 1986	Frequent visits by Social Scientist and Quaid-i-Azam University staff and other collaborators to research sites.
Sept. 1986	Prepare work plans for next year.

Development of Groundwater-Surface Water Models

Aug. 1985	Participating staff selected.
Sept.-Nov. 1985	Study available models to ascertain their adaptability to micro or mini computers.
Nov.-Dec. 1985	Evaluation of number and level of expertise of systems analysts in concerned Pakistani institutions.
Jan.-Feb. 1986	Delineate requirements for data management programs in operating divisions of WAPDA and Provincial Irrigation Departments.
Mar. 1986	Select appropriate model(s) for further development and adaptability to micro or mini computers.
April 1986	Develop data management programs incorporating the various types of surface water data available.
May 1986	Evaluate other models (U.S.-based) for adaptation in Pakistan.
June-Aug. 1986	Refine model and select areas to calibrate model and verify their utility under varying hydrogeological conditions.
Sept. 1986	Prepare work plan for next year.

Farm Water Management

Sept. 1985	Review existing/planned projects at Mona, LIM, Faisalabad University.
Sept.-Oct. 1985	Select studies to become a part of the project during rabi 85/86.
Nov. 1985	Conduct test on wheat planting techniques at Mona. Short-term TA needed.
Nov.-May 1986	Conduct rabi experiments with frequent field visits by project scientists.
May 1986	Workshop to present and discuss rabi results and to plan kharif trials.

June-Sept. 1986	Conduct kharif trials.
Sept. 1986	Prepare work plans for next year.

Beyond Watercourse Improvement

Oct. 1985	Select staff from Watercourse Monitoring and Evaluation Directorate for training in microcomputer use.
Nov. 85-Jan. 1986	Training in computer use for selected participants and training in research methods to wider staff.
Feb.-Mar. 1986	Review watercourse evaluation data set.
Apr.-May 1986	Computer entry of data set.
June-Aug. 1986	Re-analysis of data set.
Sept. 1986	Prepare work plan for next year.

4. First Year Work Plan - Competitive Grants Program

In this program the proposals, research methods and reports will be guided in such a way that the researcher is constantly aware of the problem being addressed, how the research will help to solve that problem (or that part of it), and how the results can be used to make changes over broad areas of the irrigated regions of Pakistan. This will be done by careful preparation of the research proposal, reporting format, and assistance from research collaborators.

The collaborative assistance will be provided by the long-term team and TDY scientists. Each U.S. collaborator will probably handle more than one grant project. The TDY scientist would probably make two trips to Pakistan each year and would be involved in other aspects of the Program.

The sequence of events for the grants program during the first year will be as follows:

July-Sept. 1985	Development of guidelines, brochures, etc.
Oct. 1985	Workshop on competitive grants program, research planning, and proposal preparation
Dec. 1985	Receipt of preproposals

Jan. 1986	Workshop to critique preproposals and provide further training in proposal preparation. Assignment of collaborators
Jan-Apr. 1986	Develop proposals with assistance from collaborators
May 1986	Evaluation of proposals
June 1986	Award of grants
Aug. 1986	Workshop on research management
June-Sept. 1986	Research conducted by grant recipients
Sept. 1986	Semi-annual workshop on research programs to be attended by all researchers supported by this program

5. First-Year Work Plan - Information System Management

This component of the Program will be assisted principally with short-term TA. The first-year program will be as follows:

Aug. 1985	In-depth review of programs and needs with the library staffs of WAPDA, IDFCRC, and the Center for Excellence
Sept. 1985	Develop a time plan for implementation of the reference, referral, documentation and dissemination programs
Oct. 1985	Order necessary equipment
Nov. 1985	Trainees selected
Dec. 1985	Microcomputer training in Pakistan Reference training in Pakistan
Jan.-Mar. 1986	Dissemination training, USA/Pakistan
April-June 1986	Documentation training, USA/Pakistan
July 1986	Referral system training in Pakistan
Sept. 1986	Work plans for the next year

6. Short Term Technical Assistance

Considerable short-term technical assistance is necessary during the first year because project start-up requires development of specific project designs, location of research sites, selection of trainees and cooperators, and implementation activities such as equipment purchase, implementation of data collection techniques and considerable hands-on training. A summary of short-term technical assistance involvement in this program follows:

First Arrival	Activity	Level of Effort (Man-Months) First Year	Remaining Three Years	Total
May 1985	Models	6	6	12
June 1985	Farm Water Mgt.	3	9	12
June 1985	Drainage	3	7	10
July 1985	Irrigation Systems	3	7	10
July 1985	Research Grants	2	10	12
Aug. 1985	Beyond Watercourse	3	9	12
Aug. 1985	Tubewells	2	6	8
Aug. 1985	Information Systems	3	3	6
Aug. 1985	Research Mgt.	3	2	5
Sept. 1985	Watercourse Mgt.	2	5	7
Nov. 1985	Water Users	2	8	10
Total		32	72	104

7. Training

a. Formal Training

There are two alternatives for implementing the formal training program programmed as part of the Water Management Research Program. The first would include all formal training in the implementation contract with the University of Idaho. The second alternative would require that the USAID Mission assume responsibility for management of the formal training, long-term and short-term.

The University of Idaho and Washington State University are prepared to participate directly in the formal and informal training. Graduate degrees through the Ph.D. are offered at one or both universities in all of the disciplines mentioned previously. Specialization in irrigation, groundwater hydrology and other water-related areas is offered in several of these disciplines. Through a cooperative graduate teaching program between the University of Idaho and Washington State University, the graduate courses listed in these degree programs are cross-listed at both universities so that students registered at one

university can take courses at the other. Faculty from both universities serve on graduate committee at either location.

In addition to the traditional M.S. thesis-type degree programs in engineering, the University of Idaho and Washington State University offer Master of Engineering degree programs which are especially designed for mid-career engineers. In place of the thesis requirement which prepares the student for further graduate study, a candidate for this degree is required to prepare a technical paper and pass a written and/or oral exam. This degree program has proven to be especially valuable to mid-career professionals who want to upgrade and improve their technical skills but do not plan to pursue the Ph.D. degree.

In many cases, other educational institutions will be better suited than the University of Idaho or Washington State University to provide training in some technical specialties. For example, training requirements for sailaba agriculture could best be met at universities in the southwestern U.S. In these cases, the implementation team will assist in identifying and placing prospective students in U.S. institutions and will continue to provide follow-up support. The team will work with professors from sister institutions in relating thesis and dissertation work to the ongoing research program and provide in-country support to students. Professors from other institutions would be used on a limited TDY basis to guide the students as well as conduct short seminars in their specialty areas.

The additional fee or percentage charge for managing the formal training program would have to be determined by campus administration and settled during contract negotiations.

The schedule for formal training is as follows:

August 1983	2 Ph.D. candidates begin
August 1985	6 M.S. candidates begin
January 1986	4 Ph.D candidates begin
January 1986	16 M.S. candidates begin
August 1986	2 Ph.D. candidates begin
August 1986	8 Non-degree candidates begin
January 1987	4 Non-degree candidates begin
January 1987	4 Non-degree candidates finish
February 1987	6 M.S. degree candidates finish
August 1987	8 Non-degree candidates finish

Formal Training, continued

September 1987	16 M.S. degree candidates finish
January 1988	4 Non-degree candidates finish
February 1988	4 Non-degree candidates finish
February 1988	2 Ph.D. degree candidates finish
September 1988	4 Ph.D. degree candidates finish
February 1989	2 Ph.D. degree candidates finish

b. Informal Training

In-country and U.S.-based informal training will be managed as an integral part of the specific projects or in the research management component. Training schedules will be determined according to individual project implementation schedules. The research program specialist will be responsible for schedules, logistics, materials, and speakers. He will act in a service mode for individual project managers and as lead scientist for informal training activities to the broader research community.

In those cases where the informal training would be in the U.S. (ad hoc courses designed especially for the Pakistan program), the Program Director and staff will handle the necessary arrangements.

8. Commodity Procurement

A listing of the equipment required by program activity is furnished in Annex E. Procurement of most items would be done under a subcontract to DAI through the Procurement and Logistics Division which is organized to provide overseas projects with reliable, timely and cost-effective support services. In coordination with the Program Director, the Division would order, receive, package, ship, and prepare the paperwork on commodities essential for Program start-up. This is anticipated for September, 1985. The cost of procurement services is estimated at 5 percent of commodities plus freight and shipping. The rate will be confirmed during contract negotiations.

Certain items in the procurement package will require special attention. Vehicles will be purchased by the Mission outside of contract funds. This should be done as soon as possible so that vehicles are on hand for Program start-up. Similarly, the Mission will procure office and household equipment for the team.

The University of Idaho is prepared to provide, if necessary, a justification for computers required for implementation as well as specific recommendations for brands and models. IBM-PC's are recommended as appropriate and compatible with other computers provided under the ISM Project. It is assumed that the Mission will move forward to obtain necessary AID/W approvals.

C. Arrangements with Pakistani Institutions

The totality of water management research does not fit the scope of any one institution because agricultural, engineering, socioeconomic, and management research are involved in combination and in isolation. It has not proved successful anywhere to house all water management research in an institute designed for that purpose. The scope of the field is simply too broad and varied to expect one unit, however large, to provide well-researched answers to all problems. Most countries, including Pakistan, have many institutions each dealing with specific elements. The need is to provide coordination and support for existing institutions.

It is important to involve at least some institutions with operational functions in the Program. Pakistan is fortunate that WAPDA has responsibility in planning, design, and operation of systems and also has some research responsibilities.

It is important that the Program interface with other agencies wherever possible. The Irrigation Departments will be asked to cooperate on all studies that have a bearing on supply of water to the outlet or through public wells. The Agriculture Departments' cooperation is needed in most projects because of direct involvement of the OFWM cells, and the Extension Service and because the research institutes are the next users of a host of research findings.

The Program must also collaborate with several other USAID programs. (See Annex G.) The other components of the Irrigation Systems Management Project (engineering, planning and management, and equipment) are a part of the same integrated program and very close linkages are expected in identification of research needs and dissemination of research results. Other USAID program linkages include Command Water Management, Managing Agriculture Research Technology, Baluchistan Area Development, and the NWFP Agricultural University development.

Finally, there are non-AID funded programs relevant to the Program. These include Baluchistan Minor Irrigation, On-Farm Water Management (ADB and IBRD) and the to-be-developed International Irrigation Management Institute program. All of these programs will provide important links for discussions regarding implementation constraints, research needs, research techniques, and extension techniques. It is intended to promote these discussions by open reporting and frequent interface with personnel involved.

Another important linkage is with the USDA-sponsored **Foreign Agricultural Research Grants Program.** Initial discussions with the Far Eastern Regional Research Office (FERRO) indicate that scientists working with the Program can serve as cooperating scientists on existing projects, and they can assist Pakistani researchers with development of projects for possible funding.

Because of the diversity of the field and the institutional involvement planned (see Table 8), the proposed program envisions collaboration and cooperation with several institutions. This creates unavoidable complications because concerned institutions represent all provinces and several ministries. Thus, it will be necessary to concentrate programs where possible and to plan realistically when scheduling development of individual projects.

The institutional involvement is presented in Table 8. It will be noted that the Principal Investigators (PI) for all projects involves only two institutions - WAPDA and IDFCRC. These are as follows:

WAPDA

1. a program with Mona, including:

   a) Integrated Watercourse Improvement, b) Surface Drainage and Water Table Control, c) Private and Public Tubewells, and d) Farm Water Management.

2. a program with Lower Indus Mona (LIM) including:

   a) Surface Drainage and Water Table Control, b) Public and Private Tubewells, and c) Farm Water Management).

3. a program with the Central Monitoring and Evaluation Organization:

   a) Groundwater and Surface Water Models, b) Public and Private Tubewells.

4. a program with the Monitoring and Evaluation Unit on:

   a) Beyond Watercourse Improvement b) Integrated Watercourse Management.

IDFCRC

1. Coordination of a program in Surface Drainage and Water Table Control.

2. Coordination of the program in Encouraging Water User Involvement in Better Water Management.

3. Coordination of the Competitive Grants Program.

4. Management of the Information System.

There are several other institutions that will be collaborators (involved with financial support). They include the University of Agriculture, Faisalabad; Pakistan Agricultural Research Council (PARC); Quaid-i-Azam University; Pakistan Institute of Development Economics (PIDE); and the Drainage and Reclamation Institute of Pakistan (DRIP). Several others will be cooperators (involved but need no funding). These include PARC, the Departments of Agriculture in Punjab, Sind, and Baluchistan; all Provincial Irrigation Departments, Universities of Agriculture at Faisalabad and Tando Jam, and the Center for Excellence in Water Resource Engineering at Lahore. It is assumed that project agreements can be made with WAPDA and IDFCRC to fund the other institutions through their approved PC-1s.

Because of the diversity of the water management field and because of the number of institutions involved is large, it is not readily apparent which GOP agency should be responsible for overall implementation and coordination of this project or if, in fact, it should be one agency. There are at least three possibilities:

1. The coordination/implementation responsibility would be placed at the federal level in the Ministry of Water and Power. It would assign a coordinating unit, and the total program would be placed under one umbrella program.

2. The program would be started with an agreement with the Ministry of Water and Power for support of the core (in-country) field office. This would initiate the program, and the field team would assist with development of PC-1s for each project during implementation.

3. The program would be initiated by having WAPDA and IDFCRC develop PC-1s for the activities where they are to be Principal Investigators. Implementation could start as soon as one PC-1 is approved.

At some point, coordination of the Program should be provided by a unit representing concerned agencies. This role could be evolved by starting with the interagency group of scientists to be formed to review and approve projects under the Competitive Grants Program. Through involvement with the program, discussions among themselves and with others concerned, and through advice and council from GOP, this body could be asked to recommend the composition of and scope for a national coordinating body for this program and for future water management efforts. Either Option 2 or 3 above would facilitate this strategy.

TABLE 8.

INSTITUTIONAL INVOLVEMENT

PROJECT	INSTITUTION
1. Integrated Watercourse Management	P.I.* WAPDA (Mona) Coll.* Univ. Ag (Faisalabad) Coop.* WAPDA (M&E Unit) Coop. Punjab Dept. Ag Coop. PID (Punjab)
2. Surface Drainage and Water Table Control	P.I. DRIP through IDFCRC Coll. WAPDA (Mona) Coll. WAPDA (LIM) Coll. DRIP Coop. Univ. Ag (Tando Jam) Coop. PID's (Punjab, Sind, Baluchistan)
3. Public and Private Tubewells	P.I. WAPDA (Central M & E Org.) Coll. WAPDA (Mona) Coll. WAPDA (LIM) Coop. PID's (Punjab, Sind, Baluchistan) Coop. IDFCRC Coop. DRIP
4. Irrigation Systems Outside the Indus Basin	P.I. WAPDA (C.E. Planning - Baluchistan) Coll. PARC Coop. Dept. Agr. (Baluchistan) Coop. PID (Baluchistan)
5. Encouraging Water User Involvement in Better Water Management	P.I. IDFCRC Coll. Quaid-i-Azam University Coll. Univ. Ag (Faisalabad) Coll. Punjab University Coll. Applied Econ. Res. Inst. Coll. PIDE
6. Ground & Surface Water Models	P.I. WAPDA (Central M & E Org.) Coop. WAPDA (Dir. of Geohydrology or Hydrology & Systems Analysis Section) Coop. Center for Excellence

---

* PI = Principal Investigator
Coll = Collaborator, implies funding
Coop = Cooperator, implies no funding

7.	Farm Water Management	P.I. WAPDA (Mona) P.I. WAPDA (LIM) P.I. Univ. Ag (Faisalabad) Coll. PARC Coll. DRIP Coll. OFWM (Sind) Coop. Dept. of Ag (Punjab and Sind)
8.	Beyond Watercourse Improvement	P.I. WAPDA (M & E Unit)
9.	Competitive Grants Program	P.I. IDFCRC Coop. PARC
10.	Information Management System	P.I. IDFCRC Coop. PARC

D. Program Management

The proposed Program described in this report is comprehensive from the standpoint of the number and scope of proposed research and institution-building activities. Proper management of this program will require establishment of effective procedures for coordinating and managing these activities. It will entail both in-country and U.S. support staff, coordination between these two support groups, and coordination between U.S. and GOP institutions involved in this program. Provisions will have to be made to effectively handle needed program planning, monitoring, evaluation and reporting activities. Provisions will also have to be made to handle personnel, fiscal and other program management activities on a day-to-day basis.

It is anticipated that the management scheme for this program will also be used as a model for training Pakistani program managers in the development and use of effective management techniques. In-service training on how to set up and carry out day-to-day program management activities similar to those described in the following paragraphs will be provided to cooperating Pakistani program managers.

1. Institutional Coordination and Support

Close working relationships were developed between the University of Idaho, Washington State University and Development Alternatives, Inc. during the design of this program. It is anticipated that these institutions will continue to work together during implementation. with the University of Idaho being responsible for overall management of the program. All three institutions will be involved in planning and carrying out the proposed activities. The management structure shown in Figure 1 will be used to facilitate coordination between the entities involved.

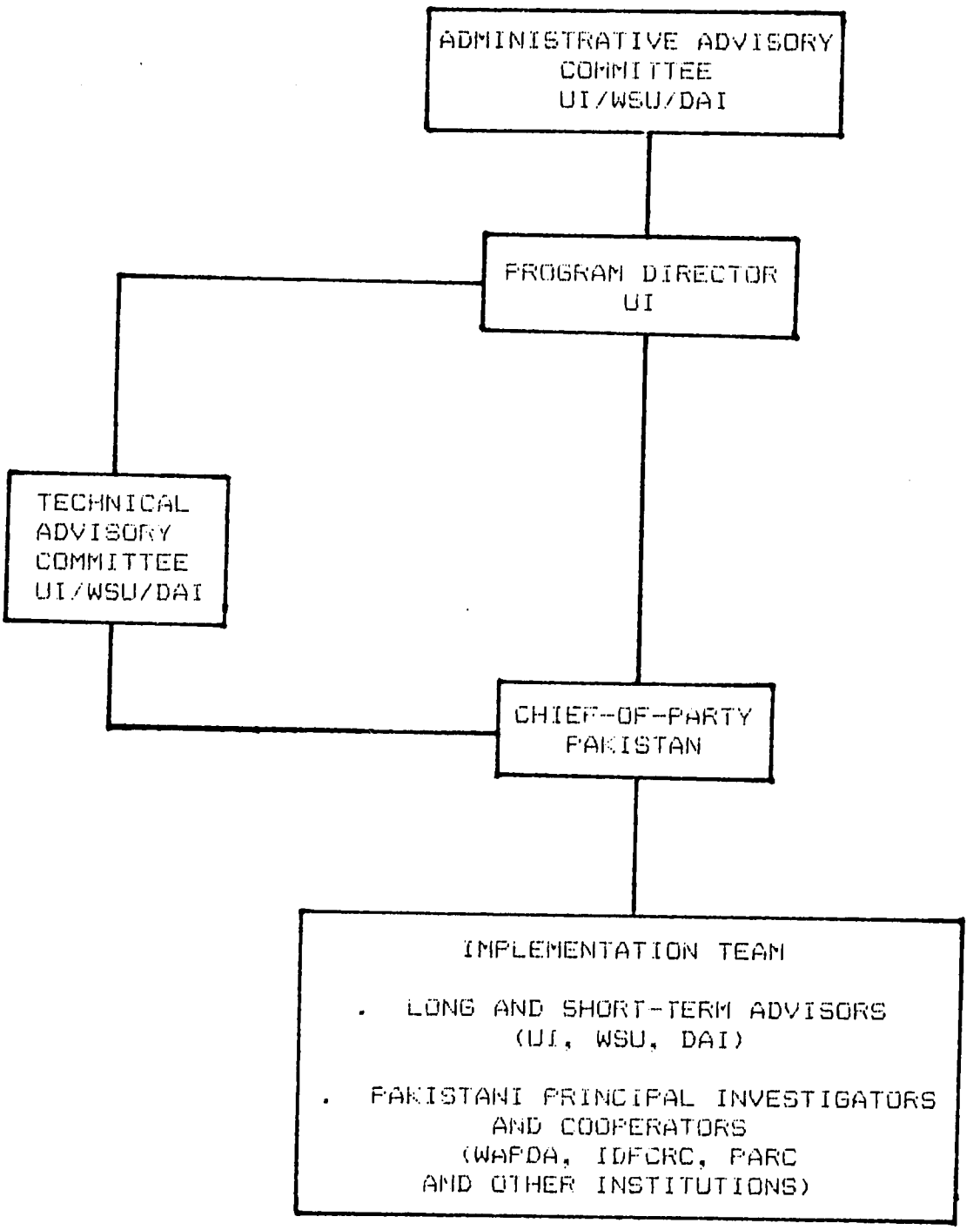

FIGURE 1.

Management Structure for Water Management Research Program

The Administrative Advisory Committee will be established to provide high-level coordination between the three U.S. institutions involved in this program and to provide overall policy guidance. The main functions of the committee will be (1) to provide advice and guidance to the Program Director and the Chief-of-Party on policy, financial and other institutional matters and (2) to insure that the required support from the three institutions is provided as required. The committee membership will include the Dean of the College of Agriculture from the University of Idaho, the Director of International Program Development from Washington State University, the President of Development Alternatives, Inc., and the Controller of the University of Idaho. The Program Director and Chief-of-Party will serve as ex-officio members of this committee. It will elect its own chairman and will meet at least semi-annually.

The Technical Advisory Committee will be established as a means of obtaining broad-based institutional support for this program. All of the subject matter areas and disciplines involved in the program will be represented in the committee's membership. Many of the members will be potential candidates for either short- or long-term assignments in Pakistan. The main functions of the committee will be to 1) provide advice to the implementation team on technical matters related to research, training or other activities to be conducted in Pakistan and 2) provide a communication link between the implementation team and the broader community of the three institutions. The Program Director will serve as chairman of this committee. The committee will meet at the start of implementation and at least semi-annually thereafter.

2. U.S. Management Responsibilities

A program director, who will be headquartered at the University of Idaho, will be responsible for overall administration and management of this program. This professional will insure that the terms of the agreement are fulfilled and that the field team is adequately supported at all times. The Director will travel to Pakistan on a regular basis to interact with the Chief-of-Party and other field team members, USAID and Government of Pakistan officials. The Director will also participate in research, training and other project activities while in Pakistan. This individual will be assisted by a support team consisting of (1) a full-time administrative assistant and (2) a half-time record keeper. The administrative functions of the University of Idaho support team will include:

a. Overall Program Management

i. Program planning, monitoring and evaluation to insure that the terms of the main agreement for this program as well as agreements with subcontractors are being met, including all reporting requirements.

ii. Maintenance of lines of communication with all parties involved.

iii. Coordination of training activities to be carried out in the U.S.

b. Personnel Management

i. Development of position descriptions for team members.

ii. Recruitment of team members.

iii. Negotiations with team members concerning a) their duties and responsibilities, b) duty periods, c) compensation.

iv. Preparation and processing of personnel, payroll, travel (including international travel) and similar forms (University of Idaho personnel only).

v. Presentation of pre-departure orientations for new team members.

vi. Annual performance reviews and evaluations of all long- and short-term expatriate staff (in cooperation with the Chief-of-Party).

c. Financial Management

i. Preparation of budget estimates.

ii. Allocation of contract funds, including allocations to sub-contractors (WSU, DAI, and others).

iii. Preparation and processing of expenditure requests, approval and processing of vouchers, and financial record keeping.

iv. Preparation of financial reports as needed to satisfy contractor, subcontractor, USAID, and GOP requirements.

3. In-Country Management Responsibilities

The field team will be led by a Chief-of-Party who will be responsible for administration of all in-country program activities. This individual will be the principal in-country representative of Idaho, WSU and DAI and will have the authority to act for all three institutions. The Chief-of-Party will be responsible for supervising the field team and for overall in-country coordination of the total program.

This individual will also direct selected research activities and participate in training and other program activities. The Chief-of-party will be assisted by a locally-hired Pakistani support

team consisting of (1) a full-time assistant, (2) an office manager, and (3) a secretary/bookkeeper. The management/administrative activities of the in-country support team will include:

a. Overall Program Management

i. Communication/coordination with the Program Director, other team members, advisory committees, the USAID Project Officer and GOP officials.

ii. Program planning and development including the selection and funding of Pakistani-led research projects.

iii. Program monitoring and evaluation to insure that program goals are being met.

iv. Preparation of progress and other reports, including financial reports needed to satisfy contractor, subcontractor, USAID and GOP requirements.

b. Personnel Management

i. Identification of personnel needs including both expatriate and Pakistani staff.

ii. Review and selection of short- and long-term expatriate staff (in cooperation with Program Director).

iii. Recruitment and hiring of all Pakistani support staff (technical assistants, drivers, part-time typists, etc.).

iv. Annual performance reviews and evaluations of all staff involved in in-country program activities (in cooperation with the Program Director).

c. Financial Management

i. Preparation of annual budget estimates and requests for all in-country project activities.

ii. Allocation of funds used in-country including funds for administrative, research, training, research management, and information management activities.

iii. Processing and approval of all in-country expenditures, including payrolls.

iv. Financial record keeping needed to account for USAID, GOP and other in-country fund expenditures.

4. Reports

Reports will be prepared on a regular basis during the course of this program. They will include progress and final reports required in the contract or agreement for this program, reports needed for program management, and reports of research findings.

Both quarterly and annual progress reports will be submitted to USAID/Pakistan, GOP cooperators, and the home office. The quarterly progress reports will be prepared by the Chief-of-Party and will contain a summary of achievements, problems, constraints and actions taken to solve problems and remove constraints during the previous quarter. Annual progress reports will be prepared by all participants with field-party responsibilities. Each participant will also prepare a final report. The format and procedures for preparing these reports will be similar to those used in preparing annual and final research reports for Foreign Agricultural Research Grant Programs under the Special Foreign Currency (PL 480) program. A copy of the instructions for preparing these reports is presented in Annex K.

All participants in the research component of this program will be expected to prepare reports of their research findings. They will also be expected to publish their findings in appropriate journals in Pakistan, the United States or other countries.

Trip reports will be prepared by the field staff and all travelers on TDY from the U.S. for internal use by the UI/WSU/DAI team and Pakistani cooperators. The reports should include the names of persons and institutions visited; a statement of accomplishments, decisions or conclusions reached; and any other information of value to the program. The actual cost of the travel should be included in the report.

5. Evaluations

Regular evaluations of program activities will be carried out by technically qualified personnel who are not participants in this program. These evaluations will be for the purpose of 1) improving program planning and evaluation, 2) assessing program benefits and 3) providing guidance to implementors. The following evaluations will be conducted:

a. An internal evaluation by non-participant University of Idaho, Washington State University and Development Alternatives, Inc. representatives. The evaluation will take place in the field with the Project Director, USAID Project Officer and field staff participating. It will also include meetings with all host-country participants. It will be scheduled 12 to 15 months after the program is started.

b. A full-scale evaluation by USAID at no cost to the contractor will be requested 24 to 27 months after start-up. Contractor staff will participate at whatever level is specified in the evaluation plan.

c. A second internal evaluation, similar to the initial one, will be scheduled 42 to 45 months into the program. A product of this evaluation will be an assessment of lessons learned and recommendations for future programs of this nature.

E. Budget

The estimated costs of this program are summarized by activity in Table 9. Long-term technical assistance, in-country support and campus support costs are summarized in Tables 10 through 12 respectively. Worksheets providing information on development of the budgets are shown as Tables 13 through 17.

TABLE 9.

SUMMARY OF ESTIMATED PROGRAM COSTS
TOTAL COSTS IN DOLLARS

ACTIVITY	FY85	FY86	FY87	FY88	FY89	TOTAL
1. LONG-TERM TECHNICAL ASSISTANCE	278,163	689,913	721,476	777,384	386,155	2,853,091
2. IN-COUNTRY SUPPORT	414,026	291,170	277,778	287,719	148,926	1,419,619
3. CAMPUS SUPPORT	61,676	127,538	135,981	142,700	74,951	542,926
Subtotal	753,865	1,108,621	1,135,235	1,207,883	610,032	4,815,636
4. RESEARCH MANAGEMENT	51,205	88,041	45,375	54,313	46,750	285,684
a. INFORMATION SYSTEM	276,632	94,903	92,648	53,625	53,625	571,433
5. COMPETITIVE GRANTS	35,393	174,653	490,545	356,895		1,057,486
6. TRAINING	140,520	1,127,456	1,500,785	689,491	123,387	3,581,639
Subtotal	503,750	1,485,053	2,129,353	1,154,324	223,762	5,496,242
7. RESEARCH PROJECTS						
a. Integrated Watercourse Management	162,594	245,850	199,815	205,370	62,191	875,820
b. Surface Drainage	123,342	81,111	110,481	118,621	64,075	497,630
c. Tubewell Performance	98,371	106,288	127,449	113,121	46,406	491,635
d. Irrigation Outside Indus	147,062	120,876	131,863	134,778	101,228	635,807
e. Encouraging Water Users	60,356	152,873	119,268	42,020	20,873	395,390
f. Groundwater Models	249,087	175,134	90,537	94,084	87,629	696,471
g. Farm Water Management	252,006	118,291	106,521	110,646	46,681	634,145
h. Beyond Watercourse	99,153	197,471	200,399	114,187	46,551	657,761
i. Unspecified Research Reserve (including unspecified equipment)		400,000	650,000	550,000	100,000	1,700,000
Subtotal	1,191,971	1,597,894	1,736,333	1,482,827	575,634	6,584,659
8. MONA/LIM CORE SUPPORT	125,000	250,000	250,000	175,000	0	800,000
GRAND TOTAL	2,574,586	4,441,568	5,250,921	4,020,034	1,409,428	17,696,537

TABLE 10.

LONG-TERM TECHNICAL ASSISTANCE ESTIMATED COST

ITEM	FY 85 DOLLAR COST	FY 85 RUPEE COST	FY 86 DOLLAR COST	FY 86 RUPEE COST	FY 87 DOLLAR COST	FY 87 RUPEE COST	FY 88 DOLLAR COST	FY 88 RUPEE COST	FY 89 DOLLAR COST	FY 89 RUPEE COST	TOTAL DOLLAR COST	TOTAL RUPEE COST
1. SALARY												
Chief of Party	27,480		57,720		60,600		63,600		33,420		242,820	
Social Scientist	27,480		57,720		60,600		63,600		21,200		230,600	
Hydrologist			57,720		60,600		63,600		10,600		192,520	
Irr. Agronomist			43,290		60,600		63,600		21,200		188,690	
Management Spec.	9,160		57,720		60,600		53,000				180,480	
2. FRINGE BENEFITS	16,190		69,230		76,510		77,620		21,820		261,370	
3. TRAVEL												
Recurrent		7,000		29,925		33,000		33,640		9,760		113,325
One-time	16,350	35,400					5,450	11,800	21,800	47,200	43,600	94,400
4. OTHER DIRECT COSTS												
Allowances	21,280		91,200		100,200		102,080		29,600		344,360	
Storage-HHE	1,400		5,985		6,600		6,670		1,920		22,575	
Miscellaneous		960		4,845		5,400		5,510		1,520		18,235
One-time moving	39,600		26,400					15,200		60,800	66,000	76,000
5. INDIRECT COSTS (25% of items 1-4)	39,735	10,840	116,746	8,693	121,578	9,600	124,805	16,538	40,390	29,820	443,254	75,490
6. SUBTOTAL	198,675	54,200	583,731	43,463	607,888	48,000	624,025	82,688	201,950	149,100	2,216,269	377,450
7. CONTINGENCY (10%)	19,868	5,420	58,373	4,346	60,789	4,800	62,403	8,269	20,195	14,910	221,627	37,745
8. TOTAL	218,543	59,620	642,104	47,809	668,676	52,800	686,428	90,956	222,145	164,010	2,437,896	415,195
9. GRAND TOTAL	278,163		689,913		721,476		777,384		386,155		2,853,091	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Total person months:

Chief of Party: 48

Social Scientist: 46

Hydrologist: 40

Irrigation Agronomist: 36

Research Program Specialist: 36

TABLE 11.

IN-COUNTRY SUPPORT ESTIMATED COSTS

ITEM	FY 85 DOLLAR COST	FY 85 RUPEE COST	FY 86 DOLLAR COST	FY 86 RUPEE COST	FY 87 DOLLAR COST	FY 87 RUPEE COST	FY 88 DOLLAR COST	FY 88 RUPEE COST	FY 89 DOLLAR COST	FY 89 RUPEE COST	TOTAL DOLLAR COST	TOTAL RUPEE COST
1. LOCAL HIRE												
Prof. staff		21,030		44,160		46,320		48,720		25,560		185,790
Supoort staff		15,420		32,400		33,960		35,700		18,720		136,200
2. TRAVEL		6,000		12,600		13,230		13,890		7,290		53,010
3. OPERATING EXPENSES		22,000		46,200		48,510		50,940		26,740		194,390
4. INDIRECT COSTS (25% of items 1-3)		16,113		33,840		35,505		37,313		19,578		142,348
5. LOGISTIC SUPPORT		37,500		75,000		75,000		75,000		37,500		300,000
6. COMMODITIES	258,325		20,500								278,825	
7. SUBTOTAL	258,325	118,063	20,500	244,200		252,525		261,563		135,388	278,825	1,011,738
8. CONTINGENCY (10%)	25,833	11,806	2,050	24,420		25,253		26,156		13,539	27,883	101,174
9. TOTAL	284,158	129,869	22,550	268,620		277,778		287,719		148,926	306,708	1,112,911
10. GRAND TOTAL	414,026		291,170		277,778		287,719		148,926		1,419,619	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) First year commodities includes household appliances and equipment equipment, furniture, rugs, office equipment, furniture, and vehicles to be provided by USAID.

(3) Total person months:
professional staff, 183 pm
support staff, 693 pm

TABLE 12.

CAMPUS SUPPORT ESTIMATED COSTS(1)

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARIES												
Coordinator	13,750		28,875		30,320		31,830		16,710		121,485	0
Support staff	11,750		23,500		25,900		27,200		14,280		102,630	0
2. FRINGE BENEFITS	5,865		12,050		12,930		13,580		7,130		51,555	0
3. TRAVEL												
International	5,250		11,025		11,580		12,160		6,380		46,395	0
Intl. per diem	300		630		660		690		360		2,640	0
In Pakistan		300		630		660		690		360	0	2,640
Pakistan per diem		1,890		3,970		4,170		4,380		2,300	0	16,710
In United States	1,000		2,100		2,205		2,310		1,220		8,835	0
U.S. per diem	250		525		550		580		300		2,205	0
4. OFFICE EXPENSES	4,500		9,450		9,920		10,420		5,470		39,760	0
5. INDIRECT COSTS (25% of items 1-4)	10,666	548	22,039	1,150	23,516	1,208	24,693	1,268	12,963	665	93,876	4,838
6. SUBTOTAL	53,331	2,738	110,194	5,750	117,581	6,038	123,463	6,338	64,813	3,325	469,381	24,188
10.CONTINGENCY (10%)	5,333	274	11,019	575	11,758	604	12,346	634	6,481	333	46,938	2,419
11.TOTAL	58,664	3,011	121,213	6,325	129,339	6,641	135,809	6,971	71,294	3,658	516,319	26,606
12.GRAND TOTAL	61,676		127,538		135,981		142,780		74,951		542,926	

NOTES:

(1) Rupee costs are shown in dollar equivalents

TABLE 13.

Cost Estimate Worksheet

Long-Term Technical Assistance - FY 85 Rates

Line Item	Dollar Costs	Rupee Costs[1]
A. Annual Costs		
1. Salary ($55,000/yr base)	$ 55,000	
2. Fringe Benefits (25.25% including DBA insurance)	13,900	
3. Allowances		
a. Post Differential (20%)	11,000	
b. Sunday Differential (5%)	2,750	
c. Education	4,500	
4. Storage of HHE in U.S. ($100/month)	1,200	
5. Travel and Per Diem		$ 6,000
6. Other Direct Costs		1,000
7. Indirect Costs (25% of Items 1-6)	22,090	1,750
Total Annual Costs	$ 110,440	$ 8,750
B. One-Time Costs		
1. International Per Diem to & from post	900	
2. Shipment of HHE to post	10,000	
3. Shipment of POV to post	1,200	
4. Shipment of UAB to post	2,000	
5. International Per Diem for medical travel	400	
6. Arrival Costs		
a. Travel to post	9,600	
b. Medical travel/ emergency travel		$ 3,200
c. Inland shipment of HHE & POV to Lahore		1,000
7. Departure Costs		
a. Travel from post		9,600
b. Shipment of HHE from post		10,000
c. Shipment of POV from post		1,200
d. Shipment of UAB from post		2,000
8. R & R Travel		10,800
9. Indirect Costs (25% of Items 1-8)	6,020	9,700
Total One-Time Costs	$30,120	$ 48,500

[1] Rupee costs are shown in dollar equivalents

TABLE 14.

Cost Estimate Worksheet

Short-Term Technical Assistance - FY 85 Rates

	Line Items	Monthly Dollar Costs	Monthly Rupee Costs[1]
1.	Salary ($55,00/yr base)	$ 4,580	
2.	Recruitment Incentive (10%)	460	
3.	Fringe Benefits (25.25% including DBA Insurance)	1,270	
4.	Travel		
	a. International	3,200	
	b. International Per Diem	400	
	c. In-Country		$ .500
	d. In-Country Per Diem		1,960
5.	Other Direct Costs	500	
6.	Indirect Costs (25% of Items 1-5)	2,600	610
	Total Monthly Costs	$ 13,010	$ 3,070

[1] Rupee Costs are shown in dollar equivalents.

TABLE 15.

Cost Estimate Worksheet

In-Country Program Support - FY 85 Rates

Line Items		Rupee Costs[1]
1. Salaries		
a. Professional Staff		
i. Assistant to COP	$	13,560
ii. Research Officers (3)		28,500
b. Support Staff		
i. Office Manager		
ii. Secretary/Bookkeeper		6,480
iii. Clerks (2)		5,040
iv. Messengers (2)		5,040
v. Drivers (5)		9,000
vi. Peons (4)		5,280
2. Travel		12,000
3. Operating Expenses		
a. Telecommunications		2,000
b. Office Equipment Maintenance		4,000
c. POL Charges (4 vehicles)		25,700
d. Vehicle Repair and Maintenance		5,100
e. Office Supplies		4,800
f. Miscellaneous		2,400
4. Indirect Costs (25%)		32,225
Total Annual Cost	$	161,125

[1] Rupee costs are shown in dollar equivalents

TABLE 16.

Cost Estimate Worksheet

Campus Support - FY 85 Rates

Line Item	Dollar Costs	Rupee Costs[1]
1. Salaries		
a. Campus Coordinator (0.5 FTE @ $55,000/year)	$ 27,500	
b. Administrative Assistant	17,500	
c. Record Keeper (0.5 FTE @ $12,000/year)	6,000	
2. Fringe Benefits (23%)	11,730	
3. Travel		
a. International (3 RT @ $3500)	10,500	
b. International Per Diem (6 days @ $100)	600	
c. In-Country		$ 600
d. In-Country Per Diem (54 days @ $70)		3,780
e. U.S. Travel	2,000	
f. U.S. Per Diem	500	
4. Operating Expenses		
a. Telecommunications	2,500	
b. Office Supplies	4,000	
c. Miscellaneous	2,500	
5. Indirect Costs (25%)	21,330	1,090
Total Annual Costs	$ 106,660	$5,470

[1] Rupee Costs are shown in dollar equivalents.

TABLE 17.

Cost Estimate Worksheet

Training - FY 85 Rates

Line Item	Dollar Costs	Rupee Costs[1]
1. Recurrent Costs		
a. In United States		
i. Long-Term	$ 1,700/mo.	
ii. Short-Term	3,100/mo.	
b. In Pakistan		$ 25/day/person
c. Third Country	1,000/mo.	
2. One-Time Costs		
a. International Travel (Round Trip)		3,000

---

[1] Rupee costs are shown in dollar equivalents

ANNEX A

SCOPE OF WORK
Contract No. 391-0467-C-00-4028-00

ARTICLE I - STATEMENT OF WORK

A. OBJECTIVE

The objective of the contract is to design priority research programs in areas of water management both within and outside the Indus system, and strengthen the capabilities of involved government institutions to carry out research activities.

BACKGROUND

1. Introduction

The Pakistan Indus irrigation system is the largest contiguous irrigation system in the world. The total length of the canal system is about 58,500 kilometers (km) with watercourse, farm channels and field ditches running another 1.6 million km. Total length of surface drains is over 14,000 km. However, conditions of these canals and drains have deteriorated due to lack of adequate maintenance.

The seven-year AID-financed Irrigation Systems Management (ISM) Project, which will be co-financed by AID and World Bank (IBRD) through its Inter-Rehabilitation (ISR) Project, is designed to assist the Government of Pakistan (GOP) and the four Provincial Irrigation Departments (PIDs) to rehabilitate provincial capability to plan, design, research, operate and maintain the country's irrigation systems so that reliable and equitable water supplies are available to the irrigated agriculture sector.

2. The AID-financed ISM Project

The AID project consists of four distinct but complementary and inter-related components as follows: (1) rehabilitations works; (2) institutional improvement involving management and technical skill development; (3) planning, policy implementation, and research; and, (4) command water management (CWM). The fourth component will be funded through an amendment to the existing ISM project. AID funds for the ISM project are being provided for technical assistance, training, commodities, reimbursement for civil works related to canal rehabilitation, and research operating expenses and field research demonstrations. The paragraphs below provide a brief description of each of the project's components.

a. Rehabilitation Works

The objectives of this component are to assist the GOP, in cooperation with the IDA Project, to: (a) rehabilitate and maintain an estimated 14,000 km of canals and about 3,500 km of surface drains; and, (b) strengthen its human and physical resources and management operations to plan and design civil works activities and effectively operate and maintain the entire irrigation system.

b. Institutional Improvement: Management and Technical Skill Development

Institutional improvement will take place at both the provincial irrigation departments (PIDs) and federal levels. In order to increase the capability of the PIDs to operate and maintain the entire system, the following activities are planned: (1) new earthmoving and workshop equipment, and spare parts will be provided to increase existing machinery stocks; (2) PID maintenance workshops will be upgraded; (3) improved capability of the civil works; (4) canal design capacity will be improved to reduce continuing maintenance demands; (5) substantial management training will be provided for PID personnel; and (6) a Management Information System (MIS) will be developed and institutionalized to generate information needed for management control and decision-making. In order to increase the capability of federal level bodies, namely, the Ministry of Water and Power and the Water and Power Development Authority (WAPDA), to coordinate both water policies and storage supplies, the following activites will occur: (1) the establishment of a Federal Coordinating Cell (FCC) to ensure effective implementation, coordination, and supervision of the project; (2) the establishment of a Central Procurement Office (CPO) to order spare parts routinely and to serve as an expeditious channel for emergency orders; and (5) the expansion and application of a water management computer modelling system in WAPDA to monitor total water supplies and scheduled distribution.

c. Planning, Policy Implementation, and Research

This component is divided into two subcomponents: Planning and Policy Implementation, and Research. The objective of the Planning and Policy Implementation subcomponent is to strengthen the capacity of the PIDs to engage in the planning process for future projects in the water sector and to continue, with WAPDA, the transformation of policy guidelines into action programs. The objective of the research subcomponent is to strengthen existing critical research programs in areas of water delivery and water management, both within and outside the Indus system. The research subcomponent is further divided into two portions: engineering and hydraulic research, and water management research. The water management research portion is the subject of this procurement as explained below in Section D.2 of the statement of work.

d. Command Water Management

Once operational, this component is intended as a pilot effort to integrate the management of irrigation water at all levels within canal commands. The objectives of this effort are to: (a) substantially increase agricultural production in selected pilot areas through improved water management; (b) develop water management techniques and programs which can be replicated throughout the country; (c) reduce inequities in actual water deliveries at all levels; and (d) build within the provincial agencies (i.e., Irrigation and Agriculture Departments and WAPDA) a continuing capability for planning, implementing, and operating integrated programs for irrigated agriculture.

3. Research Procurement

The water management research activity under this procurement shall be carried out in two phases. A Research Definition Team is being contracted initially (Phase I). Assuming the contractor's performance is satisfactory, the services for the long and short-term U.S. and local Pakistani advisors for the Research Team to implement the findings and recommendations of the Research Definition Team would then be contracted (Phase II).

4. Current Research Problems

A great deal remains to be learned about the irrigation system and the potential for optimization of water use. The size and complexity of the system prohibit the simple transfer of current technology without a period of adaptive research. The basic institutional structure and core of skilled manpower are in place; what is required is: technical assistance to transfer skills and impart knowledge to existing staff and to carry out in-service training; commodities; and funds for critical research programs.

The scope of research activities to be supported under this contract is broad and reflects the diversity of problems encountered. In some cases, research efforts are focused on water management problems outside of the Indus System. It is becoming increasingly clear that water management problems associated with dryland agriculture are, in many cases, directly related to the integrity of the Indus System. Better utilization of arable land promises not only increased agricultural production and income for inhabitants of these areas but also serves as a means of protecting the watershed and controlling periodic floods. In the western provinces of the Northwest Frontier and Baluchistan, a sustainable agriculture depends on utilizing scarce water resources through such means as water spreading, where seasonal torrents are capture to provide moisture for subsequent plantings.

(a) Engineering and Hydraulic Research

The Indus system presents several engineering and hydrological challenges that cannot be met by importing technological solutions from other countries. Priority problems must be tested in Pakistan under existing conditions. The Punjab Irrigation Research Institute and Sind Hydraulic Research Station will address, inter alia, the research agenda described below:

1) developments of excluding or extracting silt as required to properly distribute silt at headworks;

2) develop design procedures for alluvial channels and incorporate the latest findings in design standards;

3) develop suitable hydraulic lift mechanisms that can increase the gradient of small canals and thus solve siltation problems, or adapt existing pumping equipment for this purpose;

4) develop least cost methods for silt removal from canals of various sizes while water is flowing by such means as suction dredges, excavation equipment, and hydraulic sluices, and determine the best method for utilizing the removed silt for strenghtening banks;

5) study the use of grass and tree cover to improve canal bank stability, especially as protection against wind and rainwater erosion;

6) study water redistribution problems that arise on distributary canals after rehabilitation; and,

7) improve information transfer to engineering departments of universities and design, operation, and research personnel in the PIDs.

b. Water Management Research

Research priorities in water management include developing methods for identification and monitoring of available water resources, including groundwater, and on-site tests to improve the quantity and quality of water available for agricultural production. WAPDA has continued to carry out research in these areas, often with limited internal funds. The contractor shall design research in such areas as the following, to be carried out by the contractor, WAPDA and/or other institutions:

1) examination and refinement of on-farm water management technologies at Mona Reclamation Experimental Project site (where the original research for the AID-financed On-Farm Water Management (OFWM) Project was conducted) and under the Lower Indus Water Management and Reclamation Research Project, located in Sind Province. At the Sind site, findings from earlier Mona research will be evaluated to test their

suitability under different conditions, as well as to identify research problems specific to the farming environment of Sind;

2) tubewell research, including studies of tubewell performance and studies of the quality of water pumped;

3) modification and development of computer models to predict availability and expected irrigation water utilization rates. Merging groundwater and surface supplies in one predictive model will be undertaken;

4) development of standard design procedures for small diversion structures to replace temporary bunds constructed by farmers at the headworks of privately managed canals in the Northwest Frontier Province (NWFP) and Baluchistan;

5) investigation of the potential for on-farm and other local reservoirs and development of standards for design and construction;

6) investigation of the potential to create groundwater storage schemes in river flood plains; and

7) an analysis of the socio-economic environment governing the final use of the water. A high degree of cooperation is required among the 20 to 80 farmers that comprise a watercourse command area for the system to function effectively. How this cooperation takes place within the formal rules of government bodies is a critical determinant of the productivity of water use.

5. Location of Research Work and Institutions Involved

The ISM Project will fund research activities that involve WAPDA and the PIDs. Locations of WAPDA research will likely include Lahore, Mona, and Tando Adam, with other research sites yet to be identified. PID research will center around the Punjab Irrigation Research Institute near Lahore and the Sind Hydraulic Research Station in Hyderabad.

The contractor will deal primarily with WAPDA but may also interact with PIDs, Universities, and PARC in their water related research activities. Research assistance to the PIDs will be provided primarily by two researchers who will be part of an Engineering Team provided under a separate direct AID contract. The engineering and hydraulic research discussed in Section 4.a. above will primarily be the responsibility of that Engineering Team, whereas the water management research discussed in Section 4.b. will be the responsibility of the Research Team under this contract. It is anticipated that the researchers provided by the Engineering Team will participate with the Research Definition Team in undertaking the scope of work discussed below:

C. SCOPE OF WORK

1. The contractor shall:

a. Review and evaluate tentatively proposed research programs such as the illustrative examples in Section 4.b. above, by studying available documents, making site visits, and holding discussions with appropriate host government and AID officials and others involved in water management research in Pakistan, and recommend which research activities should be included in the project.

b. Prepare a detailed life of project research plan including the identification of specific research problems by priority, time frame, and outputs for the life of the project.

c. Develop a profile of Pakistani institutions including personnel involved in water management research activities and make recommendations for improvement in this regard for each research activity as well as for needed institutional linkages between different activities. Since most costs of personnel salaries, land, agriculture, buildings (new or remodeled), and operating budget will be incurred by the GOP and not funded by AID under the project, the contractor shall also be responsible for identifying additional GOP input requirements and for costing them out as part of the institutional/personnel profile development.

d. Compile a detailed list of commodities required, such as vehicles, instrumentations, test equipment, equipment and material for construction or operation of research projects, technial aids, specialized office equipment, etc., including specifications, estimated costs, and source/origin considerations.

e. Assess and define specific training requirements (in-country and overseas) for Pakistani research personnel.

f. Suggest the long-term team composition for Phase II, including a time frame, location, and a detailed scope of work for each member;

g. Prepare a list of short-term consultant requirements for Phase II, including a time frame (to the extent possible) and a scope of work for each; and,

h. Define in detail proposed working relationships between the Phase II Research Team and other ISM Project Technical Advisors and On-Farm Water Management Project Advisors.

2. The Research Definition Team (a multidisciplinary team) will approach its task on the basis that "RESEARCH" as used in the context of this contract is interpreted in its broadest sense. As such, consideration will be given to engineering and hydraulic

research (in collaboration with the Engineering Team researchers), water management research (distribution to on-farm utilization), agronomic/production research, social/motivational research, economi (water value/returns, etc.) research, water development and utilization (tubewell, rainfed, etc.) research, and other pertinent areas as the team may define.

3. The scope of work shall be implemented as follows:

a. Step One: Initial Design in Pakistan

The team members will assemble at UI/WSU for a three-day predeparture orientation and planning session for the work to be conducted in Pakistan. Included in this period will be: clarification and refinement of individual Statement of Work, review of the irrigation improvement programs in Pakistan and the role of the water research component, brief review of historical and cultural influences as related to water management in Pakistan, discussion of Pakistani institutions involved in the Project, and team building exercises. This will prepare the team to immediately address the Statement of Work.

Step One begins with the arrival of two members of the design team in Pakistan: Team Leader and the Soil Scientist. During the first two-week period they will:

(a) Begin discussions with AID and GOP officials to ascertain: the goals and objectives of current GOP water management improvement programs, research priorities, the institutions which will participate in the research programs, the scope of the Irrigation System Management (ISM) and the Irrigation Rehabilitation Projects, recomendations for expected training requirements, and discussions with related technical advisory teams associated with the ISM Project.

(b) Collect and begin review of research work underway or completed in the past ten years. This will include the Revised Action Program, work performed with Colorado State University, WAPDA-managed research in dryland areas, and data collection programs, including evaluation work for the On-Farm Water Management Programs.

(c) Guided by GOP and AID personnel, visit representative, targeted areas for research in order to enable the team to better relate the research objectives of the GOP to specific field conditions.

(d) In collaboration with GOP officials and the AID Project Officer, identify and establish priorities for potential research topics and confirm arrival dates of remaining team members.

The Long-Term Leader will arrive 1 week after the Team Leader.

Under the direction of the Team Leader, the remaining members of the design team will continue to shape the research program and develop recommendations forspecific research projects, identify potential principal investigators, estimate time for completion, and budgets.

b. Step Two: Interactions with U.S. Institutions and Faculty

At the conclusion of the first step, the team will return to the United States. GOP officials and the USAID Project Officer will return with the team to continue the process of designing the research program. Accompanied by senior university officials, GOP and AID officials would visit research facilities, University and Subcontractor professional staff, examine irrigation and dryland water management practices in Idaho and Washington, visit with relevant departments to define training requirements, and define with design team members, the skill requirements for the long-term team. Special meetings will be scheduled to discuss research topics to elicit suggestions on prior work, a methodological approach and candidates for research in Pakistan. The research itinerary/plan shall be proposed by the contractor by 15 August 1984 to AID for approval.

The recommendations developed in Step One will be shared with researchers in the home institutions and principal investigators identified for subsequent involvement in Pakistan. As required, additional individuals will be identified to return to Pakistan for the final step to refine specific research projects for implementation and assist in the final preparation of the Phase I report. Candidates for long-term positions will be included.

c. Step Three: Preparation of the Final Report

The Team Leader will return to Pakistan for the last month of the design phase to prepare the final report and review findings with GOP (WAPDA) and AID officials. He will be accompanied by a professional staff to a) finalize the broad parameters of the program, b) describe the management structure for the program, c) prepare cost estimates (GOP and AID) for the program, and d) prepare a detailed implementation plan with expatriate requirements. Additional professionals will complete development of specific research projects slated for early attention during the implementation phase. The final report will include all requirements as specified in paragraph c.1. of this Article. The Long-Term Leader will participate in Pakistan in the review and approval of the final recommendations.

4. Participation in the design of the Command Water Management component of the Irrigation Systems Management Project is outside the scope of work of this project.

ANNEX B

P R O P O S E D R E S E A R C H P R O J E C T S

TITLE: Integrated Watercourse Management

JUSTIFICATION:
One of the problems in irrigation management is the fact that not enough research has been directed at understanding and improving the watercourse sub-system which includes the canal network supplying the watercourse, the watercourse, the farms, the fields and the institutions involved, including farmers.

This lack of attention on the integration of all variables affecting water management and agricultural production at the "business" end of an irrigation system has resulted in piecemeal and often discouraging approaches to improved management. Even more serious, it has created a lack of understanding of practical irrigation by almost everyone who deals with the subject. Researchers who have the time and resources to study complicated systems have, for some reason, been reluctant to try to understand such an array of complicated variables. This creates a knowledge gap that planners, designers, builders, and operators of irrigation systems cannot fill. Their response is to attempt improvements by making systems more complicated and sophisticated technically; something that will function in spite of misunderstood management problems. Usually this results in failure.

Pakistan's irrigation systems were designed to operate with run-of-the river supplies. They are also designed to be water deficient in that the full supply discharge of conveyance channels is insufficient to provide water to meet consumptive demands if the entire service area is planted to irrigated crops.

The design results in a delivery system that is rigid where each farmer receives a "dose" of water the size of which is proportional to the size of his land holding. The "dose" is received by each farmer each week at the same time and it is insufficient to cover his entire farm with an effective irrigation. The design farm area to be irrigated (irrigation intensity) varies with canal command with some being as low as 25 percent while other commands (rice) may be as high as 80 percent. The rigid delivery pattern is possible because of the low intensities. In other words, farmers almost always want water when it is available. Such a system, however, has the great advantage of each farmer benefitting directly from any water he is able to save through better management. The incentive for good management by individual farmers and/or groups of farmers is higher in this system than perhaps any other irrigation system, because usually in irrigated agriculture water saved by one farmer only benefits someone else at some distant location.

Flexibility in such a system must be provided by the farmer himself in his selection of a cropping pattern (species and area) or by farmers working together to trade timings and water supplies. The rigidity is also relaxed by supplemented water supplied from wells, either private or public.

Better use of the scarce water supply in this system must come from more efficient and equitable distribution, effective means of reducing operational and other losses, selection of cropping patterns to match supplies, and in better programming of groundwater supplies where available.

The particular irrigation water delivery method in Pakistan is unique to the Indus Basin. It is old, having been developed in the past century. Since it was developed long before the subcontinent was partitioned, the same type of system is evident on the Indus tributaries in India. The higher production levels found in the Indian Punjab indicate that production in Pakistan can be significantly increased with better management of all inputs, including water. To date in Pakistan, no research has been directed at management of these resources over an area sufficiently large to remove the field plot bias and to identify implementation constraints.

OBJECTIVES:

This research project is designed to study the interactions among all factors affecting water delivery to the field. These include the reliability of the canal network, the location of fields within the watercourse area, the operation of the warabandi system, the supplemental supplies (wells and rainfall), the cropping pattern, the water table depth, the condition of the watercourse, the crop and soil cultural practices, and the farmer and how and if he is organized.

The overall objective of the research is to optimize the use of existing water supplies within a canal command and to determine means and costs of implementing proven technologies over larger areas. Specific objectives are:

1. To develop a better understanding of the interrelations among the various physical and management components of a watercourse system.

2. To manipulate components to improve the use of water and to increase agricultural production.

3. To work with farmers in selecting and managing cropping patterns to best use the available supplies.

4. To test various manipulations within the warabandi system (with farmer involvement) to improve scheduling. Possible techniques might include: (all would be within the present delivery constraint).

   i. dividing the chak into smaller sections
   ii. delivery to all or some farms on a twice weekly basis
   iii. varying the frequency throughout the season depending on crop stage and weather
   iv. cooperative use among 2 or more farmers

v. temporary storage at the village level
vi. mechanized maintenance of field channels

5. To incorporate, where possible, groundwater supplies into the delivery pattern and program its use to best meet consumptive demands.

6. To study implementation constraints of successful component changes and develop implementation guidelines.

7. To observe the watercourse system in its totality taking advantage of the data base and interventions being tested. Monitoring methods and data collection and analysis techniques can also be learned.

OUTPUTS

1. A monitoring procedure to evaluate effectiveness and efficiency of water delivery over a command area.

2. An evaluation of water delivery and use within the pilot area.

3. Guidelines for matching cropping patterns to water supplies. Recognition will be taken of the SCS-prepared On-Farm Water Management Series, Volume IV, Irrigation Water Management.

4. Implementation guidelines regarding methods of providing flexibility of water supply within the rigid warabandi system.

5. Guidelines for the use of water supplies from private and public wells.

6. An evaluation (with recommendations and procedures) of technologies that are appropriate for extension to other areas.

PERSONNEL/COLLABORATION

USAID - The entire research team, other advisors from the ISM project and advisors to the On Farm Water Management Project.

GOP - All research scientists of Mona Reclamation Experimental Project. Irrigation Department personnel will also need to be closely associated. The OFWM Directorate, Government of Punjab, will also be involved for training and perhaps improvement of some watercourses.

INSTITUTIONS

The initial pilot area would be developed with WAPDA at the Mona Reclamation Experiment Station on a portion of the 110,000 acre

area served by that station. All research personnel there would be involved because the complexity of the research requires engineering, agronomic, economic, soils, extension and social skills. The totality of water management in a gravity canal system is embodied in the program.

The Punjab Irrigation Department would of necessity be involved because they provide the major channel operation and maintenance. Because of the close working relationship between Mona and the Irrigation Department, no difficulties with such collaboration is anticipated. The Mona station is already empowered to operate the public tubewells within the area.

PROCEDURES

1. A pilot area will first need to be selected. In order to facilitate initiation of the project, the first pilot area will be within the 110,000-acre area commanded by the Mona Reclamation Project. Similar projects in other areas and provinces could be started but only after the first one has demonstrated success. The program is complicated and requires much innovation and many decisions as it unfolds. To implement in several locations would only lead to poor execution and possibly erroneous results.

   The pilot area should be sufficiently large to be representative of the canal delivery system. It should encompass the area served by at least one main channel of the delivery system and it should have private and public tubewells somewhere within the command.

2. A preliminary step would involve an inventory of the pilot area. This would include:

   i. Description of the delivery system (size and lengths)
   ii. Description of each chak area (outlet discharge, no. of farmers, etc.)
   iii. Inventory of all wells (location, size, private or public)
   iv. Evaluation of conditions of the delivery system (main and watercourses)
   v. Estimate of agricultural production
   vi. Description of any special problems (salinity, waterlogging, etc.)

3. Monitoring procedures will be selected by reviewing methods used elsewhere and developing techniques to fit the Pakistan system. There will need to be two methodologies - one to monitor water flows and another to monitor agriculture production. The development of these monitoring methods will be a valuable output of this project.

4. The monitoring program will need to commence before any effective changes are made in the area so that benchmark

data are available to measure change.

5. Early in the implementation the program will be explained to farmers. This will need to be done carefully and thoroughly because any success of the program will be directly related to farmer involvement and acceptance. This is an important step.

6. The above process will take perhaps one year at which time the physical pilot area will be known in detail, the farmers will have been informed and queried as to what they feel is possible, and the delivery system constraints will be known. At this time, and only at this time, it will be possible to decide on technologies to be implemented to improve water use efficiencies to increase agricultural production.

7. Technologies will be implemented in a manner that benefits from discrete activities that can be monitored and quantified. The number and success of technologies tested can only be decided as the project unfolds but certainly within the realm of possibilities described under OBJECTIVES (above) several will be productive.

8. Making any technology useable requires removal of the implementation constraints. For the results of this research to be appropriate it will be necessary for the research to address the implementation problems. Therefore, just as important as developing improvement technologies will be development of procedures to implement them on a large scale.

9. Summarizing the procedures can be done by considering the project in phases as follows:

Phase 1 -	Selection of Site	3 months
Phase 2 -	Baseline data & research plan	9 months
Phase 3 -	Selection of technologies	3 months
Phase 4 -	Testing of technologies	24 months
Phase 5 -	Development of extension methodologies	6 months
	Total	40 months

Depending on the site selected, the condition of the watercourses, and the technologies selected it is likely that the Punjab OFWM cell would be involved with improvement of some watercourses. This also should present no difficulty since they would be performing their ordinary function.

Finally, all research stations involved in water management would use the pilot area as a demonstration/training site to familiarize trainees with water management technologies and techniques for monitoring. These relationships need not be formal because they would only deal with short-term access to the project site.

REPORTS

Reports will include semi-annual progress reports as well as several manuals describing the monitoring methods, and implementation strategies for successful technologies developed. Technical reports will result from the pilot area description, the results of monitoring, the experience with farmer involvement and other findings worthy of description.

INTEGRATED WATERCOURSE MANAGEMENT ESTIMATED COSTS

ITEM	FY 85 DOLLAR COST	FY 85 RUPEE COST	FY 86 DOLLAR COST	FY 86 RUPEE COST	FY 87 DOLLAR COST	FY 87 RUPEE COST	FY 88 DOLLAR COST	FY 88 RUPEE COST	FY 89 DOLLAR COST	FY 89 RUPEE COST	TOTAL DOLLAR COST
1. SALARY											
Short-term TA	5,040		10,580		11,120		11,660				38,400
2. FRINGE BENEFITS	1,270		2,660		2,800		2,940				9,670
3. LOCAL HIRE											
Prof. staff		7,200		20,160		21,120		22,080		11,760	
Supoort staff		13,140		55,380		57,900		61,500		31,770	
4. TRAVEL											
International	3,200		6,720		7,060		7,400				24,380
Intl. per diem	400		840		880		920				3,040
In Pakistan		2,500		3,050		3,100		3,160			
Pakistan per diem		1,960		4,120		4,320		4,540			
5. OPERATING EXPENSE	500	17,000	1,050	34,000	1,100	34,000	1,160	34,000		1,700	3,810
6. INDIRECT COSTS (25%)	2,603	10,450	5,463	29,178	5,740	30,110	6,020	31,320		11,308	19,825
7. COMMODITIES	65,505		20,000		10,000		10,000		5,000		110,505
8. SUBTOTAL	78,518	52,250	47,313	145,888	38,700	150,550	40,100	156,600	5,000	56,538	209,630
9.CONTINGENCY (10%)	7,852	5,225	4,731	14,589	3,870	15,055	4,010	15,660	500	5,654	20,963
10.TOTAL	86,369	57,475	52,044	160,476	42,570	165,605	44,110	172,260	5,500	62,191	230,593
11.GRAND TOTAL	143,844		212,520		208,175		216,370		67,691		848,601

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 7.

(3) Vehicle costs are not included in commodities ($18,750).

EQUIPMENT LIST
INTEGRATED WATERCOURSE MANAGEMENT

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Pickup	10,000	1	10,000
Jeep (4wd)	5,000	1	5,000
Motor bikes	750	5	3,750
			18,750
FIELD EQUIPMENT			
Current meter(LED readout)	1500	4	6,000
Fluees (Parshall et al)	900	4	3,600
Pipe flow meter	650	1	650
Engr. level w/rod, tripod	1000	2	2,000
Engr. transit w/tripod	1000	1	1,000
Steel tape	400	2	800
Water stage recorder	2000	6	12,000
Recorder charts	400	1	400
Tool kit	300	1	300
Tractor(used)	25000	1	25,000
			51,750
OFFICE EQUIPMENT			
Photocopier	6000	1	6,000
Overhead projector	300	1	300
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Projection screen	150	1	150
			7,800

PROJECT TOTAL W/O VEHICLES	59550
PROCUREMENT COSTS(5%)	2978
PACKING/FREIGHT(5%)	2978
TOTAL COSTS W/O VEHICLES	65505
VEHICLE COST	18750
PROJECT TOTAL	84255

TITLE: Surface Drainage and Water Table Control

JUSTIFICATION

Development of extensive systems of canals for irrigation of the Indus Plains without adequate provision of drainage facilities has led to waterlogging and salinity problems in certain localities. The drainage problems are complicated by minimal land slopes, particularly in the lower region of the Indus Basin where slopes are as small as a one foot drop in three miles. Lack of adequate outlets for drain discharge in most areas of Pakistan has prevented efforts toward extensive on-farm drainage.

Although irrigation is needed for most of the year, much of the land, especially Punjab, suffers from too much surface water during the monsoon season. Many surface drains are inadequate to handle flows needed to prevent flooding of farmland. Most farms do not have provisions for removing excess surface water. Lack of surface drainage adds to the waterlogging problem of certain areas. If this excess water could be removed from the fields before infiltration, it would not contribute to rise of the water table.

In 1960, the GOP embarked on a program to relieve salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPs). Drainage (water table control) in these SCARPs has been by pumping tubewells operated by the Provincial Irrigation Departments (PIDs). Discharge of the tubewells is usually mixed with canal water in the watercourse. In some cases, the salinity of the pumped groundwater is too high for mixing and the tubewell discharge must be disposed of. Surface drains into which this saline water may be routed are either nonexistent or in need of maintenance.

Often saline or brackish water is brought to the ground surface in attempts to control the water table by pumping deep tubewells. Perhaps total salinity problems could be reduced by not withdrawing this deeper saline water, but instead controlling the water table by tile drainage. The latter would remove only the relatively shallow groundwater which usually is of better quality than deeper groundwater. The quality of effluent from tile drains would usually improve with time while that from tubewells rarely improves.

Only recently has tile drainage been seriously considered in Pakistan. In two fairly large areas, construction of tile drains has ' cher begun or is planned. One area is East Khairpur in the Sin Province and includes a pilot project of about 2,000 acres. Drains have been installed at present on about 1,200 acres of this pilot project. The pilot project is planned to include two types of drain layout, two spacings, two depths, various gradations of gravel as envelope material, and various types of synthetic fiber for filter material. The pilot area was chosen in part because an outlet exists for the drain effluent. In the other area, the Mardan SCARP in the Northwest Frontier Province,

the tile drains are designed to exit by gravity flow and remodeling of open drain ditches is included to increase both their depth and carrying capacity. Approximately 73,000 acres are proposed to receive tile drainage in Mardan. A small pilot tile drainage project is planned in which various drain depths, spacing, layout patterns, and materials will be used. This project of 350 acres is part of Pabbi Unit V which is a Sub-unit of Peshawar Tubewells SCARP Project. This area is said to have a drainage problem which is representative of large areas in Pakistan.

The aforementioned drainage projects indicate a recent interest of the GOP toward evaluation of tile drainage for water table control. One of the greatest constraints to extensive use of tile drains is the relatively high initial cost for installation. Ways of reducing the installation costs would be a great benefit to the country.

OBJECTIVES

1. To establish physical, chemical, social and economic criteria and methodology for selection, design, construction and evaluation of drainage systems suitable for Pakistani conditions.

2. To develop and field test low-cost methods for construction of on-farm drains.

3. To categorize, develop and field test methods for removal of excess surface water from farm fields.

PROCEDURES

The initial work on this research will be centered upon obtaining and analyzing existing monitoring data on SCARP tubewells. Of particular interest will be the discharge pumping history, water table elevation, quality of pumped water (TDS or EC, SAR, pH), electrical usage, pumping efficiency, and pumping costs. If these data are not available on the proper number or selection of wells, then a data collection program will be initiated to obtain the necessary information. This effort will be fully coordinated with the project entitled "Public and Private Tubewell Performance" because the same database is needed for both projects. Both of these projects will provide data valuable to verification of models developed in the project on "Groundwater-Surface Water Models".

Since installation of tile drains is much more recent than tubewells, the data are not expected to be complete for tile drains. As a first step, all data on existing and planned tile drainage systems will be assembled. Especially sought after will be data on field monitoring of constructed drains. Project personnel will design a data collection program as needed and install measurement structures and equipment to collect data to evaluate

performance of tile drains which have been installed in the field. Data needed will be water table elevation, drain depth, spacing, diameter, discharge and water quality of effluent (TDS or EC, SAR, pH). Required to obtain these data would be piezometers or observation holes, weirs, water stage recorders, and associated laboratory equipment.

An important aspect of this research is the cooperation of agencies responsible for construction and maintenance of the planned tile drainage systems mentioned in the "Justification" section. Some minor modifications of the systems may be necessary during or following construction in order to collect necessary research data on drain performance. For example, a small weir or flume might be installed for research purposes at the tile outfall or a manhole may be necessary to isolate a specific drain lateral.

In order to extend the range of applicability of field data on both tubewells and tile drains, computer models will be developed to simulate these systems. These models will be smaller than those being developed in the research entitled "Groundwater-Surface Water Models," and will be developed for operation on microcomputers. To speed implementation of this aspect of the research, two microcomputers will be needed - one in Pakistan and one in the U.S. on the WSU campus. The one on the WSU campus will be needed to allow model development to begin soon after the start of implementation of this research. It would be available for training of Pakistani engineers as part of graduate degree or specialized short-term training on the WSU campus. These microcomputers will also aid in data analysis for other aspects of this research. The models to be developed will be able to predict water table response and water quality of effluent under different conditions than where field systems are constructed. The models can also predict results to be expected under a wide range of operating and/or design variables for the tubewells and/or drainage systems before the systems are constructed. The models will be applicable for a range of irrigation practices, crops, soils, rainfall, and drain and/or tubewell design parameters. They will be verified by the data collected on field performance of tubewells and drains. These models will be a significant benefit in the training of Pakistani researchers and in establishing continuing research collaboration between U.S. and Pakistani researchers.

The project will address surface drainage problems in the following sequence of activities:

(1) A review will be made of literature and maps to delineate zones where surface drainage is inadequate and widespread.

(2) Categorization will be made of the principal factors contributing to impeded drainage from these zones, for example: no drainage system, inadequate drainage system capacity, poor drainage system maintenance, lack of slope to permit outfall, heavy textured soils or impermeable soil horizons, excessive contribution from a high water table, etc.

(3) Strategies and design criteria will be developed to address poor surface drainage for each of the major categories. Strategies would include engineering, agronomic, and/or institutional solutions, for example: use of tile drains, construction of main drainage arteries, use of raised beds for planting upland crops, changes in crops with emphasis on paddy, formation of drainage districts, etc.

A significant part of this research is to develop low-cost methods for construction of on-farm drains. The high cost for installation of conventional tile drains and typically small land holdings in Pakistan have been significant deterrents to use of this method of drainage. This research will focus on finding ways to significantly reduce costs of installing drains to benefit individual farms. For instance, conventional, deep (8 to 10 feet) tile drains on a wide spacing might be constructed which may be far too wide to provide proper water table lowering for a considerable area between the drains. Then perhaps shallow drains (3 to 3.5 feet) perpendicular to the deep drains might be constructed by hand labor of trenching and laying tile. The proper spacing of the deep and shallow drains would be determined for this combined system as influenced by variables in the field. Perhaps low-cost materials could be used for the shallow drains. Clay tile could be manufactured locally for these shallow drains. Various ideas for providing low-cost tile drains will be evaluated in field trials and by use of the aforementioned models. Much of the research related to this objective is envisioned to continue well beyond the initially planned four years of research implementation.

The removal of excess surface water from farm fields before it can contribute to a rising water table could provide a considerable benefit through increased crop production. This research will include careful study of methods for providing surface drainage. Most of this problem arises from the heavy rainfall during the monsoon season and the relatively flat terrain of much of the farmland. Most of the efforts of this research will be to find ways for the farmers to help themselves to handle excess surface waters. These ways may include bed and furrow formation to be investigated in the "Farm Water Management" project, and precision land leveling where slope could be given to farmer's fields provided eventual exit conditions exist. Another idea that might be tested is the formation of "mini-doabs", or micro-relief, on for example, a spacing of 100 feet.

TIME SCHEDULE:

Work would begin in 1985 on assembling and analyzing available data on tubewell and tile drain performance. Work would also begin early on model development at Washington State University. By Fall, 1985, the participants will have been selected for training in the U.S. and will begin such training. Field work would be started only after careful analysis of existing data is

completed. Work on surface and subsurface drainage on the farm would begin by March, 1986.

PERSONNEL:

USAID: Agricultural Engineer
Sociologist
Agricultural Economist

GOP: Personnel to be determined during the implementation phase of the research. Types of personnel needed include:

Agricultural Engineers
Field Assistants
Laboratory Assistants

TRAINING NEEDS

To upgrade capability for drainage research in Pakistan, one Ph.D. and two M.S. degree students should be sent to the U.S. to study engineering. These individuals must be selected early in the implementation of ISM/R, so that they may be involved in model development at WSU during the coursework phase and field drainage work in Pakistan during the research phase of their degree study. These individuals could participate in field trips to see drainage in the U.S. during breaks between semesters.

INSTITUTIONAL UNITS INVOLVED

The U.S. institutions include the University of Idaho, Washington State University, and Development Alternatives, Inc. The Pakistani institution proposed to lead this project is the Drainage and Reclamation Institute of Pakistan (DRIP) at Tando Jam, under IDFCRC. WAPDA will play a major role with Mona and LIM as collaborators. Cooperators will include the Universities of Agriculture at Tando Jam and Faisalabad and the Provincial Irrigation Departments.

REPORTS

Progress reports will be issued when significant technical progress has been made on any phase of the research. Progress reports will be issued on all aspects of the work on a quarterly basis. It is anticipated that technical papers will be submitted to appropriate U.S., Pakistani and international journals.

SURFACE DRAINAGE AND WATER TABLE CONTROL ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		10,580		11,120		11,660		12,260		55,700	
2. FRINGE BENEFITS	2,540		2,660		2,800		2,940		3,080		14,020	
3. LOCAL HIRE												
Prof. staff												
Supoort staff				6,570		13,770		14,490		6,300		41,130
4. TRAVEL												
International	6,400		6,720		7,060		7,400		7,780		35,360	
Intl. per diem	800		840		880		920		980		4,420	
In Pakistan		2,000		2,050		2,100		2,160		1,520		9,830
Pakistan per diem		5,920		6,120		6,320		6,540		5,460		30,360
5. OPERATING EXPENSE	1,000	2,000	1,050	20,000	1,100	32,000	1,160	35,000	1,220	6,000	5,530	95,000
6. INDIRECT COSTS (25%)	5,205	2,480	5,463	8,685	5,740	13,548	6,020	14,548	6,330	4,820	28,758	44,080
7. COMMODITIES	47,795		3,000		4,000		5,000		2,500		62,295	
8. SUBTOTAL	73,820	12,400	30,313	43,425	32,700	67,738	35,100	72,738	34,150	24,100	206,083	220,400
9.CONTINGENCY (10%)	7,382	1,240	3,031	4,343	3,270	6,774	3,510	7,274	3,415	2,410	20,608	22,040
10.TOTAL	81,202	13,640	33,344	47,768	35,970	74,511	38,610	80,011	37,565	26,510	226,691	242,440
11.GRAND TOTAL	94,842		81,111		110,481		118,621		64,075		469,131	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 10.

(3) Vehicles not included in commodities ($28,500).

EQUIPMENT LIST
SURFACE DRAINAGE AND WATER TABLE CONTROL

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Land Cruiser 4wd(Toyota)	12000	2	24000
Motor bikes	750	2	1500
Shop tools and spare parts	3000	1	3000
			28500
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6500	1	6500
Volt. Regulator w/battery	700	1	700
Monitor	400	1	400
Printer (dot matrix)	650	1	650
Plotter x-y type	1200	1	1200
Memory upgrade	1100	1	1100
Software (DOS, W. p. etc.)	2000	1	2000
Spare Parts	1000	1	1000
Tool Kit	200	1	200
			13750
FIELD EQUIPMENT			
Flumes (Parshall et al)	900	3	2700
Engr. level w/rod, tripod	1000	2	2000
Engr. transit w/tripod	1000	2	2000
Steel tape	400	1	400
Water stage recorder	2000	6	12000
Recorder charts	400	1	400
Piezometer jetting appar.	1500	1	1500
Piezometer driving appar.	1000	1	1000
Pump,portable centrifugal	1500	1	1500
Tool kit	300	1	300
			23800
METEROLOGICAL EQUIPMENT			
Rain gage(recording)	360	5	1800
			1800
LABORATORY EQUIPMENT			
pH meter	600	1	600
Elec. Conductivity meter	1000	2	2000
			2600
OFFICE EQUIPMENT			
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Transformer	150	1	150
			1500

PROJECT TOTAL W/O VEHICLES	43450
PROCUREMENT COSTS(5%)	2173
PACKING/FREIGHT(5%)	2173
TOTAL COSTS W/O VEHICLES	47795
VEHICLE COST	28500
PROJECT TOTAL W/VEHICLES	76295

TITLE: Public and Private Tubewell Performance

JUSTIFICATION:

Widespread waterlogging and salinity problems have developed in Pakistan following extensive development of irrigation in the Indus Plains without adequate provision for drainage. In 1960, the GOP embarked on a program to relieve salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPs). In these SCARPs, tubewells were constructed by WAPDA and later operated by the Provincial Irrigation Departments. Approximately thirteen thousand public tubewells of various capacities were constructed under these projects. The majority of them are functioning satisfactorily, but many have experienced rapid deterioration and decline in discharge. About 1,000 tubewells have already been replaced during the last few years and more than 1,200 are in need of replacement.

Although some of the pumped groundwater is too saline for use in irrigation, most of the water discharged from the SCARP tubewells is mixed with and supplements the irrigation water delivered through the canal systems. In fresh groundwater zones, the tubewell discharge is put directly into the watercourse. In 1960 when the SCARPs were begun, no one anticipated the rapid development of private tubewells which was to follow. In fresh groundwater areas where having their own tubewell can provide greater flexibility of water supply, farmers have been quick to establish and utilize tubewells. Presently, there are estimated to be in excess of 200,000 private tubewells in operation in Pakistan. The GOP is now encouraging tubewell development by the private sector to the extent that new public tubewells will not be installed in fresh groundwater areas. In general, less is known about private tubewell performance than SCARP performance, and one of the objectives of this research will be to document private tubewell performance over time.

Because many existing SCARP tubewells are in areas where quality of groundwater is adequate for direct application to fields, they could be replaced by private tubewells. The GOP has recently completed the SCARP Transition Study with IBRD funding. This study outlines a strategy for divestiture of public tubewells where groundwater is fresh. Eventual divestiture of tubewells in good quality groundwater areas would release substantial funds for use in O & M of canals. At present, double water rates are levied to water users receiving additional water supplied by tubewells, but water charge recovery is insufficient to pay for operational costs.

Private tubewells are usually much shallower than the SCARP tubewells and have much lower discharge. The private tubewells have been constructed at a much lower cost using low-cost screening materials and drilling methods. Private tubewells have reportedly experienced problems of decreasing performance and less than expected life.

Since 1974, some work has been done to determine the causes of public tubewell deterioration and to devise methods for their maintenance and rehabilitation. Essentially no such work has been done for private tubewells. In fact it appears that records of tubewell performance for the private tubewells may not exist.

The aforementioned studies of SCARP tubewell performance have reported that early and rapid deterioration of SCARP tubewells took place as a result of one or more of the following reasons:

1. Corrosion/incrustation of metallic screens
2. Invasion of gravel pack by fines
3. Deposition of carbonates in the gravel pack adjacent to screen
4. Formation and growth of saline and filamentous algae or iron bacteria
5. Use of oversized gravel pack and slot size
6. Reduction in permeability of the formation within twenty-five feet radius of the well
7. Inappropriate sampling technique leading to incorrect sampling and design work

Although the above various possible causes of well deterioration have been enumerated, there is no consensus on the main causes and no effective procedures for rehabilitation of public tubewells have yet been devised. The extent of private tubewell problems has not been determined. Pakistan is faced with several policy issues regarding tubewells including encouragement of private development, possible divestiture of public tubewells, disposal of saline discharge, etc. Answers to questions of public and private tubewell performance would allow policy makers to set policy for tubewells in Pakistan from a sound technical basis.

OBJECTIVES:

1. To identify and document the characteristics of public and private tubewells.

2. To identify and document the extent and severity of problems with performance and useful life of public and private tubewells.

3. To identify the causes of both public and private tubewell deterioration under various combinations of environmental, material and design conditions.

4. To develop methods for rehabilitation of deteriorated tubewells.

5. To determine the design. construction, operation, and maintenance needs of tubewells for improved efficiency and economic life spans.

6. To develop alternatives to tubewells for private installations for supplementing irrigation supply especially when a thin layer of fresh groundwater overlies a saline zone.

PROCEDURES:

The initial work on this research will be assembly and analysis of data on the characteristics of public tubewells. Such data should be available from the government agencies involved in design, installation, and operation of the public tubewells. The characteristics of private tubewells will also need documentation. A subcontract to a private Pakistani agency or university could be used to conduct a survey and assist in this effort. If it were a university, this could be done under the grants program. The data will be assembled in computer files using a microcomputer. This effort will be fully coordinated with the project entitled "Surface Drainage and Water Table Control" because the same database is needed for both projects. Both of these projects will provide data valuable to verification of models developed in the project on "Groundwater-Surface Water Models".

Simultaneous with the determination of characteristics of the tubewells will be the gathering of information as to the extent and severity of problems with tubewell performance and useful life. Monitoring of a small sample of private tubewells would be done on a recurring basis to determine what are the "typical" patterns for private tubewell operations, how often, if ever, maintenance is performed, and to determine nature and extent of problems. The type of data needed on characteristics and performance includes the size of the well (depth, diameter), the size of the power unit, source of power (electric, diesel), placement and length of screen, type of screen, material used for screen, size and nature of screen opening, discharge, history of operation of well, records for pumping tests, time and frequency of tests, actual data from tests, technique used for well drilling, initial installation costs, maintenance costs, operational costs, history of maintenance operations, date of initial drilling, operator's or owner's impressions as to performance of well and reasons for poor performance if well is not performing as expected.

The results of previous studies on causes of tubewell deterioration will be gathered and carefully analyzed before any field operations are undertaken. Field study of certain wells selected from the records assembled in earlier phases of this research will be undertaken to locate the cause of deteriorated performance where it exists. This effort may include tests and studies of wells for which performance has not deteriorated in addition to those exhibiting declining performance. These tests will be especially valuable in isolating causative factors for declining performance. These field tests will usually involve pump testing the wells, installation of observation wells, pulling the existing pumps, use of underwater TV cameras, and use

of various logging equipment.

It is planned to complete all of the aforementioned research work before any efforts toward rehabilitation of existing wells is begun. By using this approach, the efforts toward tubewell rehabilitation will be based on a better understanding of the causes of well deterioration. Rehabilitation may not be feasible for correcting all causes of deteriorated performance. In some cases it may be better to abandon the well and drill a new one than to rehabilitate the old well. This latter approach may be best especially if causes of the earlier well's deterioration are clearly understood and can be overcome by proper design and construction of the new well. The Manual for Water Well Design and Testing published in 1983 by the Irrigation Drainage and Flood Control Research Council addresses problems of well deterioration and rehabilitation and will be used as a basis for further research efforts. For private tubewells, the question of rehabilitation versus abandonment is an important one. Economically feasible methods for rehabilitating the smaller private wells may not exist. In the private sector, the major thrust of this research will be toward better design and construction without substantially increased installation costs. This research will consider constraints to further development of private tubewells in terms of costs, technology, and policy constraints. Things to be considered include screens, availability of materials, methods of drilling, costs of power, governmental policies on licensing and subsidies for construction and/or operating costs.

This research will investigate the feasibility of alternate methods to replace tubewells for private supply of fresh groundwater to supplement the irrigation water delivered through the canals. Results of this work will be important especially for areas in which a thin layer of fresh water overlies a saline groundwater body. Methods are needed for skimming this fresh groundwater off the top of the saline water. A hand-dug well with radial collector lines is one possible method. The radial collector lines might be jetted into place. Another possibility might be a tile drain line or lines with a sump and a low-lift pump. Such techniques might be used where aquifer materials do not exist or are not favorable for normal tubewell construction. The most promising methods will be installed and tested in the field. Recommendations for design, installation and operation will be developed.

TIME SCHEDULE:

Work will begin in late 1985 on gathering and analyzing data on tubewell characteristics and performances. Actual field work is not expected to begin until late 1986 or early 1987 after the earlier work is complete and Pakistanis selected for training have completed study tours abroad working with geohydrologists and well construction specialists.

PERSONNEL:

USAID: Geohydrologist
Agricultural Engineer

GOP: Personnel to be determined during the implementation phase of the research. Types of personnel needed include:

Geohydrologists
Engineers
Field assistants

TRAINING NEEDS:

For long-term continuing involvement in tubewell research, one Ph.D. and two M.S. degree students should be sent to the U.S. to study engineering and geohydrology. These individuals must be selected early in the implementation of ISM/R so that they may be involved in the field work on well testing and rehabilitation. Two individuals should be selected for six-month non-degree study tours in the U.S. to work with well drilling firms and Johnson Division of Universal Oil Products (Johnson Well Screens) directly on well drilling and testing techniques. Each of the three individuals receiving degrees in the U.S. should also complete a six-month non-degree study tour.

INSTITUTIONAL UNITS INVOLVED:

The Central Monitoring and Evaluation Unit of WAPDA will be the lead organization. Collaboration will be from Mona and LIM. Cooperation is anticipated from PIDs, IDFCRC, and DRIP, and from a university yet to be selected.

REPORTS:

Progress reports will be issued when significant technical progress has been made on any phase of the research. Progress reports will be issued on all aspects of the work on a quarterly basis. It is anticipated that technical papers will be submitted to appropriate U.S., Pakistani, and international journals.

PUBLIC AND PRIVATE TUBEWELL PERFORMANCE ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	5,040		10,580		11,120		11,660		6,130		44,530	
2. FRINGE BENEFITS	1,270		2,660		2,800		2,940		1,540		11,210	
3. LOCAL HIRE												
Prof. staff				10,710		7,500						18,210
Supoort staff				6,570		13,770		14,490		6,300		41,130
4. TRAVEL												
International	3,200		6,720		7,060		7,400		3,890		28,270	
Intl. per diem	400		840		880		920		490		3,530	
In Pakistan		500		3,050		2,100		1,660		910		8,220
Pakistan per diem		1,960		7,120		6,360		6,040		3,080		24,560
5. OPERATING EXPENSE	500	1,500	1,050	16,000	1,100	28,000	1,160	28,000	610	6,000	4,420	79,500
6. INDIRECT COSTS (25%)	2,603	990	5,463	10,863	5,740	14,433	6,020	12,548	3,165	4,073	22,990	42,905
7. COMMODITIES	51,920		15,000		15,000		10,000		6,000		97,920	
8. SUBTOTAL	64,933	4,950	42,313	54,313	43,700	72,163	40,100	62,738	21,825	20,363	212,870	214,525
9.CONTINGENCY (10%)	6,493	495	4,231	5,431	4,370	7,216	4,010	6,274	2,183	2,036	21,287	21,453
10.TOTAL	71,426	5,445	46,544	59,744	48,070	79,379	44,110	69,011	24,008	22,399	234,157	235,978
11.GRAND TOTAL	76,871		106,288		127,449		113,121		46,406		470,135	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 8.

(3) Vehicles are not included in commodities ($21,500).

EQUIPMENT LIST
PUBLIC AND PRIVATE TUBEWELL PERFORMANCE

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Land Cruiser 4wd(Toyota)	12,000	1	12,000
Jeep (4wd)	5,000	1	5,000
Motor bikes	750	2	1,500
Shop tools and spare parts	3,000	1	3,000
			21,500
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	1	6,500
Volt. Regulator w/battery	700	1	700
Monitor	400	1	400
Printer (dot matrix)	650	1	650
Plotter x-y type	1200	1	1,200
Memory upgrade	1,100	1	1,100
Software (DOS, W. p. etc.)	2000	1	2,000
Spare Parts	1000	1	1,000
Tool Kit	200	1	200
			13,750
FIELD EQUIPMENT			
Flumes (Parshall et al)	900	2	1,800
Pipe flow meter	650	2	1,300
Engr. level w/rod, tripod	1000	1	1,000
Steel tape	400	1	400
Water stage recorder	2000	6	12,000
Recorder charts	400	1	400
Elec. well sounder	350	1	350
Downhole TV camera	6000	1	6,000
Downhole vert. vel. meter	800	1	800
Piezometer jetting appar.	1500	1	1,500
Piezometer driving appar.	1000	1	1,000
Pump,portable centrifugal	1500	3	4,500
Tool kit	300	1	300
			31,350
LABORATORY EQUIPMENT			
pH meter	600	1	600
			600
OFFICE EQUIPMENT			
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Transformer	150	1	150
			1,500

PROJECT TOTAL W/O VEHICLES	47200
PROCUREMENT COSTS(5%)	2360
PACKING/FREIGHT(5%)	2360
TOTAL COSTS W/O VEHICLES	51920
VEHICLE COST	21500
PROJECT TOTAL W/VEHICLES	73420

TITLE: Irrigation Systems Outside the Indus Basin

JUSTIFICATION:

The huge Indus irrigation system dominates the agriculture of Pakistan, yet many smaller irrigation systems of a wide variety of types exist outside the Indus basin. Many of these systems are ancient, preceeding by centuries the British initiated Indus irrigation system. These systems are especially important in Baluchistan because of the small part of the province that can be served by the Indus system, and because these systems have traditionally served the needs of the dispersed population of the area.

The systems that occur outside the Indus basin can be roughly classed according to the method used to obtain the irrigation water supply:

BARANI - rainfed agriculture, (not directly addressed by this project);

SAILABA - crop production using runoff floodwaters, collected, concentrated, and directed with bunds and channels to prepared fields;

KAREZ - use of horizontal, hand-dug gravity flow wells (with vertical access shafts) to obtain irrigation water;

WELLS - including both dug wells and modern tubewells as sources of irrigation water.

Most of the attention of irrigation research in areas outside the Indus Basin has focused on karez and well systems for groundwater use. However, the groundwater resource of these areas is extremely limited. Well pumping depths in some areas have increased. Karez flows have decreased in spite of efforts to augment flow by extending or deepening the channels. Hence recent attention in Baluchistan has focused on measures to recharge the aquifer using floodflows from storms or snowmelt, and measures to improve the efficiency of water use by techniques such as watercourse improvement and drip or trickle irrigation. These topics have attracted donor support in recent years, typified by recent work under the Baluchistan Minor Irrigation and Agricultural Development Project (BMIADP), the USAID funded Baluchistan Area Development Project (BALAD), the Asian Development Bank funded survey of groundwater resources in the province, and USAID funded trickle irrigation demonstration projects within the On-Farm Water Management Program. These projects, however, tend to heavily emphasize demonstration projects and pilot practice implementation, rather than research.

The focus of most program attention on karez and well systems or on methods such as drip or trickle irrigation to improve irrigation efficiency, reflects an apparent acceptance that these systems are the best way to increase crop output in the part of Pakistan not served by the Indus system, in spite of the expense of these systems, the problems caused by the limited groundwater resource and the need for expensive recharge remedies. Yet a very significant part of the crop acreage in Baluchistan is farmed by barani or sailaba methods.

Because rainfall is sparse (particularly in Baluchistan where it averages 22 cm.) and erratic, the strictly rainfed methods of barani agriculture are extremely risky and unproductive. When floodwater runoff is concentrated on prepared fields as in sailaba irrigation, the results are somewhat less risky and yields are higher than for barani cropping. Current sailaba practices use roughly prepared bunds without control structures to collect and direct the water. The rough structures are frequently breeched by floods, resulting not only in structural damage, but also in loss of water and soil. The crude structures also mean that it is difficult to manage the water precisely enough to effectively control water application to the fields.

While research in barani farming is being conducted by the Arid Zones Research Institute (AZRI) at Quetta and the National Agricultural Research Centre (NARC) at Islamabad, there appears to have been little research in Pakistan directed specifically to the needs of sailaba irrigation. In fact there seems to be little information as to the extent of sailaba acreage, the indigenous management practices used, the crops or crop varieties used, the yields obtained, the design or cost of structures used, or the frequency and cost of structural repairs. Research to develop low cost improved structures and to identify practices that will enhance the reliability and level of returns from sailaba irrigation is needed. Conjunctive use of floodwater and groundwater may be another viable alternative that would improve on the reliability and yields of sailaba, while placing less demand on the limited groundwater supplies than karez or well irrigation. There may also be a range of agronomic and horticultural practices -- some of them perhaps currently in use by experienced farmers -- which are complementary to improved sailaba or conjunctive sailaba/groundwater irrigation.

It is also important to recognize that successful sailaba irrigation might have substantial groundwater recharge effects. It would be useful to gain a better understanding of the extent of deep percolation of the floodwaters diverted and used in this way, compared to the economic efficiency of single-purpose groundwater recharge projects. It will also be useful to determine the contribution to aquifer recharge caused by delay-action dams, another recent intervention that holds promise of increasing recharge.

The Baluchistan Agriculture Department has had for a number of years, a subsidy program that provides bulldozers with operators

to construct sailaba bunds. Farmers pay about half of the cost of bund construction. The quality of the resulting structures depends on the training and experience of the bulldozer operator, but in most cases is low. Low cost improved structures such as spillways and control devices are not a part of this program.

Research is needed to improve understanding of the extent and nature of the various forms of traditional irrigation systems outside the Indus Basin, their potential for improvement, sustainability, and opportunities which each presents for increasing crop production in Pakistan.

The techniques and research plan of this project can serve as a model for research into traditional irrigation methods for the entire out-of Indus region including the mountainous terrain of the Northwest Frontier and Punjab Provinces. However the proposed program will be focused primarily on Baluchistan and only extended to other areas based on that experience.

OBJECTIVES:

1. Develop trained personnel necessary to conduct research on traditional irrigation systems outside the Indus Basin.

2. Define and characterize patterns exhibited by karez irrigation, sailaba irrigation, and other traditional forms with respect to area and crops; physical, hydrologic and structural characteristics of systems; indigenous management systems used; and economic success of the various systems.

3. Develop improved practices, structures, and management systems (including conjunctive use) for these types of irrigation.

4. Determine the sustainability of traditional system irrigation levels, and of proposed levels of irrigation with maximum feasible development of all water sources.

OUTPUTS:

1. Establishment of a nucleus of expertise on traditional irrigation systems, with a special emphasis on sailaba and karez irrigation.

2. An improved information base on the technical and economic performance, and potential for improvement of indigenous practices associated with traditional irrigation systems.

3. Information on the performance and the costs and benefits of proposed improved management practices and structures for sailaba irrigation, and on benefits from delay-action dams.

4. Information necessary to identify the proper place of sailaba irrigation and sailaba/groundwater conjunctive use

in a program to increase the sustainable crop production in areas of Pakistan where these forms of irrigation are widespread. This would consist of both new information generated by this project, and a collation and synthesis of results from other research studies in a form useful to guide government policy and extension implementation.

PROCEDURES:

This project will proceed in three phases. The first phase, reconnaisance and system baseline data collection, will identify more clearly the research and training needs. In the second phase essential staff for the research project will receive formal training. In the final phase, after the first staff trainees return to Pakistan, the additional research components of this project will be conducted.

Objective 1 recognizes the need for trained Pakistani scientists to cooperate with the project. Baluchistan has a severe shortage of university trained research personnel. There is no agricultural university in the province and there is relatively little province-supported agricultural research. In recent years there has been a proliferation of federal and foreign donor sponsored agricultural projects in Baluchistan. These efforts have severely strained the provincial agricultural institutions, and consequently the projects have had to rely either on training project staff abroad or at other provincial universities, on importing trained research staff from other provinces, or upon foreign experts.

One of the primary purposes of this proposed project is to contribute to the development of several persons who will become experts on traditional irrigation systems. It is vital that these be individuals who can speak local languages to work effectively with the indigenous population of the area. If such persons can be trained, induced to continue to conduct research, and to implement research findings, then this project will have made a major contribution to the development of the areas of Pakistan outside of the Indus Basin.

Four Pakistanis, with a B.Sc. in some related discipline, will be selected for training. Their formal training will depend on their present background, but will probably involve post-graduate course work in agricultural engineering, hydrology, crop production, and agricultural economics. It is recognized that this training period may be extended by the need to achieve English language proficiency prior to the beginning of formal training. Equally important will be the practical training which will result as these individuals participate actively in research under the other objectives of this project. Training will include thesis research addressing the objectives of this project, in Pakistan, under the supervision of short and long-term personnel.

Objective 2 will start as a reconnaisance survey of traditional irrigation systems and practices. During the first months following the start of this project, the four selected trainees, along with at least one team member, AID personnel with knowledge of Baluchistan conditions, and others from federal or provincial Pakistani agencies will inspect irrigation systems in Baluchistan. The purpose would be to gain an understanding of the indigenous management systems used, other inputs used, economic feasibility, and potential for improvement of these systems. Initial work by W.D. Kemper, Mazher-ul-Haq, and Ahmed Saeed can provide a starting point for this reconnaisance work. At the conclusion of this study, this team will prepare a report outlining their findings, their recommendations for the training of experts, and their recommendations for further research.

Work on this objective will need to be matched to the phased departure of trainees for formal coursework in the US. Following completion of the initial reconnaissance work the first trainees will depart for training and those remaining will continue to collect irrigation system baseline data. The additional work needed under Objective 2 will be a more precise characterization of costs, performance, successful management systems, and physical characteristics of these systems. This is likely to require some very limited use of farmer surveys, and measurement and monitoring. A photographic record of practices and structures encountered will be kept, for later extension and training usage.

Objective 3 work will begin as soon as Objective 2 begins to produce conclusions about improved management systems and definite proposals for improved sailaba structures and possibly delay-action dams, probably beginning in Year Two of the project. As these improved management systems and structures are identified, they will be implemented on the fields of a few selected cooperating farmers. Funding for structural improvement and other inputs would be probable. In exchange the farmers should agree to undergo some training in proper use of the practice and monitoring and recording of practice performance.

This objective should produce two results: improved information about the technical and economic performance of improved irrigation practices, and a start toward on-farm testing of these practices on farmers' fields. The Agricultural Engineering and On-Farm Water Management programs of the Baluchistan Agriculture Department -- the two agencies having direct contact with farmers in this subject area -- must be involved if this objective is to achieve the desired results.

One must take a cautious perspective on improving traditional irrigation. The limited time frame of the project is inadequate to obtain definitive results and to affect changes. Thus it is important for the project to focus on training and improving the capability of local institutions to carry on with the monitoring of these farmer-field demonstrations following the completion of the Program.

Objective 4 work will begin with the return of the trainees to Pakistan. This objective is proposed because it was perceived that while many Pakistani and donor agencies are involved in irrigation assistance work in the out-of-Indus areas of Pakistan, there is little apparent effort to carefully monitor this work, or to synthesize any conclusions from this work into a comprehensive understanding of the present and potential role of systems in increasing the productivity of Pakistani agriculture.

One purpose of this objective is to identify the proper role that sailaba irrigation can play vis-a-vis well and karez irrigation in the future agricultural development of these areas. For example: is tubewell technology obsolete and best replaced by karezes? Is tubewell acreage amenable to large increases, or is it even sustainable at current levels given available groundwater supplies? Is groundwater recharge to sustain karezes and wells an economically viable program? How does this compare to the economic viability of sailaba? What is the contribution of delay-action dams to aquifer recharge?

This project does not propose a major program of experimentation or monitoring to address these questions. Rather, this objective provides an opportunity for the project to collaborate with ongoing projects in the out-of-Indus area, to improve their monitoring efforts, to exchange data, and to extend their results. For example the groundwater modeling project proposed can interface and exchange data with projects such as the Baluchistan Minor Irrigation and Agricultural Development Project, the ADB-funded groundwater project, and the Baluchistan Area Development Project. The existing OFWM programs in watercourse improvement and drip/trickle irrigation and the proposed ADB project on trickle irrigation may also provide information useful to this objective. These projects could be generating, over the next few years, valuable data on groundwater characteristics, and the performance of groundwater recharge channels, delay action dams, and karez improvements. It may be useful in some cases to collaborate more formally with some of these projects, and to provide some funds for additional instrumentation and monitoring in exchange for needed data. Using baseline data acquired in this way the groundwater model can be used to help address questions about the sustainability and economic viability of the various systems.

The first task under objective 4 will be to determine the proper scope and methodology for meeting this objective, given the issues identified in the reconnaisance phase, the available models and data, the collaborative possibilities, and the manpower and other resources available for the research.

The IDFCRC is proposing a study on synthetic unit hydrographs for several catchments in NWFP. The results of this study should also have applicability for estimating water yields and planning structures under Baluchistan conditions. The possibility of cooperation with IDFCRC on this study will be investigated.

PERSONNEL:

Co-principal investigators:

Pakistani scientist - to be selected during final project definition: From WAPDA, Baluchistan office, Planning

UI - part time involvement of a long term team member (specialist in hydrology or irrigation agronomy)

Project professional staff:

Four trainees to be selected

UI - short term expatriate TDY staff including agronomist, hydrologist, irrigation engineer, and agricultural economist

INSTITUTIONAL INVOLVEMENT:

The project can be implemented using Pakistani staff with the extensive staff training component proposed, and with the frequent involvement of short-term advisors.

The lead Pakistani institution is anticipated to be WAPDA's Water Resources Planning and Research Department of the Planning and Investigation Unit.

The four trainees, for reasons of career continuity, should be employees of some Pakistan government agency (probably the Baluchistan Agriculture Department). Staff may have to be added to the Baluchistan section of WAPDA, Chief Engineering, Planning. The Agriculture Department should collaborate as this would give direct access to the Baluchistan Agricultural Research Institute, which is presently doing some related research; the Agricultural Engineering Directorate, which provides the bulldozers for subsidized sailaba bund construction; the Agricultural Extension and the On-Farm Water Management programs, which will both be prime avenues for research dissemination; and the Agricultural Training Institute, which is the the only provincial unit involved with education in agricultural subjects.

The Baluchistan Irrigation Department must also play an important role in this proposed research. This is required to allow close collaboration between the proposed project, and the ongoing Baluchistan Minor Irrigation and Agricultural Development Project.

The PARC stations at AZRI and NARC are also potentially important collaborators, because of the possible relevance of ongoing barani farming research at these two stations, and because of PARC's access to trained research personnel.

PROJECT SCHEDULE AND REPORTS:

The attached project scheduling chart assumes that final arrangements for this project will be finalized several months following the approval of the Program. This would allow for the completion of the irrigation system reconnaissance work in late 1985, with formal training of the first trainees to begin during the following winter.

Reports will be submitted every six months, as indicated on the attached chart. The final report of the project will be submitted approximately four years after the start of the project.

BIBLIOGRAPHY:

Buzdar, Nek M., "Range Management and Shepherds in Baluchistan, Pakistan", USAID, Islamabad.

Fisher, B., "Irrigation Systems of Persia", The Geographical Review, Vol. xviii, 1928.

Kemper, W. D., Mazher-ul-Haq, and Ahmed Saeed, "Farm Water Management in Upland Areas of Baluchistan", Colorado State University, Report #51, 1979.

Rahman, M., "Ecology of Karez Irrigation: A Case of Pakistan", GeoJournal, Vol. 5.1, 1981.

Shamsul Islam Siddiqi, "Water Resources and their Conservation in the Mastung Valley", The Oriental Geographer, 1962.

Schedule and Report Dates for Out-of-Indus Irrigation Project

Month After Start	Obj 1 Training of "Experts"	Obj 2 System Baseline	Obj 3 Improved Practices	Obj 4 Irrigation Sustainability
	select system trainees	begin reconnaisance study		
6	first trainees leave for US	RECON. REPORT		
12		PROGRESS REPORT complete follow-up work	start planning practices for farmer field	
18	last trainee leave for US		FOLLOW-UP REPORT	
24	first trainees return, begin their research		PROGRESS REPORT begin practices on farmer fields	begin sustainability research
30			begin to monitor performance	PROGRESS REPORT
36	FIRST THESES DONE last trainees return, begin their research			PROGRESS REPORT
42	PROGRESS REPORT			
48	LAST THESES DONE			FINAL REPORT

IRRIGATION SYSTEMS OUTSIDE THE INDUS BASIN-ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		10,580		11,120		11,660		12,260		55,700	
2. FRINGE BENEFITS	2,540		2,660		2,800		2,940		3,080		14,020	
3. LOCAL HIRE												
Prof. staff												
Supoort staff		5,200		13,140		13,770		14,490		8,820		55,420
4. TRAVEL												
International	6,400		6,720		7,060		7,400		7,780		35,360	
Intl. per diem	800		840		880		920		980		4,420	
In Pakistan		1,500		1,800		1,850		1,910		1,720		8,780
Pakistan per diem		4,920		5,620		5,820		6,040		5,760		28,160
5. OPERATING EXPENSE	1,000	13,500	1,050	29,500	1,100	43,500	1,160	43,500	1,220	24,000	5,530	154,000
6. INDIRECT COSTS (25%)	5,205	6,280	5,463	12,515	5,740	16,235	6,020	16,485	6,330	10,075	28,758	61,590
7. COMMODITIES	51,722		20,000		10,000		10,000		10,000		101,722	
8. SUBTOTAL	77,747	31,400	47,313	62,575	38,700	81,175	40,100	82,425	41,650	50,375	245,510	307,950
9.CONTINGENCY (10%)	7,775	3,140	4,731	6,258	3,870	8,118	4,010	8,243	4,165	5,038	24,551	30,795
10.TOTAL	85,522	34,540	52,044	68,833	42,570	89,293	44,110	90,668	45,815	55,413	270,060	338,745
11.GRAND TOTAL	120,062		120,876		131,863		134,778		101,228		608,805	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Vehicles are not included in commodities ($27,000)

(3) Short-term technical assistance person month: 10

EQUIPMENT LIST
IRRIGATION OUTSIDE THE INDUS BASIN

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Land Cruiser 4wd(Toyota)	12,000	2	24,000
Shop tools and spare parts	3,000	1	3,000
			27,000
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	1	6,500
Volt. Regulator w/battery	700	1	700
Monitor	400	1	400
Printer (dot matrix)	650	1	650
Memory upgrade	1,100	1	1,100
Software (DOS, W. P. etc.)	2000	1	2,000
Spare Parts	1000	1	1,000
Tool Kit	200	1	200
			12,550
FIELD EQUIPMENT			
Current meter(LED readout)	1500	2	3,000
Flumes (Parshall et al)	900	1	900
Pipe flow meter	650	1	650
Engr. level w/rod, tripod	1000	1	1,000
Engr. transit w/tripod	1000	1	1,000
Steel tape	400	1	400
Water stage recorder	2000	4	8,000
Recorder charts	400	1	400
Elec. well sounder	350	2	700
Soil auger	50	2	100
Tool kit	300	1	300
Sed. samp., infilt. equip.	1500	1	1,500
			17,950
METEROLOGICAL EQUIPMENT			
Rain gage(recording)	360	2	720
Evap. pan(w/ gage & well)	625	2	1,250
Thermometers,psychrometers	600	2	1,200
Enclosure,std. U.S.W.S.	400	2	800
			3,970
LABORATORY EQUIPMENT			
Sed. filtration apparatus	800	1	800
Soil seive set w/shaker	1000	1	1,000
Glassware	1000	1	1,000
			2,800

OFFICE EQUIPMENT			
Photocopier	6000	1	6,000
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Projection screen	150	1	150
Flip chart-chalk board	100	1	100
Drafting or printing equip.	1000	2	2,000
Transformer	150	1	150

			9,750
			========

PROJECT TOTAL W/O VEHICLES	47020
PROCUREMENT COSTS(5%)	2351
PACKING/FREIGHT(5%)	2351
TOTAL COSTS W/O VEHICLES	51722
VEHICLE COST	27000
PROJECT TOTAL	78722

TITLE: Encouraging Water User Involvement in Better Water Management

JUSTIFICATION:

Government of Pakistan and foreign donor programs in water management have been designed with an underlying assumption that the creation of water user associations is a necessary prerequisite for watercourse improvements, watercourse maintenance, and direct agronomic benefits. Yet after nearly a decade, diverse attempts to organize farmers sharing a single watercourse into viable, continuing associations have not shown notable success. Projects, such as those coordinated through the On-Farm Water Management Program, require water users on a single watercourse to form an association before receiving capital outlays for watercourse straightening, partial watercourse lining, and installation of concrete turnouts. They have found that in most cases water user associations are active only during the two to three month period of physical renovation and cease to function as viable units afterwards. Farmers do not regularly clean and maintain their watercourses which soon become clogged with weeds and filled with silt. The benefits of watercourse improvements are felt immediately and then quickly diminish.

Without the active participation and cooperation of water users, the government's ambitious program for improving the nation's watercourses and better managing its limited water resources may be in jeopardy. There are ongoing attempts to determine a satisfactory set of incentives to encourage water users to form functioning associations. Better water management might also be achieved by working directly with individual water users through a well-designed program based on practical applications of research results. In this way, the actual water users, who are often tenants, may be reached rather than only the landowners who now participate in the program. Certainly, water users must join together to permit the physical improvements of the watercourses, but, at present, once the renovations are completed there may be little reason for water users to continue as a group.

Research conducted on water users to date is disappointing. In fact, the dynamics of the social organization of the watercourses throughout Pakistan are still not understood. The data base is severely limited to small areas of the Punjab, and government implementation plans have been designed without attention to regional differences in landownership and tenancy patterns. Attempts in different parts of the country to organize farmers, particularly water users, into associations have rarely been monitored or examined in any depth or for any length of time. Little attention has been given to the institutional constraints at higher levels: the climate created by government agencies, such as the Provincial Irrigation and Agricultural Departments, and their interactions with each other and with the water users. Until we understand the workings of relevant government agencies,

how they interact in practice with each other and with water users, and how to strengthen their operations the likelihood of motivating water users to become involved in water management strategies will remain remote.

OBJECTIVES:

1. Establish a data base on the organizational patterns of water users in different parts of Pakistan.

2. Learn what attempts to organize water users have been successful and learn underlying elements leading to cooperative activities.

3. Determine the institutional constraints which have impeded the creation of viable water user associations.

4. Attempt to foster better water management through "action research" programs.

OUTPUTS:

1. Case studies of watercourse shareholders selected to reflect the variety of organizational patterns in Pakistan so that watercourse improvement programs are adapted to local conditions.

2. Evaluations of different strategies used to organize farmers into associations in order to assist government programs, including Command Water Management Project implementation.

3. Recommendations on ways to reduce institutional constraints to the creation of viable water user associations and identification of a role for the private sector in water management activities.

4. Training students in the sociological aspects of water management for their later recruitment into relevant government agencies.

5. Identification of social factors encouraging or restricting farmer adoption of project interventions.

PROPOSED RESEARCH PROJECTS:

1. The Dynamics of Watercourse Organization

Pakistani government officials have repeatedly expressed the opinion that after years of research and implementation projects the actual ongoing relations among water users and their implications for cooperative activities are still not clearly understood. Of the few studies completed to date, nearly all are based on survey research which has provided broad and shallow data. With the exception of a single research effort (Merrey

1983), time-series studies of water users are virtually non-existent. Action research in Pakistan in this area, by which water users are encouraged to join into associations, is conducted in a context of impressions of behavior rather than with an understanding of the underlying principles of social organization and cultural patterns.

Although watercourse improvements are being implemented in the four provinces, supporting sociological studies are limited almost exclusively to the central Punjab (Mirza 1975; Lowdermilk, Clyma, and Early 1975; and Mirza and Merrey 1979). Strategies based on its predominant pattern of small landownership cannot be easily translated to Sind, for example, which has large landowners and an entrenched tenancy system. Guidelines for program implementation have not taken into account this important regional difference or even variation within the Punjab, and, as a result, programs have been designed which have focused on involving absentee landowners rather than the actual water users.

This project calls for the intensive examination of watercourses in different parts of the country to be conducted over the life of the ISM/R Project. It is likely that some of the selected watercourses will be within Command Water Management Project areas in order to support that upcoming GOP effort. Among the characteristics to be considered in their selection are the following: landowning and tenancy patterns, caste differences, cropping patterns, position of the watercourse on the minor, and presence or absence of public and private tubewells for supplementary supply. These studies are expected to go beyond the confines of a single watercourse by examining the water users' relations with other users upstream and downstream and with officials of related government agencies.

Studies of the dynamics of watercourse organization will support a number of other research efforts to be conducted by the ISM /R. It will provide information on the actual extent of conjunctive use of groundwater and surface water by farmers which may then be built into the proposed modeling work. Every attempt will be made to select some watercourses with public or private tubewells. Research will also support the study of surface drainage and water table control by providing information on the performance of horizontal and tubewell drainage systems. The studies will have an "action" component, particularly during later years of research on watercourses, when research findings by the project may be introduced to farmers to learn more about the dynamics of local relationships and what strategies, if any, might work to strengthen the local groups. In this case, the research will require the assistance of researchers working on the various proposed Farm Water Management projects. This work will also support the objectives of the Beyond Watercourse Improvement project in identifying the social factors that encourage or restrict farmer adoption of improved practices that would make better use of increased available water.

Among the points to be examined are the following:

- shareholders' regulation of water scheduling and watercourse use
- joint activities related to watercourse use and maintenance, including presence and role of water user associations
- social and cultural divisions among shareholders which relate to water use
- interactions with government officials, including participation in the On Farm Water Management Program
- strategies for dealing with uncertain or insufficient water supplies
- where relevant, management of surface and groundwater use
- the role of tenants in watercourse operations
- constraints on watercourse activities due to chak size
- evidence of values and mechanisms which encourage conflict as a source of status and discourage long-term cooperation
- effect of actual project interventions on local relationships

a. Institutions:

The water user case studies will be coordinated by the Department of Anthropology, Quaid-i-Azam University, Islamabad. The department, which provides only graduate training, has a unique program which requires that its students conduct six months of rural field research as the basis of their theses. Students' training prior to fieldwork includes courses in social and economic theory, the ethnology of Pakistan, and research methods. They are closely supervised when analyzing their data and writing their theses. Students have tended to do field research in their own provinces where they speak the language. During the period of field research they are given a stipend, provided out of university funds.

Research on watercourses will be incorporated into the department's graduate training program, and students will do fieldwork on selected watercourses throughout Pakistan. Case studies of the watercourses will serve as Master's theses and will form the beginning of a data base on the social dynamics of watercourse users. In addition, a series of summary volumes will be produced under the responsibility of the department's

faculty and the long-term social scientist. They will integrate the disparate studies and discuss the practical implications of the research for interested government departments. Certainly a priority of this research project is for government officials to become aware of the variability of water user organizations and incorporate that variability into their implementation plans.

On the USAID side, the ISM/R Project's long-term social scientist will help train students and take part in designing the research projects and supervising the research, analysis and writing. He will also help select the sites. Two graduate students in the Departments of Anthropology and Rural Sociology from the two sponsoring American universities will also be recruited to spend two semesters in Pakistan, taking courses in the department as part of their own academic program, doing language training, and conducting field research on watercourse organization as the basis of their theses. They will be located near Pakistani researchers and will be expected to work cooperatively with them. One or two students from the Department of Anthropology in Quaid-i-Azam University will be funded to continue their graduate training for a Ph.D. at Washington State University or another institution in the Department of Anthropology or Rural Sociology. They will be expected to conduct their dissertation research in Pakistan on some aspect of water management and will enter the department at Quaid-i-Azam University as faculty members.

ISM/R will assist the Department of Anthropology in expanding its ethnographic laboratory with the objective of establishing it as a future focal point of water management research in the social sciences in Pakistan. This assistance will consist largely of providing needed equipment for data analysis and documentation. Students are already trained in quantitative analysis, although the department presently has no equipment to improve this capacity. A microcomputer and software for social science analysis will be provided. The project long-term social scientist, other team members, and short term consultants will help integrate their use into the department's research program. The computer will be used for training students in quantitative methods, analyzing research data from the individual watercourse studies, integrating their data into comparative analyses, and drafting reports. Photographic and sound equipment will be provided so that a visual and oral record of watercourse use may be established.

Specialized field teams examining watercourse organization will necessitate the hiring of a field supervisor who will be recruited out of the department's pool of graduated students. He too, will be required to attend the two planned courses prior to fieldwork. It will be necessary to purchase a 4-wheel drive jeep and hire a driver for the exclusive use of the watercourse re-

search team during the fieldwork periods in order to facilitate site visits and supervision. Funds will be allocated to improve the library's collection of works on water management and irrigation. A list of books will be complied to be used as references during training and writing. Each field researcher will be given a set of books to be used during his graduate training and in his professional life.

b. Personnel/Collaboration:

USAID - ISM/R team social scientist
two anthropologists/rural sociologists TA/TDY
Local - Department of Anthropology, Quaid-i-Azam University
faculty field supervisor (M.Sc. Anthropology level)
selected M.Sc. graduate students

c. Schedule:	Duration	Terminate by
First Phase		
Training	8 mos	May 86
Fieldwork	6 mos	Nov 86
Case studies writing	6 mos	March 87
First summary volume	4 mos	August 87
Second Phase		
Continuing case studies and comparative volumes		through May 89

d. Reports:

A series of case studies in the form of master's theses and comparative, analytical volumes will be produced during the life of the project. The department's faculty and the project long-term social scientist will take responsibility for the supervision of the former and the production of the latter. They will be made available to interested government officials, project team members, and staff of OFWM and the other ISM projects.

2. Evaluating and Monitoring Existing Water User Associations and Farmer Cooperatives

A relatively small number of diverse groups have tried to organize farmers into associations and cooperatives in Pakistan. Attempts centering on the watercourse began with the Water Management Research Project in the mid-1970s. Since then, efforts have been made by the On Farm Water Management (OFWM) Program in the Ministry of Food and Agriculture, the Water Management Research and Training Project for Rural Development in the University of Agriculture, Faisalabad, and the Aga Khan Foundation's Rural Support Project. Surprisingly little work has been done to monitor the impact of these activities so that later efforts to organize water users might be more successful. Few reports exist and conversations with those involved indicate

variable success. The following question remains unanswered: Are there incentives that can be offered to water users to encourage them to organize into viable, continuing associations?

Each of the above attempts argues from a unique perspective. The CSU advisors suggested that water users be interviewed prior to improvements (Mirza and Merrey 1979). Those with a particular set of social characteristics (reflecting landholding pattern, kinship group structure, and power relationships, among others) would be more likely to work cooperatively and maintain their watercourses post-improvement. They did not address the issue of what was to be done with the vast majority of watercourses which did not meet this set of attributes although they did counter the view that the water users were simply being uncooperative. The On Farm Water Management Program has relied upon the water users ordinance of 1981 to facilitate their registry into legally recognized groups but has found that the watercourse improvements have frequently been made in the chak of a single family cluster. Another effort under the OFWM Program, funded by the Asian Development Bank, provides extension advice and plans to make credit available for the installation of private tubewells. The Water Management Research and Training Project at Faisalabad has argued that water user associations will be viable only if they are registered as cooperatives so that members may acquire farm inputs at subsidized rates. However, programs which focus on credit and fertilizer will have only a short term impact, if any, without the applied research and extension that are needed to identify promising technologies and provide information and skills to farmers to employ those technologies. The Aga Khan Rural Support Program in the Northern Areas of Gilgit, Chitral, and Hunza appears to have remarkable success organizing villagers into cooperatives as a prerequisite to receiving physical infrastructural improvements, women's programs, training, and agricultural credit. It ought to be noted that the program is active in areas of Pakistan where a large proportion of the population is Ismaili, the Muslim sect which supports the Aga Khan Foundation. To what extent the religious ties form a basis for development efforts will have to be examined.

Initially, a review of the literature and activities of these groups is required to determine what may be incorporated from them into a program of improved water management and to discover their successes as well as their common weaknesses. A preliminary examination of these different efforts indicates that the incentives offered are not always logically related to water management goals and that all appear to lack a well developed extension component which uses practical research results. Growing out of this socioeconomic monitoring and evaluation will be an examination of the incentives offered and suggested to revitalize water user associations. A requirement of the research team will be to provide workable recommendations on how water user association formation might be facilitated, if at all.

Among the points to be examined are the following:

- methods of organizing farmers, leadership patterns, membership selection and continuity -regularity and nature of meetings and evidence of cooperative decision-making

- incentives offered to induce membership, particularly related to water management

- uses by members of the incentives

- expansion of program to other needs by association members

- methods of resolving disputes and dealing with violations of regulations

- reactions of farmers to watercourse improvements

- distribution of benefits to association members and water users

- training and extension activities

After a brief period during which all reports from the groups will be reviewed, an extended period of field visits is anticipated. Efforts have been undertaken in quite diverse areas of the country, including all four provinces as well as the Northern Areas. Data-collection is expected to be carried out through interviews and repeated visits to sites. If survey research techniques are used, it will be on a very limited basis, only to support data collected by other means and not as a primary tool.

In those cases where attempts to organize farmers have been successful, a monitoring component will be added whereby data will be collected over a longer period of time. Cases will be selected if there is evidence, based on preliminary visits, that viable organizations have been created and are functioning. Certainly, these associations or cooperatives will require prolonged examination in order to improve our understanding of why they operate. Although, at this point, it is difficult to isolate such cases, it appears that village cooperatives in the Northern Areas and perhaps water user associations in the ADB districts of D.I. Khan (NWFP) and Layyah (Punjab) are prospective sites. Determinations will be made during the period of analysis and writing of the final evaluation report.

a. Institutions:

The evaluation and monitoring of efforts to organize water users associations and farmer cooperatives will require researchers from sociology and economics. Sociology is relatively underdeveloped as a discipline in Pakistan, which likely accounts for the scarcity of sociological studies. Therefore, individual sociologists may have to be recruited, whereas economic research institutions will be utilized. Staff of the Department of Sociology,

Punjab University, and of the Department of Rural Sociology, University of Agriculture, Faisalabad will be recruited. In addition, the Applied Economics Research Centre at Karachi University and the Pakistan Institute for Developmental Economics in Islamabad have well-trained research staff and will be responsible for economic monitoring and evaluations of the efforts.

On the USAID side, the resident social scientist on the ISM/R team will be closely involved in the design and implementation of the evaluation and in the drafting of the final report. One social scientist with experience working with water user associations elsewhere in Asia will be involved in this effort, particularly in the design and draft stages. Data-collection will be left to the in-country team. The team members working on this evaluation and monitoring research project will visit successful water user associations in other countries, such as Sri Lanka and the Philippines, to observe programs which have had continuing, productive results. The period of data-collection and field research will be divided into two phases, before and after the projected observation tour, since it is anticipated that such a visit will provide a new perspective based on those in-country visits.

b. Personnel/Collaboration:

USAID - ISM/R long-term social scientist
social scientist with experience with water user associations TA/TDY

Local - faculty of the Department of Sociology, Punjab University
faculty of the Department of Rural Sociology, Faisalabad
Applied Economics Research Institute, Karachi University
Pakistan Institute for Development Economics, Islamabad

c. Schedule	Duration	Terminate by
First Phase: Evaluation		
Literature review and design	2 mo	Sept 85
Data-collection	3 mo	Dec 85
Observation Tour (out of country)	1 mo	Jan 86
Data-collection 2	3 mo	Apr 86
Final report	3 mo	July 86
Second Phase: Monitoring		
Data-collection	intermittently during 12 mo	June 87
Report	3 mo	Aug 87

d. Reports:

An evaluation of existing water user associations and farmer cooperatives will be produced and distributed for the particular attention of interested parties which include WAPDA, the OFWM Program, the University of Agriculture at Faisalabad, the Aga Khan Foundation, the Ministry of Local Government and Rural Development, USAID, and the Command Water Management Project. A report based on the monitoring of apparently successful efforts will be similarly distributed.

3. Institutional Constraints Impeding Water User Association Formation

Previous attempts to form viable water user associations have shared the view that organizational problems lie primarily with the water users. There is little doubt that conflicts and oppositions among the shareholders of a watercourse make cooperation very difficult. The only study of the social organization of a single watercourse has noted that Punjab rural society is characterized by a set of values and mechanisms which encourage conflict as a source of status and tend to discourage cooperation on a long-term basis. This point has only been explored in northern Punjab (Merrey 1979), and the extent to which it is an underlying principle of behavior in other parts of the country is not understood. Research on watercourses throughout Pakistan and the evaluation and monitoring of attempts to form water user associations, as designed here, will give us a much better idea of the actual ongoing relationships of water users.

However, water users are not the only actors involved in watercourse operations and irrigation activities. They must deal regularly with people in the public and private sectors. These include engineers who are charged with delivery of water to the outlet, revenue assessors, and public tubewell operators from the provincial irrigation departments and the occasional extension agent and, more recently, the staff of the OFWM Program under the provincial agriculture departments, and repesentatives of agricultural credit banks. They may also meet officials from the Ministry of Local Government and Rural Development and a host of other government agencies. They are by no means isolated from government intervention and government programs. Yet no studies have been done of the interaction between water users and government officials to determine if this is a source of blockages in the system. Nor is there an understanding of the workings of these government agencies and how they interact with each other, both at high levels of organization and locally. The role of the private sector has not been examined, although input distributors, marketing facilities, and informal credit suppliers are crucial parts of the agricultural system and affect farmer behavior. Until we understand how these agencies operate and interact with each other and with water users it is improbable that efforts to form associations will be any more successful than they have been in the past.

Local and foreign experts in organizational behavior will work jointly with representatives of the identified agencies, including PIDs and PADs (extension and OFWM directorates) and the Ministry of Local Government and Rural Development) to examine their structure, goals, activities, and interactions. Data-collection will require visits to government offices and villages. Villages with and without watercourse improvements will be selected.

a. Institutions:

One representative from each of the government agencies who has an intimate understanding of his institution will be deputized to serve on the research team on a part-time basis. The principal investigator leader will be recruited from a school of business administration, such as at Karachi University.

On the USAID side, one long-term and two short-term expatriates will participate intermittently during the life of the research project. The two short-term consultants will include an expert in rural organizational development and another in informal government entities. They should have prior Pakistan experience.

b. Personnel/Collaboration:

USAID - ISM/R long-term social scientist
expert in organizational behavior
expert in the behavior of public institutions
Local - expert in formal organizations from school of management
representatives from identified institutions

Schedule:

Phase	Duration	Terminate by
Design	2 mo	Sept 85
Data-collection	12 mo	Sept 86
Final report	3 mo	Dec 86

d. Report

In its recommendations, the final report will focus on ways to reduce institutional constraints to the formation of water user associations. It will consider, given the present climate and the difficulties involved in changing the operations of the agencies, what the likelihood is of creating continuing associations and will identify how the role of the private sector might be expanded.

REFERENCES:

Lowdermilk, Max, Wayne Clyma, and Alan Early
1975 Physical and Socio-Economic Dynamics of a Watercourse in Pakistan's Punjab: System Constraints and Farmer's Responses. Water Management Technical Report No. 42. Fort Collins: Colorado State University.

Merrey, Douglas
1979 Irrigation and Honor: Cultural Impediments to the Improvement of Local Level Water Management in Punjab, Pakistan. Water Management Technical Report No. 53. Fort Collins: Colorado State University.

1983 Irrigation, Poverty, and Social Change in a Village of Pakistani Punjab: An Historical and Cultural Ecological Analysis. Unpublished dissertation. Department of Anthropology, University of Pennsylvania.

Mirza, Ashfaq
1975 A Study of Village Organizational Factors Affecting Water Management Decision-Making in Pakistan. Water Management Technical Report No. 34. Fort Collins: Colorado State University.

Mirza, Ashfaq and Douglas Merrey
1979 Organizational Problems and their Consequences on Improved Watercourses in Punjab. Water Management Technical Report No. 55. Fort Collins: Colorado State University.

ENCOURAGING WATER USER INVOLVEMENT IN BETTER WATER MANAGEMENT ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA			31,700		22,240						53,940	
2. FRINGE BENEFITS			7,980		5,600						13,580	
3. LOCAL HIRE												
Prof. staff												
Supoort staff		1,530		8,760		9,180		9,660		4,180		33,310
4. TRAVEL												
International			20,160		14,120						34,280	
Intl. per diem			2,520		1,760						4,280	0
In Pakistan		500		4,650		3,200		1,000		500		9,850
Pakistan per diem		1,000		14,860		10,140		2,000		1,000		29,000
5. OPERATING EXPENSES		8,000	3,150	16,600	2,200	17,100		17,100		9,500	5,350	68,300
6. INDIRECT COSTS (25%)		2,758	16,378	11,218	11,480	9,905		7,440		3,795	27,858	35,115
7. COMMODITIES	27,445		1,000		1,500		1,000				30,945	
8. SUBTOTAL	27,445	13,788	82,888	56,088	58,900	49,525	1,000	37,200		18,975	170,233	175,575
9.CONTINGENCY (10%)	2,745	1,379	8,289	5,609	5,890	4,953	100	3,720		1,898	17,023	17,558
10.TOTAL	30,190	15,166	91,176	61,696	64,790	54,478	1,100	40,920		20,873	187,256	193,133
11.GRAND TOTAL	45,356		152,873		119,268		42,020		20,873		380,388	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 10.

(3) Vehicle costs not included in commodities (15,000).

EQUIPMENT LIST
ENCOURAGING WATER USER INVOLVEMENT

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Land Cruiser 4wd(Toyota)	12,000	1	12,000
Shop tools and spare parts	3,000	1	3,000
			15,000
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	1	6,500
Volt. Regulator w/battery	700	1	700
Monitor	400	1	400
Printer (dot matrix)	650	1	650
Software (DOS, W. p. etc.)	2000	1	2,000
Spare Parts	1000	1	1,000
Tool Kit	200	1	200
			11,450
OFFICE EQUIPMENT			
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Movie camera 16mm	500	1	500
Movie Proj. 16mm	1200	1	1,200
Projection screen	150	1	150
B&W Darkroom equipment	3000	1	3,000
Field taping units	200	5	1,000
VHS video system and tape	2000	1	2,000
Film ,tape storage cabinet	100	10	1,000
Programmable calculators	200	10	2,000
Drafting or printing equip.	1000	1	1,000
Transformer	150	2	300
			13,500

PROJECT TOTAL W/O VEHICLES	24950
PROCUREMENT COSTS(5%)	1248
PACKING/FREIGHT(5%)	1248
TOTAL COSTS W/O VEHICLES	27445
VEHICLE COST	15000
PROJECT TOTAL	42445

TITLE: Development of Groundwater-Surface Water Models

JUSTIFICATION:

Planning and design personnel in Provincial Irrigation Departments and WAPDA have indicated a need for methods to evaluate options for groundwater development and control on a unit basis rather than on a large regional basis. Particularly, the need for rapid evaluation of pumping programs or drainage options on SCARP area operations is needed.

Evaluation of the impact of tubewell or horizontal drainage operating schemes on the trends in groundwater levels or groundwater quality requires the ability to determine the interactions of all components of a unit water budget for all time periods during the length of a study. To evaluate the most efficient pumping schemes for public tubewells to provide groundwater level control and/or supplementary irrigation supply, some method of predicting the amount and timing of pumping to achieve specific goals is required.The effect of public tubewell pumping on aquifer systems must be integrated with the combined effects of existing or planned private tubewells, horizontal drainage systems, farm field water applications, precipitation, distribution system seepage losses, crop consumptive use, and soil moisture storage.

Long-term quasi-steady state evaluations of aquifer response can be determined using water budget techniques and simplifying assumptions regarding boundary conditions. To evaluate transient systems such as the shallow aquifers in the Punjab and Sind provinces and the alluvial fan systems in Baluchistan, aquifer models are required. One or two-dimensional digital computer models are most flexible and allow rapid evaluation of alternative development or operational schemes.

Development of general purpose digital models capable of operation on micro or mini computers and training of research and design personnel will provide opportunities for more efficient and meaningful research as well as enhancing design, operation and planning capabilities. Research institutions and operating organizations in Pakistan are lacking in expertise and equipment to efficiently analyze complex groundwater-surface water systems. Currently within WAPDA, the only groundwater model sub-routine operational on the computer system is a routine called CCM which was adapted from the World Bank Indus Basin Model (IBM). This routine is a large linear programming model which requires in excess of 10 hours cpu time for one run on a command area. The linear programming package used on the IBM 370/115 computer does not run on the new IBM 4331 system so a new expensive package will be required. The IBM 4331 machine is not presently upgradable beyond the current 4Mb core memory due to import restrictions and IBM is no longer manufacturing this model. The number of terminals supported by this computer is limited so that implementation of design and planning programs on stand-alone micro computers should be pursued.

Utilization of computer-assisted techniques are state-of-the-art procedures for hydrological analysis and should be implemented to enhance research capability and increase the efficiency of water resources and irrigation planning.

Adapted models will be useful for evaluation of the economics of tubewell pumping as compared to surface or tile drainage. Routines are capable of evaluating pumping costs based on depth to water, power costs and efficiencies of pumps and motors.

Data management programs associated with groundwater systems models incorporate routines for large data bank manipulation which would be required for groundwater level and surface flow data. These routines are invaluable for maintaining regional or country-wide data systems, providing quick access to specific data and facilitating application of analytical routines. Groundwater and surface water measurements which were begun in the early 1960's have not been computerized and access to data for research and planning purposes is time consuming and expensive.

OBJECTIVES:

A. To evaluate the status of systems models, associated data management programs, and modeling capability in Pakistan applicable to small unit groundwater systems and the present needs of operating agencies.

B. To develop general purpose groundwater-surface water models and associated data management programs for micro or mini computers.

C. To calibrate and verify models on specific case studies.

D. To develop and provide documentation and operation manuals for all models and data management programs to user groups and to demonstrate the utility of models for evaluation of conjunctive use alternatives in groundwater and surface water supplies, economic evaluation of alternate drainage options, or impacts of additional development or water use efficiency changes on waterlogged areas.

E. To determine training requirements for research organizations and operating organizations requiring modeling expertise and to provide opportunities for training.

PROCEDURES:

A. A review of current models available will be made to ascertain their adaptability to micro or mini computers. These models include the groundwater subroutines of the World Bank model and regional models available at WAPDA, the groundwater model currently operated at the Center for Excellence in Water Resources at Lahore, a model available at the but not operational at the Sind Agricultural Univer-

sity at Tando Jam, and other possible models. An evaluation of the number of and level of expertise of systems analysts in Pakistan research and development agencies will be undertaken and a determination made of current agency capability in systems modeling.

The requirements for data management programs in operating divisions such as the Directorate of Geohydrology and Monitoring and Evaluation within WAPDA and Provincial Irrigation Departments will be determined.

B. An appropriate model or models will be selected for further development and adaptation on suitably equipped micro or mini computers. Data management programs incorporating pertinent hydrologic, physical and chemical parameters for linking to the aquifer model will be developed compatible with types of and levels of data available or necessary.

Models and data management systems available from the U.S. Geological Survey, the University of Idaho, other proven systems and present models available in Pakistan will be evaluated.

C. Study areas will be selected to calibrate the models and verify their utility under varying hydrogeological and irrigation system conditions. A command area or areas will be selected for initial development utilizing existing data where possible on groundwater levels, water distribution, cropping patterns, and pump test data. A groundwater monitoring network utilizing existing monitoring wells and new strategically selected locations will be developed. Estimates of private tubewell extraction, where applicable, will be made utilizing either power use records or pump operation records and measured seasonal yields. Aquifer parameters will be estimated from previous pump tests performed on existing tubewells or tests performed on different strategically located wells. Different areas will be selected for verification of the models under conditions dissimilar to the calibration study area. These areas will be selected based on availability of data, hydrogeological setting and on the suitability of the study for drainage and water supply issues. Possible study areas in addition to specific locations in the Indus Plain include the Zobe Valley in Baluchistan, the D.I.A. Khan area in NWFP and the Swat Valley.

D. Following calibration, verification and documentation of the model routines, manuals for operation of the management-oriented models will be prepared. These manuals will contain explicit instructions on data requirements and sources, analyses required, data entry procedures for surface inputs and aquifer parameters and procedures for utilization of the models for management and/or research purposes. Utilizing the documentation developed, personnel from operating agencies will be instructed in use of the models as design and

planning tools and in implementation of data management programs. For instance, the suitability of the models for determination of technical and economic feasibility of short term aquifer recharge adjacent to canal systems or in other appropriate locations can be demonstrated.

E. Federal and Provincial Government agencies and University departments involved with water management, irrigation or hydrologic research or management will be evaluated to determine the need for training personnel to effectively utilize the models. In addition, the type and number of computers required in each agency will be determined. Based on these findings, training programs involving graduate engineering programs, in-house seminars and short courses and/or field and computer internships will be structured.

PERSONNEL:

Efficient performance of this project and utilization of the results will depend on the degree of organization and involvement of Pakistan government and research officials in active and advisory capacities.

The principal investigator for the project will be a University of Idaho researcher in-residence at Lahore. The project investigator's duties will include management of the technical aspects of the project, graduate student guidance and advisement, assistance with training programs and coordination of additional research projects. If a project on river operations and management as outlined as a future project should develop, this individual would become project investigator. Additional research projects funded by ISM/R under the competitive research grants program could come under this PI's purview.

Key to the performance of the project will be the selection of associate principal investigators from Pakistan institutions who will serve full time. Three action teams will be formed under the principal investigator: a model development team, a data management team and a data aquisition team each with a team leader or junior researcher. Members of all teams would be rotated to give all participants exposure to field data collection methods and model development procedures. A University of Idaho research professor will serve as the technical advisor on a TDY basis for the duration of the project and an agricultural economist will be required for Objective 3. A computer specialist will be required on a short-term basis for initial training on microcomputers. Staff organization for the project is shown in the organization chart. An anticipated project personnel requirement for a four year project is as follows:

Position	Duration	Organization	Grade
Tech.Engr.Adv.	8 months TDY	Univ. of Idaho	Prof.
Agri.Econ.Adv.	2 months TDY	Univ. of Idaho	Prof.
Computer Spec.	2 months TDY	Univ. of Idaho	
Prin. Invest.	3 years 10 mo	Univ. of Idaho	Asst. Prof.
Assoc. P.I.	3 years 10 mo	WAPDA,other	Sr. Res. Off
Assoc. P.I.	3 years 10 mo	WAPDA,other	Sr. Res. Off
Team Ldr 1	3 years 10 mo	PID,WAPDA,other	Res. Off.
Team Ldr 2	3 years 10 mo	PID,WAPDA,other	Res. Off.
Team Ldr 3	3 years 10 mo	PID,WAPDA,other	Res. Off.
Technicians(6)	3 years 7 mo each		

TRAINING REQUIREMENTS:

The timing of the project performance will be structured to allow the associate principal investigators to pursue a Ph.D. in the United States, and for each team leader to complete the academic requirements for a master of science degree in the United States but perform the research and complete the thesis requirements on the project in Pakistan. Training for the technicians in computer applications and data collection would be performed by a computer specialist, by the principal investigator or through special programs in water resources and irrigation research in cooperation with a University, Tarbela Academy or the Center for Excellence in Water Resources. Long-term institutional relationships between Pakistan Universities and the University of Idaho and Washington State University will be pursued which could result in faculty exchanges, scholarships and long-term research collaboration.

PROJECT PERFORMANCE TIMING:

Project begins:	June	1985
Tech. Adv. in Pakistan	June-Aug.	1985
All staff selected	Aug	1985
Model Assoc.P.I., Model team ldr. and Data An. team ldr. to U.S.	Aug	1985
Data Assoc. P.I.and.Data team ldr. to U.S.	Aug	1986
Model and Data An. team ldrs. return	Jan	1987
Model Assoc P.I returns to Pakistan	Aug	1987
Data Assoc. P.I. returns to Pakistan	July	1988
Model formulation complete	Dec	1987
Data collection complete	June	1988
Model documentation complete	Dec.	1988
Project completion	April	1989

REPORTS AND INFORMATION DISSEMINATION

Project progress reports will be prepared quarterly to the Chief-of-Party showing status of data collection, model preparation and training accomplishments. Two Ph.D. disserations and three M.S. theses will be published by the University of Idaho or other institutions as completed. Papers for international scientific journals and Pakistan scientific organizations will be prepared and presented by project staff. At least four seminars will be held in conjunction with the competitive research grants seminars, other training programs under ISM/R and WAPDA training programs.

Coordination is expected between this project and the work planned for early 1985 that will deal with groundwater/surface water modeling for a portion of a Command Water Management sub-project area. That work will be performed by a team from CSU under Water Management Synthesis II funding.

A final report will be submitted in May 1989.

GROUNDWATER-SURFACE WATER MODELS ESTIMATED COSTS(1)

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		31,740		5,560		5,830		12,260		65,470	
2. FRINGE BENEFITS	2,540		7,980		1,400		1,470		3,080		16,470	
3. LOCAL HIRE												
Prof. staff												
Supoort staff		900		19,710		20,655		21,735		13,230		76,230
4. TRAINING(2)												
In United States												
long-term	10,200	5,400	68,000	3,600	71,400	5,400	23,800	3,600			173,400	18,000
short-term												
In Pakistan												
Third country												
5. TRAVEL												
International	6,400		20,160		3,530		3,700		7,780		41,570	
Intl. per diem	800		2,520		440		460		980		5,200	
In Pakistan		1,400		4,150		2,550		2,580		1,720		12,400
Pakistan per diem		4,720		14,360		5,160		5,270		6,260		35,770
6. OPERATING EXPENSE	1,000	6,000	3,150	20,000	550	22,000	580	24,000	1,220	16,000	6,500	88,000
7. INDIRECT COSTS (25% of items 1-3,5,6)	5,205	3,255	16,388	14,555	2,870	12,591	3,010	13,396	6,330	9,303	33,803	53,100
8. COMMODITIES	151,415		4,500		5,000		3,500		1,500		165,915	
9. SUBTOTAL	177,440	16,275	86,438	72,775	19,350	62,956	18,550	66,981	33,150	46,513	334,928	265,500
10. CONTINGENCY (10%)	17,744	1,628	8,644	7,278	1,935	6,296	1,855	6,698	3,315	4,651	33,493	26,550
11. TOTAL	195,184	17,903	95,081	80,053	21,285	69,252	20,405	73,679	36,465	51,164	368,420	292,050
12. GRAND TOTAL	213,087		175,134		90,537		94,084		87,629		660,470	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Vehicles are not included in commodities ($36,000).

(3) Short-term technical assistance person months: 12.

EQUIPMENT LIST
GROUNDWATER-SURFACE WATER MODELS

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Land Cruiser 4wd(Toyota)	12,000	3	36000
			36000
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	5	32500
Portable personal computer	4000	2	8000
Volt. Regulator w/battery	700	5	3500
Monitor	400	5	2000
Printer (dot matrix)	650	4	2600
Printer (impact let. qual.)	900	1	900
Memory upgrade	1,100	5	5500
Software (DOS, W.P. etc.)	2000	5	10000
Spare Parts	1000	5	5000
Tool Kit	200	2	400
			70400
FIELD EQUIPMENT			
Current meter(LED readout)	1500	2	3000
Flumes (Parshall et al)	900	6	5400
Pipe flow meter	650	2	1300
Engr. level w/rod, tripod	1000	1	1000
Engr. transit w/tripod	1000	1	1000
Steel tape	400	2	800
Water stage recorder	2000	10	20000
Recorder charts	400	2	800
Elec. well sounder	350	2	700
Soil auger	50	1	50
Tool kit	300	2	600
			34650
METEROLOGICAL EQUIPMENT			
Portable weather station w/probes and recorder)	6500	2	13000
Spare parts for station	1200	2	2400
Eprom or tape reader	2000	1	2000
Thermometers,psychrometers	600	1	600
Enclosure,std. U.S.W.S.	400	1	400
			18400
LABORATORY EQUIPMENT			
pH meter	600	1	600
Flame photometer	2000	1	2000
Nitrate electrode	350	2	700
Elec. Conductivity meter	1000	2	2000
			5300

OFFICE EQUIPMENT			
Photocopier	6000	1	6000
Camera 35 mm	800	1	800
Projector 35mm	550	1	550
Projection screen	150	1	150
Flip chart-chalk board	100	1	100
Drafting or printing equip.	1000	1	1000
Transformer	150	2	300

			8900
			=========

PROJECT TOTAL W/O VEHICLES	137650
PROCUREMENT COSTS(5%)	6883
PACKING/FREIGHT(5%)	6883
TOTAL COSTS W/O VEHICLES	151415
VEHICLE COST	36000
PROJECT TOTAL	187415

TITLE: Farm Water Management

INTRODUCTION

A series of four projects (FWM-1 to FWM-4) covering important aspects of irrigation/agronomy research will be the core studies taken up during ISM/R implementation. These are not the only irrigation/agronomy projects contemplated under ISM/R, but rather the first projects; others will be suggested with time with the lead for new project initiation coming from Pakistani researchers and with funding anticipated through the grant program.

Much of the core work is not new but follows from studies of a similar nature previously carried out in Pakistan. A thorough review of previous work in Pakistan and elsewhere will be carried out before field work is initiated.

Irrigation/agronomy research ties closely to other projects being initiated under ISM/R, e.g. Integrated Watercourse Management, Surface Drainage and Water Table Control. Research efforts are designed to be applied in projects such as Command Water Management. Much of the research will be carried out on farmers' fields using farming systems research (FSR) techniques.

FWM is a series of core projects conducted largely at Mona, and by UAF and LIM. Anticipated implementation arrangements are detailed in the text but summarized below:

FWM-1 - Mona, LIM, and UAF will be lead* institutions; DRIP and PARC(NARC) will be collaborating* institutions; cooperating* institutions are the Provincial Agricultural Extension Directorates of Punjab and Sind.

FWM-2 - LIM will be the lead institution; UAF and Mona will be collaborating institutions, as will be the OFWM Directorate in Sind; PARC and the Provincial Agricultural Extension Directorates of Punjab and Sind will be cooperators.

FWM-3 - Mona and UAF will be lead institutions.

FWM-4 - Mona will be the lead institution; LIM will be a collaborating institution; PARC and UAF will be cooperating institutions.

---

* Designation as lead institution indicates project leadership and financial support through a PC-1. A collaborating institution is one that would participate in the studies and receive financial support. A cooperating institution is one that is expected to cooperate in the work but would not normally receive financial support.

Encouragement will be given to other institutions to carry out parallel work at other locations in the country through the grant program.

Two of the projects, FWM-3 and FWM-4, have special training requirements that are mentioned in the text. For these projects and others, funds are budgeted for exchange programs whereby Pakistani researchers would spend six months (a growing season) working at a U.S. research station to acquire hands-on experience in planning and conducting trials, and in data analysis. The Snake River Conservation Research Center in Kimberly, Idaho has agreed to host a number of exchange programs, (see annex L). Depending upon the research subject matter, there will be other research centers where researchers can receive appropriate training.

A combined budget for the FWM series is presented after FWM-4 text.

TITLE: FWM-1. Water Management Strategies for Areas with Poor Drainage or Shallow Water Table Conditions

JUSTIFICATION

Although Punjab and Sind are located in semi-arid or arid subtropical climatic zones, importation of irrigation water supplied together with over-irrigation and inadequate drainage has led to a marked rise in the water table over some 6.1 million acres (1). The problem is particularly acute in the summer monsoon season when heavy rainfall together with gentle slopes causes impeded surface drainage.

Over-irrigation is a major contributing factor to the high water table. Studies by WAPDA have shown that 25% of the farmers over-irrigate by a factor of two, prior to watercourse improvements, and that 40% over-irrigate by a factor of two following watercourse improvement. When soils have a water deficit or one or two inches during the early stages of crop production, farmers have no means of applying such small amounts of irrigation water. Because of the basin method of irrigation and irregularities in surface elevation within a basin, three or more inches are the minimum that can be applied. Preliminary studies at Mona, UAF and Tando Adam (LIM) indicate that furrows and ridge planting of cotton or maize can permit smaller irrigation applications. Portable sprinklers offer a similar advantage.

In contrast to flat plantings in basins (normal farmer practice), ridge planting methods should result in better stands and increased yields for they favor improved surface drainage. It has been observed that yields of maize and cotton are depressed during heavy monsoon years when, in the absence of surface drainage, fields are often flooded. Imperfect field drainage results in poor uptake of nutrients and depressed oxygen flow to roots. Even without improved surface drainage, several agronomic options exist to combat excess field water. These include the planting techniques mentioned above, revised planting dates to avoid the likelihood of field flooding, and planting paddy rice instead of upland crops. One key problem with a revised type of planting is the development of suitable land forming implements. A second problem in need of research is suitable weed control methods.

---

1. The Central Monitoring Organization, Planning Division of WAPDA reported that serious waterlogging at depths less than five feet occurs over 3.03 million acres in Punjab and over 3.04 million acres in Sind and Baluchistan. Waterlogging in NWFP covers 0.06 million acres. Data are for June, 1979.

This research proposal addresses the development of strategies under high water table or poor surface drainage conditions. The research outlined here will be conducted in combination with research undertaken in the project entitled "Surface Drainage and Water Table Control". Related work has been done at UAF and Mona, and careful review of that work would precede establishment of field trials.

OBJECTIVES

The purpose of the research is to develop water management practices for conditions of poor surface drainage and for soils with shallow water tables. Supporting objectives include:

1. Develop recommended irrigation schedules for various crops as a function of depth to water table and crop stage.

2. Identify crops best suited for soils with high water tables.

3. Develop weed control and planting procedures for these soils.

4. Evaluate benefits from planting on permanent beds on on ridges between furrows.

5. Support development of tractor and bullock-drawn equipment for bed and furrow shaping.

6. Test the utility of portable sprinklers for stand establishment and as a means of avoiding excessive irrigation applications.

7. Conduct date of planting experiments as a means of avoiding excess field water conditions due to monsoon season.

8. Compare economics of upland crop production under impeded surface drainage conditions with production of paddy rice under similar field conditions.

OUTPUTS

1. Recommendations regarding frequency of irrigation in the presence of a high water table.

2. Recommendations regarding agronomic practices for planting techniques, weed control, planting dates, and crops.

3. Recommendations of bullock-drawn and tractor-drawn implements for land formation.

PROCEDURES

1. Test crops will initially be wheat during rabi and cotton and maize during kharif. Some test locations may be on field stations, but most of the work will be FSR work conducted on farmers' fields, always where high water table or impeded surface drainage conditions are encountered. Using piezometers or open holes, field water conditions will be monitored.

2. Extension agents and research officers will discuss strategies with farmers experiencing problems with high water tables or impeded surface drainage to gain farmer interest and ideas for cooperative studies. During the conduct of the research, the research institution will provide inputs such as furrowing and bed shaping implements, planting equipment for wet soils, herbicides, etc; farmers will provide land and management under guidance from researchers. Researchers will consult with farmers who are using various types of land shaping equipment to gain understanding of the reasons for adoption, benefits and problems encountered by these farmers.

3. In cooperation with the Farm Machinery Institute of NARC, bullock- and tractor-drawn implements will be developed to permit formation of bed and ridges with furrows. Such equipment may also be designed to plant the seed at the same time. UAF has a bed-shaper with seeder attachment that may serve as a prototype; it may need improvement. Implements will be field tested at NARC, then taken to Mona, LIM and Shahkot (UAF) for field testing.

4. Trials will be designed to obtain best management practices for wet soils. Treatments will consist of conventional versus ridge and bed plantings. Another variable will be number of irrigations and amount applied during each irrigation. Relatively large streams of water will be applied in each furrow so that water advances quickly across the field so that irrigation amounts will be not more than required to fill the root zone. Measurements will be made of:

   a. daily rainfall
   b. number and amount of irrigations
   c. number of days of standing water in the fields under each treatment
   d. depth to water table
   e. soil-water deficits and tensions
   f. stand density
   h. yield

5. A portable sprinkler system will be tested for farmer acceptance and as a means of applying light irrigations particularly for stand establishment where high water table conditions exist. Sprinklers will be moved and used on a number of farmer fields. Parameters to be measured include amount

of water applied, operating costs, plant density, yield, and social variables that deal with farmer acceptance and ability to use and maintain the irrigation method.

6. Date of planting experiments will be conducted using maize as the test crop. Plantings will be made on "permanent" ridges, once per month beginning in February and ending in late-August or early-September. A February planting may be harvested before fields become waterlogged. A September planting will be after the heavy monsoon period has ended. For the September planting, chemical weed control with atrazine is essential. Maize planted during the peak monsoon period will serve as the control. Because of the range of planting dates, different varieties of maize will be used. Prior to conduct of date of planting studies, a review will be made of the literature on the subject.

7. For field situations where surface drainage cannot easily be improved and there is sufficient irrigation water available, trials will be conducted of upland crops versus paddy rice. Economic evaluations will be made and crop budgets prepared for each crop.

8. All of the procedures mentioned above place heavy reliance on testing of recommended practices on farmers' fields using Farming Systems Research (FSR) methods. The intent is to make researchers aware of farmer constraints, to demonstrate recommended practices to farmers, and to facilitate extension of results.

PERSONNEL/COLLABORATION:

Experiments will be conducted at Mona, LIM, PARC (NARC), and by UAF at Shahkot. DRIP will be encouraged to replicate certain of the experiments to involve that institution in consideration of surface drainage strategies. The Agricultural Extension Directorates in Punjab and Sind will be encouraged to plan and participate in the farming systems work to facilitate eventual extension of results to the larger community of farmers.

Work will be supported by ISM/R staff, particularly by the irrigation agronomist and by short-term specialists as required.

IMPLEMENTATION:

FWM-1 covers a broad range of objectives and proposed experiments. An implementation plan will be prepared by the irrigation/agronomist to set priorities on order and location of experiments. It is anticipated that initial work would be conducted at Mona.

TITLE: EWM-2. Use of Brackish Groundwater for Crop Production

JUSTIFICATION:

In Pakistan there are approximately 18 million acres in culturable commands underlain by brackish water (1). In most commands, water supplies are scarce and cropping intensity is therefore limited. Use of brackish waters is seen as an alternative to developing new water sources or otherwise augmenting supplies and can lead to bringing unused lands into production.

Generally, the accepted strategy has been to dilute brackish groundwater with fresh canal supplies to obtain a water quality mix that most crops will tolerate. An alternative irrigation management practice could be to keep the two water supplies separate and to irrigate salt-tolerant crops with brackish water, using fresh canal supplies for germination and establishment and for irrigation, of less tolerant species.

Particularly after germination and establishment, several crops exhibit marked tolerance to salinity, and good production is possible using poor quality irrigation water. At Tando Adam (LIM), research is being conducted in 1984 by M. Umar Khan using 3500-ppm water to produce cotton. Using brackish groundwater, he has obtained cotton stands and growth which are comparable to cotton grown in adjacent areas using good quality canal water. Dr. Bhatti at AARI has obtained similar findings. In California, Rhoades, et al (2) have produced cotton using irrigation water with a salt concentration of 6000 ppm which yielded nearly as well as cotton with 500 ppm irrigation water.

Many varieties of other crops such as sugar beets, barley, wheat, alfalfa, clover, and tomatoes are capable of good production even with poor quality water.

Expanded use of brackish water in Pakistan is viewed as a particularly attractive proposition because:

- brackish water is abundant;
- other sources of water are scarce and costly to augment; and
- pumping of brackish water can contribute to a lessening of high water table conditions prevalent in many areas.

---

1. The Report of the Indus Basin Research Assessment Group, Planning Commission, Government of Pakistan, 1978.

2. Rhoades, J.D., S.L. Rawlins and C.J. Phene, "Irrigation of Cotton with Saline Drainage Water", ASCE Convention, Preprint, 80-119, 1980.

OBJECTIVES

1. To develop irrigation management practices which will facilitate field scale production of cotton and other salt tolerant species using brackish water.

2. To extend and test technologies for use of brackish waters in selected chaks with cooperating farmers.

3. To measure changes in soil properties due to irrigation with brackish water, to monitor long-term effects, and to suggest ways to control salinity if build-up occurs.

OUTPUTS:

The principal output from this research will be a set of recommendations regarding irrigation practices, crops, and crop stage which suggest ways to increase cropping intensity through use of brackish water. Work will be carried out and recommendations developed in cooperation with the extension directorate of the Sind Agriculture Department.

PROCEDURES:

1. Work will be carried out in study areas served with brackish irrigation water - more than 2000 ppm. Initially the test crop will be cotton.

2. Treatments will include:

   a) Various degrees of salinity of irrigation water.
   b) Use of brackish and fresh water at all crop stages. One sub-experiment will consist of germination and emergence using fresh water followed by irrigation with brackish water. Off the experiment station, this test will require parallel irrigation supply conduits (watercourses or pipelines), one to convey fresh water and the other to convey brackish water.
   c) Land forming techniques to include furrows with ridges and broad beds, versus conventional flat plantings.

3. Measurements will include yields, amount of water supplied, and changes in selected soil parameters.

4. FSR methods will be employed with cooperating farmers. Liaison with farmers would be carried out by researchers working with extension specialists from the Provincial Departments of Agriculture.

PERSONNEL/COLLABORATION:

LIM staff will provide the field leadership for the proposed work. They will draw from outside assistance from the ISM/R irrigation agronomist, and from short-term specialists as required. PARC has a responsibility for a coordinated research project entitled "Saline Agriculture" and will be encouraged to cooperate with this project and provide coordination support.

Cooperation will also be secured with several other groups: Provincial Department of Agriculture/Sind for the technology transfer effort; OFWM/Sind for provision of additional watercourses to deliver brackish water. Other groups such as UAF and Mona will in future years collaborate in similar lines of work on other crops and in other locations. The technology proposed has clear importance to Punjab's good cotton growing areas, and the Department of Agriculture/Punjab will be provided information about research findings and be encouraged to participate.

TITLE: EWM-3. Irrigation and Nitrogen Fertilizer Management

JUSTIFICATION:

Oftentimes it is reported that crop yields decrease when additional water supplies are made available from watercourse improvements. To explain this, one theory holds that increased water applied resulted in increased leaching of nitrate. One WAPDA study indicated that farmers often apply twice the water in an irrigation that can be held in the crop root zone. Studies conducted at Mona and AARI have resulted in nitrogen recoveries in the range of 30-70% of that applied. It is highly probable that farmers who are over-irrigating recover much less. Clearly, nitrogen and water management are closely linked and, in an environment where nitrogen fertilizer is a costly input to the production process, farmers are interested in improved payoff from their investments in this input.

Several options are available to improve water/nitrogen management, for example: split applications of nitrogen; decreasing the frequency of irrigations; provision of smaller water applications through larger heads of water.

OBJECTIVES:

1. To determine the degree to which nitrates are leached from soils by over-irrigation.

2. To test fertilizer sources of nitrogen in conjunction with standard and improved water management practices.

3. To develop water management guidelines which will improve nitrogen recovery and crop production.

OUTPUTS:

Outputs will consist of improved water and nitrogen management recommendations. Recommendations will be tested on the experiment station, then on farmers' fields for purposes of developing practices of demonstrated utility to farmers, and ones which they will be prone to adopt.

PROCEDURES:

1. Work will be conducted with summer plantings of maize followed by winter plantings of wheat.

2. Crops will be irrigated with different quantities of water 1, 1.5, and 2 times estimated ET to test the effect of over-irrigation on yield.

3. Irrigations will also be made using less frequent irrigations, and larger heads of water designed to reduce the amount applied in a given irrigation.

4. Fertilizer treatments will consist of:

   a) different forms of nitrogen including SCU;
   b) splits of applications, at seeding and at six weeks.

5. Similar studies may be conducted in lysimeters where nitrate movement out of the root zone can be determined.

6. Yield and nitrogen recovery will be determined.

7. The economics of various water management and fertilizer alternatives will be determined.

PERSONNEL/COLLABORATION:

UAF and Mona staff will carry out the research. Both groups have carried out similar work in the past and review of such work will be done prior to conducting work in the field. Jointly planned and executed research carried out by both institutions is suggested. Work at Mona and by UAF will be done on farmers' fields.

ISM/R (irrigation agronomist) will assist UAF and Mona staff as required. Short-term TA will be arranged depending on specific needs.

TRAINING:

Participant training for one of the JRO's from Mona and one from LIM is recommended. These individuals would spend a growing season at the Snake River Conservation Research Center in Idaho where he would participate in ongoing nitrogen recovery studies. One of these will be extended to an M.S. study with the individual taking coursework at a U.S. university and then returning to Pakistan to complete his research work for the thesis. The other will go back to Pakistan from SRCRC to get results in Pakistan and help develop guidelines to achieve potential production improvement.

TITLE: FWM-4. Biotic and Chemical Reclamation of Sodic Soils

JUSTIFICATION:

Approximately seven (7) million acres of land in the Indus Basin are said to be affected by concentrations of salt in excess of 16 mmhos/cm.(1) Commonly, many are also affected by high concentrations of sodium.(2) Severely affected soils are often abandoned; agricultural production is poor from less severely affected soils because of ionic imbalance and/or specific ionic toxicity. Amelioration of sodium problems is considered an important priority particularly in Sind and southern Punjab where the problem is most prevalent.

Soil sodicity reduces water intake, or infiltration rate. Studies of water intake rates on sodic soils by AARI in the 1970's showed that soils with high exchangable sodium had low infiltration rates. Three-inch irrigations resulted in water standing on the surface for 3 or 4 days. On non-sodic soils, the same amount of irrigation water would enter the soils within 20 hours. Monsoon rains tend to seal the surface of sodic and saline-sodic soils resulting in runoff and surface drainage problems. Thus, rainfall which might be needed to recharge the groundwater, contributes to a surface drainage problem because infiltration rates are so low. Dr. Shah Muhammad (UAF) and Ch. Bashir Ahmad (Mona) have shown that gypsum applied to these soils followed by leaching can remove a portion of the exchangeable sodium and restore high infiltration rates. However, gypsum costs around Rs. 250/ton and most farmers feel they cannot afford to apply it.

In recent years, C.W. Robbins at the Snake River Conservation Research Center in Idaho has been experimenting with biotic reclamation techniques on sodic soils. He found that many roots of forage crops (e.g. sudan grass) die soon after the surface portion of the plant is cut off. Decomposition of those roots releases large amounts of CO_2, which if trapped in the soil until it reaches high concentrations, produces large amounts of bicarbonate which solubilizes calcium from lime in the soil. The resulting Ca concentrations can reach levels higher than those in gypsum saturated solutions and will cause Na to be replaced on the soil exchange. If, after removing fodder, an irrigation is applied to the soil at the proper time to trap most of the CO_2 from the decaying roots and the amount of water is sufficient to provide adequate leaching, a substantial portion of the sodium can be removed with each cutting of forage. This can be done at

---

(1) Choudhri, M.B., Secondary Salinization in the Indus Plains - Pakistan, Soil Survey of Pakistan, Lahore, 1977.

(2) A 1977 field survey by WAPDA of 21 million acres in the Indus Basin revealed that 30% of the area surveyed could be classified as having sodic soils. See Hussain, Tariq "Potential for Irrigated Development in Pakistan." The World Bank, Appendix 1, Table 9, 1981.

little cost to the farmer who benefits from forage offtake as well as from land reclamation. One essential to the biotic reclamation technique is presence of lime in the soil.

OBJECTIVES:

1. To test biotic and conventional reclamation techniques for sodic soils in Pakistan.

2. To determine the time and duration following forage harvest when water sealing the soil surface will most effectively trap CO_2 and cause leaching of sodium.

3. To determine which forage crops are the most effective in biotic reclamation and to develop management practices (e.g. nitrogen fertilization) for those crops.

4. To evaluate the comparative economics of biotic and other types (e.g. gypsum) of reclamation.

OUTPUTS

Research outputs will be a series of recommendations concerning improved reclamation techniques for sodic soils. Recommendations will be conveyed to extension personnel in Punjab and Sind. Participation of extension personnel in the planning and evaluation of the ongoing research will be sought.

PROCEDURES:

1. Review will be made of past work in Pakistan and relevant work elsewhere that pertains to biotic and conventional reclamation techniques for sodic soils.

2. Test crops will be selected on the basis of tolerance to sodicity and on their ability to produce large amounts of forage material. Sordan, a cross between sudan grass and sorghum, and Kallar grass (*Diplachne fusca*) are initially suggested for evaluation. Others such as elephant grass and sugar cane will be included later.

3. Lysimeter studies will be conducted to quantify the time of the biochemical reactions involved in the biotic process. CO_2 levels in the soil atmosphere will be measured, rates of sodium replacement and leaching will be monitored. Optimum forage cutting times will be determined. For comparison, conventional reclamation techniques using gypsum will be compared.

4. Various timings and amounts of irrigations will be applied to effect the reclamation.

5. Field studies will be conducted with cooperating farmers to verify the practicality of the two techniques from the

vantage point of the farmer. Results will feed back into refined practices which will be tested in a second crop season.

6. Economic studies will be carried out to determine costs and benefits from the techniques.

PERSONNEL/COLLABORATION:

Work will be carried out by researchers initially at Mona, and depending on results, later by LIM. Depending on interest, parallel studies may be conducted by UAF personnel at Shahkot, and/or by PARC researchers in connection with PARC's coordinated research program on Saline Agriculture.

The irrigation agronomist on the ISM/R team will provide technical assistance to the GOP officials who conduct the studies. Short term TA will be provided.

TRAINING:

A JRO on assignment or to be assigned to Mona will be sent to the USA to complete the M.S. in soil chemistry at the University of Idaho. He will work with Dr. Robbins in Kimberly to learn the techniques of research on biotic reclamation. His thesis work will be conducted at Mona under the direction of his advisor, the irrigation agronomist, and the GOP principal investigator for this project.

FARM WATER MANAGEMENT ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		15,870		16,680		17,490		6,130		66,250	
2. FRINGE BENEFITS	2,540		3,990		4,200		4,410		1,540		16,680	
3. LOCAL HIRE												
Prof. staff		1,000		1,800		1,900		2,000				6,700
Supoort staff		1,960		14,700		15,200		16,000		7,000		54,860
4. TRAVEL												
International	6,400		10,080		10,590		11,100		3,890		42,060	
Intl. per diem	800		1,260		1,320		1,380		490		5,250	
In Pakistan		1,400		3,075		3,150		3,240		910		11,775
Pakistan per diem		4,720		8,680		8,980		9,310		3,080		34,770
5. OPERATING EXPENSE	1,000	1,500	1,575	21,400	1,650	13,000	1,740	13,000	610	9,500	6,575	58,400
6. INDIRECT COSTS (25%)	5,205	2,645	8,194	12,414	8,610	10,558	9,030	10,888	3,165	5,123	34,204	41,626
7. COMMODITIES	155,755		4,500		1,000		1,000		1,000		163,255	
8. SUBTOTAL	181,780	13,225	45,469	62,069	44,050	52,788	46,150	54,438	16,825	25,613	334,274	208,131
9.CONTINGENCY (10%)	18,178	1,323	4,547	6,207	4,405	5,279	4,615	5,444	1,683	2,561	33,427	20,813
10.TOTAL	199,958	14,548	50,016	68,276	48,455	58,066	50,765	59,881	18,508	28,174	367,701	228,944
11.GRAND TOTAL	214,506		118,291		106,521		110,646		46,681		596,646	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 12.

(3) Vehicle costs are not included in commodities (37,500).

EQUIPMENT LIST
FARM WATER MANAGEMENT

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Pickup	10,000	2	20,000
Jeep (4wd)	5,000	2	10,000
Motor bikes	750	6	4,500
Shop tools and spare parts	3,000	1	3,000
			37,500
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	2	13,000
Volt. Regulator w/battery	700	2	1,400
Monitor	400	2	800
Printer (dot matrix)	650	2	1,300
Software (DOS, W. p. etc.)	2000	2	4,000
			20,500
FIELD EQUIPMENT			
Current meter(manual read)	750	1	750
Flumes (Parshall et al)	900	2	1,800
Engr. level w/rod, tripod	1000	1	1,000
Steel tape	400	1	400
Water stage recorder	2000	3	6,000
Recorder charts	400	1	400
Portable sprinkler system	5000	3	15,000
Tractor(med)	25000	2	50,000
Tillage Equip.	10000	1	10,000
			85,350
METEROLOGICAL EQUIPMENT			
Rain gage(Std. USWS)	240	3	720
Psychrometer(recording)	200	3	600
Evap. pan(w/ gage & well)	625	3	1,875
Net radiometer(Fritschen)	600	3	1,800
Hygrothermograph(recording)	700	3	2,100
Sunshine recorder	1000	3	3,000
Anemometer, integrating	600	3	1,800
Chart and spare parts	200	3	600
Thermometers,psychrometers	600	3	1,800
Enclosure,std. U.S.W.S.	400	3	1,200
			15,495
LABORATORY EQUIPMENT			
pH meter	600	4	2,400

Nitrate electrode	350	6	2,100
Elec. Conductivity meter	1000	4	4,000
Glassware	1000	1	1,000
Digester unit	700	2	1,400
Gas analyzer	150	3	450
Microkjeldal unit	1250	2	2,500
Gas standard samples	20	15	300
Misc. and spare parts	5800	1	5,800

			19,950
OFFICE EQUIPMENT			
Transformer	150	2	300

			300

PROJECT TOTAL W/O VEHICLES	141595
PROCURMENT COSTS(5%)	7080
PACKING/FREIGHT(5%)	7080
TOTAL COSTS W/O VEHICLES	155755
VEHICLE COST	37500
PROJECT TOTAL	193255

TITLE: Beyond Watercourse Improvement: The Socioeconomic Impact of Public Investments and Private Contributions in Water Management

JUSTIFICATION:

In 1977 the GOP, with USAID assistance, initiated a nationwide program in on-farm water management designed to provide physical watercourse improvements and precision land-leveling and establish two water management training institutes. During its nearly five years of operation, more than 1,300 watercourses were improved and more than 30,000 hectares of land were levelled. USAID's financial support for the civil works ceased in 1981, after which the World Bank and the Asian Development Bank undertook to provide funds for a continuation of the watercourse improvement component. The program been institutionalized in the On-Farm Water Management Coordinating Cell in Islamabad and four provincial wings operating in the provincial agriculture departments.

Assessments of the program's effectiveness have generally been limited to water savings realized by farmers. However, savings are not constant because additional water depends upon a number of factors including season, adequacy of the overall water supply, length of time after the watercourse improvement, and degree of maintenance of the watercourses during the period.

One recently distributed study, The Monitoring and Evaluation of the On-Farm Water Management Programme (1984) has avoided this narrow approach by examining both the economic and social benefits of the program. The report was produced by the Watercourse Monitoring and Evaluation Directorate within WAPDA's Planning Division. However, the poor sampling techniques and unsophisticated analysis used are certain to have the evaluation raise more questions about the benefits of the program. For example, the data show that measuring canal deliveries at the mogha before improvement were significantly higher than measurements taken after improvement. By its own admission, the report states that the watercourse sample was not of a sufficient size to make statistically valid estimates at the provincial level. The randomly timed measurements taken by the team did not provide the data necessary to rigorously evaluate the program's efforts. Conclusions are often based on estimated contributions of several factors rather than on regression analyses which can quantify the contribution of each. The Directorate, in fact, did not use a computer for the data analysis; all calculations were done manually. If canal levels were lower, then statistical techniques should have been used to adjust for this disturbance in order to measure the true extent of water savings and importance on production, crop mix and gross income.

With these inherent weaknesses, the report makes the following conclusions:

- The watercourse improvement program has increased the conveyance efficiency of the main watercourse and the overall conveyance efficiencies.

- Indicators of increased cropped acreage, increased cropping intensity, shift to higher water requirement crops, higher crop yields, and increased gross crop returns appeared relatively insensitive to increases in conveyance efficiencies, although they tended to move slightly in accordance with expectations.

- There is a reported reduction in the purchase of tubewell water.

- Farmers are found to over-irrigate post-improvement to a much greater degree than they did before.

Deficiences in research techniques and analytical methods makes these points far from conclusive. Further weakening the study is the discontinuity of the research efforts of the Water Monitoring and Evaluation Directorate. Initial funding by USAID supported the evaluation, but under the terms of the agreement with the World Bank, the research sites shifted to new locations. As a result, the monitoring of the watercourses after the USAID funded improvements lasted no longer than a year. A planned long term monitoring of the first set of watercourses had to be abandoned.

The On-Farm Water Management Program is being expanded continually although its social and economic benefits are still not conclusively known. The implications of watercourse improvements for increased production, the long range objective, have yet to be examined in convincing detail. Yet the GOP and donors are making investments in the program for materials and technical expertise and landowners are required to make increasingly large contributions for labor costs and materials. The program has been successful in gaining the short-term participation of farmers, but whether the long-term economic benefits are to be realized is still to be determined.

Continuing, long-term research involving the monitoring of the on-farm water management activities will strengthen the program and help determine its future course. Research on the social and economic benefits of the program will deep understanding of the program and assist engineers and agronomists to define technology that can assist in bringing watercourse improvement benefits to farmers. This research can also be used in other water related activities. On-farm economics, organizational patterns, and farmer attitudes are key topics that directly affect the shape of other research and future development programs. In addition, a careful economic analysis of the impact of the various water programs will provide critical information for policy formulation.

This project will provide technical assistance and computer technology be provided to the Watercourse Monitoring and Evaluation Directorate to strengthen its capacity to review programs in water management. It also will provide funds to the Directorate for special studies which will permit the staff to address socioeconomic issue not directly related to their evaluations. WAPDA has already expressed an interest in incorporating the directorate permanently into its Planning Division. Even at present, it is the only body in Pakistan which conducts regular and systematic evaluations of water management activities.

Studies on the benefits of watercourse improvements will support the activities of the Farm Water Management and the Integrated Watercourse Management projects which seek to improve irrigation and agronomic practices for the water user and enhance delivery and utilization of water on farmers' fields. The proposed evaluations will be crucial to their design of various studies and interventions. Staff of the Directorate and of the two projects will be expected to work closely. They will also work with the investigators of the Encouraging Water User Involvement project which will set a social context for the evaluations.

OBJECTIVES:

1. Strengthen the institutional capacity of the Watercourse Monitoring and Evaluation Directorate in its conduct of quality evaluations.

2. Review and re-analyze the data base established by the Directorate using more sophisticated analytical methods.

3. Monitor the social and economic benefits of watercourse improvements at regular intervals to obtain time-series data.

OUTPUTS:

1. Series of evaluation reports of the socioeconomic impact of the watercourse programs.

2. A well-trained staff within WAPDA's Planning Division able to conduct socioeconomic studies of all water-related programs.

3. An analytical base, provided through evaluation and special studies, for policy makers to plan future interventions in the water sector.

PROCEDURES

The proposed project has four components:

1. Review and re-analysis of the data base established by the Watercourse Monitoring and Evaluation Directorate for its evaluation of the On-Farm Water Management Program.

The Directorate has already collected time-series data over a three-year period on the operation of watercourses from pre-improvement through post-improvement periods. Although the post-improvement period was relatively brief, lasting only one year, the data presently represent the only base from which the water-course improvements can be assessed. As noted, rudimentary analytical techniques have weakened the impact of the study and raised doubts about its conclusions, and the data set has been only partially analyzed.

As part of an objective to upgrade the skills of the Directorate staff, it is proposed that the use of microcomputers be integrated into the program of the Directorate. Data collected for the evaluation will be entered and re-analyzed using appropriate statistical techniques, given the limitation of the data set. Technical assistance and the participation of local research economists will be provided by the Program to review the data set, determine which part of it requires further analyses, and draw up a plan for managing its computer entry. Selected staff of the Directorate will be trained in computer techniques and be responsible for completing the entry. A TA advisor will then work with the staff in the re-analysis of the data for what is expected to be a series of reports which will, in part, assess the validity of the conclusions of the earlier evaluation.

2. Training of the Directorate's Staff in Social and Economic Methodologies

The Program team, with the assistance of local economists, will train staff of the Directorate in research methods and analytical techniques. The training will include Ph.D. and M.A. degree training in economics in the U.S. and workshops and seminars in-country on computer use, statistical methods, economics (analysis and evaluation) and social theory. It is recommended that some staff be trained in project evaluation at WAPDA Academy. Although presently funded only by outside consultants, it is likely that the Directorate will soon be incorporated permanently into WAPDA's Planning Division and be made responsible for evaluating all water-related programs coordinated by WAPDA. The Directorate has presented a proposal to the World Bank for funding to evaluate six water projects: On-Farm Water Management I and II, Command Water Management, Irrigation Systems and Rehabilitation, Fourth Drainage and Left Bank Outfall Drain - Stage I.

3. Continuing the Monitoring of Watercourse Improvement Programs

The re-analysis of the data collected for an evaluation of the now terminated USAID-supported program will serve as a base and set the parameters for the continued monitoring of these water-

courses. Continued examination is crucial to Pakistan's understanding of the benefits of the watercourse improvements program, for making critical judgements on how the program might be improved and for determining what interventions in watercourse improvements ought to be made in the future. Post-improvement data now covers only a one year period, yet, there is general agreement that the conditions in the watercourses are not stable. A time series study is a requirement for any program assessment. Using a variety of characteristics, researchers will identify two improved watercourse types: maintained and unmaintained and select their samples on that basis. The monitoring will focus on the reasons for the differences in maintenance and the examine the differences in water delivery and benefits. This effort will be done contemporaneously with the Directorate's evaluation of the World Bank program and will complement it.

4. Special Studies of Water-Related Activities

The Directorate will be supported to conduct special studies related to water management which falls outside its mandate. Two examples are a study on the role of rural women on irrigation activities and a study of water trading and selling. These studies have important policy implications although the topics have been neglected in the past. In some cases, the Directorate will not itself conduct the study but rather contract the assignments with local research institutions and private sector consulting firms, working in collaboration with it on the design of the research.

IMPLEMENTATION PLAN:

1. Training of the staff of the Directorate will begin with the arrival of a short-term agricultural economist in October 1985.

2. The review and re-analysis of the Directorate's data set is expected to last one year with a series of evaluation studies beginning in October 1986.

3. The continued monitoring of the water users will begin in September 1986 through 1988 with reports released during the period.

4. Special studies will be undertaken by the Directorate or on contract as required.

PERSONNEL:

USAID - Long-term team social scientist
Agricultural economists on TDY

LOCAL - Staff of Watercourse Monitoring and Evaluation Directorate of Planning Division, WAPDA
PIDE (Islamabad)
Agricultural Economics Research Institute (Karachi)

BEYOND WATERCOURSE IMPROVEMENT ESTIMATED COSTS

ITEM	FY 85		FY 86		FY 87		FY 88		FY 89		TOTAL	
	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST	DOLLAR COST	RUPEE COST
1. SALARY												
Short-term TA	10,080		15,870		16,680		11,660		12,260		66,550	
2. FRINGE BENEFITS	2,540		3,990		4,200		2,940		3,080		16,750	
3. LOCAL HIRE												
Prof. staff		1,695		1,785		1,875		1,965		2,055		9,375
Supoort staff												
4. TRAVEL												
International	6,400		10,080		10,590		7,400		7,780		42,250	
Intl. per diem	800		1,260		1,320		920		980		5,280	
In Pakistan		1,500		2,075		2,150		1,660		1,720		9,105
Pakistan per diem		3,920		6,180		6,480		4,540		4,760		25,880
5. OPERATING EXPENSE	1,000		1,575	100,000 Sp.Study	1,650	100,000 Sp.Study	1,160	50,000 Sp.Study	1,220		6,605	250,000
6. INDIRECT COSTS (25%)	5,205	1,779	8,194	27,510	8,610	27,626	6,020	14,541	6,330	2,134	34,359	73,590
7. COMMODITIES	55,220		1,000		1,000		1,000				58,220	
8. SUBTOTAL	81,245	8,894	41,969	137,550	44,050	138,131	31,100	72,706	31,650	10,669	230,014	367,950
9.CONTINGENCY (10%)	8,125	889	4,197	13,755	4,405	13,813	3,110	7,271	3,165	1,067	23,001	36,795
10.TOTAL	89,370	9,783	46,166	151,305	48,455	151,944	34,210	79,977	34,815	11,736	253,015	404,745
11.GRAND TOTAL	99,153		197,471		200,399		114,187		46,551		657,760	

NOTES:

(1) Rupee costs are shown in dollar equivalents

(2) Short-term technical assistance person months: 12.

(3) No vehicles in this project.

BEYOND WATERCOURSE IMPROVEMENT

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	4	26,000
Volt. Regulator w/battery	700	4	2,800
Monitor	400	4	1,600
Printer (dot matrix)	650	4	2,600
Memory upgrade	1,100	4	4,400
Software (DOS, W. P. etc.)	2000	4	8,000
Spare Parts	1000	4	4,000
Tool Kit	200	4	800
			50,200

PROJECT TOTAL W/O VEHICLES	50200
PROCUREMENT COSTS(5%)	2510
PACKING/FREIGHT(5%)	2510
TOTAL COSTS W/O VEHICLES	55220
VEHICLE COST	0
PROJECT TOTAL W/VEHICLES	55220

ANNEX
PROFILES OF MAJOR INSTITUTIONS
INVOLVED IN WATER MANAGEMENT RESEARCH IN PAKISTAN

INTRODUCTION:

The intent of this section is to provide a description of major Pakistani institutions that are involved in research pertaining to irrigation. The list of institutions in this report is not exhaustive -- there are others that have minor involvement with irrigation research. Detailed profiles have been prepared for only the most important of these institutions -- the ones underlined in the paragraphs which follow.

In Pakistan, as in most countries, there are a number of agencies and institutions which share responsibility for irrigation research. Such research tends to be commodity or discipline-focused, and serves the needs of various clientele groups, levels of decision making, and geographic regions. The diversity of irrigation research needs makes a single centralized research organization undesirable, and probably infeasible. However, the task facing countries like Pakistan is to coordinate these diverse agencies into an effective research program with conscious duplication, and with inter-agency linkages that are synergistic rather than destructively competitive.

An important difference between U.S. and Pakistan is the more limited role of universities in research. In contrast to land grant universities in the U.S. where research shares equal emphasis with teaching and extension, Pakistani universities tend to be limited to teaching functions. This division of effort means that research activities by university staff happen only under special circumstances rather than by programmatic design. Thus, coordinating a research program in water where an effort is made to draw on skills housed in the universities becomes more difficult in Pakistan as contrasted to the United States.

At the national level in Pakistan there are two umbrella type organizations that share coordinative and funding responsibilities in the irrigation research area: the Pakistan Agricultural Research Council (PARC), and the Irrigation Drainage and Flood Control Research Council (IDFCRC). Both agencies fund work at other institutions, and also conduct some in-house work that pertains to ISM/R objectives. The most closely related in-house research station is the IDFCRC funded Drainage and Reclamation Institute of Pakistan (DRIP). The PARC research stations at Quetta (Arid Zones Research Institute) and at Islamabad (National Agricultural Research Centre) also carry out work which is potentially relevant to ISM/R.

For historic reasons, some of the most important federal level irrigation research has been conducted by the Water and Power Development Authority (WAPDA) through its Mona Reclamation Experimental Project (MREP). Parallel work is now being

conducted at the Lower Indus Water Management Project (LIM) near Hyderabad.

The On-Farm Water Management (OFWM) program can also be thought of as a national level program since it consists of a federal cell within the Ministry of Food and Agriculture, that coordinates and sets policies for the OFWM action arms located in the provincial agriculture departments.

On the provincial level, provincial agriculture departments and the Provincial Irrigation Departments (PID's) are the line agencies having responsibility in the water management area. The agriculture departments discharge this responsibility through the Provincial Agricultural Research Institutes, the agricultural extension programs, and OFWM. It should be noted that the actual water management research efforts of the PID's, OFWM, and agricultural research and extension is not large. The PID's, OFWM, and agricultural extension are all action and implementation agencies, not research organizations. The agricultural research institutes have traditionally focused on variety testing, pest and disease control, fertility, and cultural practices, rather than irrigation management.

Also at the provincial level, the agricultural universities play a role in water management research. While the universities receive much of their funding from the federal level, they are under the administrative control of the provincial education departments. Their primary mandate is teaching -- they were formally split off years ago from the provincial agricultural research institutes and agricultural extension. The University of Agriculture, Faisalabad and the Sind Agricultural University, Tando Jam are well-established. The Northwest Frontier counterpart at Peshawar, the Northwest Frontier Province Agricultural University (NWFP AU) is now being created with the help of donor funds, and a Baluchistan counterpart is in an early formative stage within the extension program's Agricultural Training Institute.

The engineering universities also play a role in water management research, although their primary mandate is again in the teaching area, and they are under the administrative supervision of the provincial education departments. Established engineering universities are the Punjab Engineering Academy, Lahore, the Sind Engineering School at Jamshiro which we were unable to visit because of disturbances on campus, and the Northwest Frontier Province University of Engineering and Technology, Peshawar. The Punjab Engineering Academy at Lahore serves a more nearly national mandate, giving postgraduate engineering training to engineering employees of various agencies. Tarbela Academy in WAPDA serves a more specialized role, providing management training primarily to employees of WAPDA.

The Quaid-I-Azam University at Islamabad plays a somewhat different role because it is a national rather than a provincial school. While several of its departments may have some involve-

ment in water management research, the anthropology department is of particular interest since it is one of the few Pakistani agencies having research capability in the social aspects of water user organizations.

The final group involved with water management research are the federally designated "Centers of Excellence": the Center for Excellence in Water Resources Engineering at Lahore, the Applied Economics Research Center at Karachi, and the Pakistan Institute of Development Economics at Islamabad. All of these research and training entities are physically located on university campuses, but are administratively and financially separate.

PAKISTAN AGRICULTURAL RESEARCH COUNCIL (PARC)

OBJECTIVES: The role of PARC is to undertake, aid, promote and coordinate agricultural research; to arrange expeditious utilization of research results; to establish research establishments to fill in gaps in the existing programs of agricultural research; to arrange training of high level scientific manpower in agriculture; to generate, acquire and disseminate information relevant to agriculture; and to establish and maintain a reference and research library.

ORGANIZATION: PARC is the federal-level agricultural research organization, analogous to the US's Agricultural Research Service (ARS) or Australia's CSIRO. It conducts agricultural research of national importance. PARC also coordinates and funds agricultural research throughout the country in liaison with the international networks active in agricultural research. Besides support divisions, PARC is organized into four technical divisions: Crop Sciences, Natural Resources, Animal Sciences, and Social Sciences. Water management falls principally under the Natural Resources Division, but overlaps with the work of other divisions, and with work in range management, forestry, remote sensing and watersheds.

Under support from USAID, PARC constructed the National Agricultural Research Centre (NARC) which was inaugurated in May 1984. NARC is a first-class research facility on 565 ha, located 6 km southeast of Islamabad. A Farm Machinery Institute has been established at the NARC. Other research facilities under PARC control include the Arid Zone Research Institute, headquartered in Quetta with substations in D.I. Khan, Bahawalpur and Umerkof; the Cereal Diseases Research Institute in Islamabad, Murree and Karachi; the Southern Zone Agricultural Research Centre at Sujawal; the Date-Palm Research Station at Turbat; and the National Herbarium and Museum at Islamabad.

STAFF: The 1982 PARC staff consisted of 17 Ph.D., 75 M.Sc., and 52 B.Sc. scientists. The Land and Water Management Division consists of a staff of 16 Scientific Officers (1982-83). Through PARC funded research projects, the Council has access to many additional irrigation management research personnel in many other institutions all over Pakistan.

CURRENT ACTIVITIES: 1984-85 allocations for PARC's four technical divisions reached Rs. 41 million of which 25% is designated for Natural Resources and 9% for Social Sciences. Principal water related research interests are:

1. Water management and conservation
2. Water measurement and control systems
3. Techno-economic studies for optimizing land use
4. Estimation and monitoring surface runoff and soil losses
5. Development of conservation structures
6. Development of low-cost, high efficiency irrigation systems.

Extensive consumptive use studies have been conducted or funded by PARC. This line of work will likely be supplanted by field studies to determine how to use consumptive use data, i.e. matching water deliveries to crop water needs. This will necessarily involve some additional research on irrigation scheduling.

At present, PARC's Division of Social Sciences has no member to direct its activities. Although a division of Social Science, it has no capacity in sociology; the directors are economists. Priorities for research include: studies in marketing agricultural produce, food processing for agro-based industries, and the displacement of rural labor through agricultural mechanization. This division has not yet funded a study dealing with water management. During this past year, the division received 8 proposals and accepted three in the area of water management.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: PARC has expressed keen interest in collaboration with the research component of ISM. However, PARC's principal research mandate has been in the area of agricultural production research, not water management research. There remains considerable ambiguity as to the proper division of research and coordinative responsibilities in the water management area between PARC and IDFCRC. It should be an objective of ISM to reinforce and strengthen PARC's coordinative and information dissemination roles within its areas of responsibility.

Certainly PARC's mainstream agricultural research relates integrally to research being proposed under ISM. For example, the Crop Sciences Division can feed agronomic research information to the ISM project which will be used to develop a better water management package of practices, and the Farm Machinery Institute can assist by developing tillage and land forming implements that can permit better water management.

IRRIGATION DRAINAGE AND FLOOD CONTROL RESEARCH COUNCIL (IDFCRC)

OBJECTIVES: IDFCRC has a mandate to take a leadership role in organization, coordination and promotion of research in the fields of hydraulics, hydrology, irrigation and drainage, reclamation, flood control and desertification. The Council provides financial and technical support to universities, other research institutions and private organizations, and promotes research in water resources by funding fellowships in the engineering and agricultural universities. Publication of research reports and scientific papers and dissemination of research information is also their responsibility. Liaison with other national and international organizations in the various research fields is promoted.

ORGANIZATION: Established in 1965, IDFCRC pertains to the Ministry of Science and Technology. The governing body of IDFCRC consists of:

Chairman (IDFCRC))
Member (water) of WAPDA
Joint Secretary of the Ministry of Water and Power
Secretaries of all the Provincial Irrigation Departments
Chairman of the University Grants Commission
Vice Chancellor of the Engineering University
Secretary (IDFCRC)

Outside of the headquarters in Islamabad, its only other physical unit is the Drainage and Reclamation Institute of Pakistan (DRIP) located near Tando Jam. Other than DRIP, the Council performs little in-house research, but rather serves as a funding mechanism to support work at other research organizations.

STAFF: Total staff consists of 1 Ph.D., 19 M.Sc., and 4 B.Sc. at the Council Headquarters in Islamabad, 17 at the Council funded DRIP, 8 at the Land Reclamation Directorate at Lahore, and 10 at the Desertification Monitoring Unit in Chilistan. All of the authorized posts are not utilized because of a shortage of qualified manpower.

CURRENT ACTIVITIES: The Council currently has 8 projects funded in 1984 - 85 with a budget of approximately Rs 52 million. Major funding is for DRIP (Rs 40 million) with additional funds for lysimeter studies at Sind Agricultural University (Tando Jam) and at the Engineering University at Lahore, desertification monitoring, and monitoring of the tile drain pilot project in Khaipur. Some 14 new projects are proposed for 1984 - 85 including establishment of a National Institute of Hydrology, setting up hydrologic monitoring stations in Baluchistan, and studies of rainwater harvesting, coastal hydrology, irrigation with saline water the Warabandi system and water requirements of irrigated crops.

Since 1971, the Council has published a bi-annual technical bulletin, and currently publishes a monthly newsletter. The technical bulletin includes papers from Pakistani irrigation and drainage researchers, as well as papers from researchers outside Pakistan. The Council has also published monographs and bibliographies on various irrigation and drainage topic areas. Professional cooperation and communication is fostered through occasional seminars and professional meetings. The Council funds six fellowships per year for students in the hydrology and water resources courses at the Centre for Excellence in Water Resources.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: This institute is intended to be an umbrella organization for focusing research in irrigation and drainage. However, there appears to be a need to improve liaison and cooperation with PARC, WAPDA, and the provincial governments. Cooperation and institutional effectiveness would be improved by a better delineation of the respective roles of these various organizations in irrigation/drainage/water management research.

A principal objective of the ISM project is "to provide a scientific and institutional base for continued water management research in Pakistan". IDFCRC, because of its important coordinative, research documentation and information dissemination, and funding roles in the water management area is a natural candidate for strengthening and modernization. The Council could use aid in staff training, equipment modernization (including computerization), and help in upgrading their subject-area library and research documentation and dissemination abilities. The Council should play a direct role in helping to disseminate ISM research results.

DRAINAGE AND RECLAMATION INSTITUTE OF PAKISTAN (DRIP)

OBJECTIVES: The Institute is structured and staffed to conduct research on drainage and irrigation system design, soil reclamation, soil and water management, and irrigation methods.

ORGANIZATION: DRIP is an in-house research agency, funded and administered by the Irrigation Drainage and Flood Control Research Council. The research facilities are located about one half mile from Sind Agricultural University at Tando Jam and there is some cooperative use of equipment and facilities.

STAFF: The Institute began operation in 1975 and now has 8 senior staff and 80 total personnel with some located away from the Tando Jam site. The General Director is a civil engineer and former chief engineer with Sind Irrigation Department. The fields of other staff emphasize engineering and technical agriculture. The Institute has a full time technical editor and report writer.

CURRENT ACTIVITIES: The Institute is doing research on tile drainage systems and assisting East Khaipur drainage project in monitoring an experimental installation of 1200 acres. An experiment in soil reclamation is being conducted utilizing large soil columns to evaluate soil reclamation by leaching with fresh and saline water.

Field plot work emphasizes use of saline groundwater from a tubewell for various types of irrigation water application. Instrumented plots are used to test the effectiveness of drip irrigation on gourds, utilizing home-made tube type drippers. Pitcher irrigation of trees and other crops is being investigated, with clay pitchers buried near the plant and filled with water daily. There is also work on salt tolerance of vegetable crops for water-short desert conditions.

There are plans to compare SCARP drainage with tile drainage using an aquifer model developed at Lahore Engineering University using DRIP/IDFCRC funding. Proposals are being submitted to PARC for modeling of the SCARP drainage of North Rohri aquifer.

The institute publishes a newsletter and individual project reports. Twenty one publications have been produced during the past ten years.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: This institute has a mandate to be a leader in water management research. However, the ISM Research Definition team felt that DRIP requires some institution-building before reaching that level of effectiveness or productivity. This may be true because of the weakness of linkages between DRIP and other organizations. There is little direct contact with the Extension Service, with DRIP researchers attempting to extend their own results through farmer contacts and other media. There seems to be little formal or informal liaison with irrigation departments, universities, or other research entities except through government-sponsored

seminars, etc.

In addition to the need to integrate DRIP more effectively into a coordinated country-wide water management program, there are needs for additional training of DRIP staff, and for some upgrading of research equipment. For example, there presently are no computer facilities on either the DRIP or the adjacent Tando Jam campus.

WATER AND POWER DEVELOPMENT AUTHORITY (WAPDA)

OBJECTIVES: The principal objectives of WAPDA are to build, operate, and maintain the means to supply water and electric power to Pakistani users. WAPDA operates the major water storage and hydroelectric dams on the upper Indus and most of the country's electricity distribution grid. WAPDA's responsibility for water distribution ends when it turns water over to the PIDs at the level of the main link and feeder canals.

WAPDA evolved a major role in the SCARP tubewell program, planning and developing the SCARP areas, and then turning control and operation over to the PIDs. This also led to WAPDA's involvement in monitoring and evaluation of the performance of the public tubewell program, and to an even more general interest in promoting and conducting research into methods to improve water management, through its sponsorship of the Mona Experimental Reclamation Project, and its efforts to establish similar centers to serve the particular research needs of the other provinces.

ORGANIZATION: WAPDA is organized by function into three wings with one member of a governing board from each wing. The largest wing is Power, followed by Water, then Finance. The Water Wing contains seven divisions, each headed by a general manager, assisted by 3-5 chief engineers and their staffs. Divisions are North, South, Central, Tarbela, Dams, Kalabagh, and Planning. The ISM/R project will be most closely associated with the planning division.

Primary units or directorates within WAPDA which will likely be involved in ISM/R are:

- Hydrology and Systems Analysis Unit
- Evaluation and Monitoring Unit
- Alluvial Channel Monitoring Unit
- Directorate of Geohydrology
- Mona Project
- Lower Indus Water Management & Reclamation Research Center (LIM)

STAFF: In 1983, the Water Wing had a total of 17,962 employees including:

Engineers	946
Economists, geologists, agronomists, etc.	668
Administration/Accounts	307
Grade 17 and above - Subtotal	1921

Most higher echelon staff have engineering training, and many have attended the Tarbela Academy management course. New technical personnel generally have at least a B.Sc. from a Pakistan University.

CURRENT ACTIVITIES: Activities related to agronomic research are limited to Mona and LIM. However, activities under the Monitoring and Evaluation unit related to tubewell problems and SCARP monitoring are other types of important applied research efforts. All of these are closely related to work being proposed under ISM/R. The Alluvial Channel Observation Project funded by the U.S. National Science Foundation, also assists in data collection for research on sedimentation problems in irrigation distribution systems. Many foreign donor assisted development projects are funded through WAPDA. Some of these projects such as the River Flow Forecasting and Flood Warning System are not specifically research efforts, but data collected are useful in irrigation distribution system related research.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH:

Because of WAPDA's nationwide responsibilities, prominence in water resources and irrigation efforts, and organized field and analysis units, it will be heavily involved with ISM/R in water management research. Staffing of some units is not currently geared for major research efforts and research equipment levels are deficient in many units. For example, the Monitoring and Evaluation unit monitors some 5400 wells each year and analyzes the data for planning purposes, all with a staff of twenty people. Computer capabilities must be increased to allow application of more rigorous analytical techniques and more efficient management of research and monitoring data. WAPDA has a relatively progressive attitude toward research as compared to some other operating agencies.

Because of WAPDA's extensive experience in monitoring and evaluation of tubewell performance and watercourse improvement, it is essential that the Monitoring and Evaluation Unit of WAPDA be closely involved in ISM work in these areas.

MONA RECLAMATION EXPERIMENTAL PROJECT (MREP)

OBJECTIVES: The original objectives of the Mona Project were to monitor the effectiveness of the Salinity Control and Reclamation Project (SCARP) tubewell program in lowering the water table, reclaiming the salinized and sodic soils, and increasing cropping intensity and yields. It was also charged with developing improved water, soil and crop management techniques to enable farmers to effectively use the extra water received from the SCARP wells.

The objective of developing and evaluating types of watercourses to convey more of the water to the field was added when it was found that watercourse losses were excessive. Researchers found that cleaning and maintenance were cost effective means of increasing water deliveries to the field. Hence, a major new objective has been to find ways to motivate farmers to participate actively in watercourse operation and maintenance. Additional objectives which have become apparent are: 1) development of tubewells to skim fresh water off aquifers where deeper waters are saline, 2) determine the extent to which saline waters can be used for crop production, and 3) determine the effect of irrigation method and amount on nitrate fertilizer recovery.

ORGANIZATION: The MREP is headed by a director who reports to the Chief Engineer of the Planning and Investigation Organization who is responsible to the General Manager, Planning Division in the Water and Power Development Authority (WAPDA), a semi-autonomous agency which receives its funds from the Ministry of Water and Power of the GOP.

The Mona project is located within SCARP-II in the Bhalwal and Sargodha areas of the Punjab. MREP's research is conducted in two ways. There is a research farm under operational control of MREP scientists. Here plot type research is conducted as it is on any experiment station. Other MREP research is applied, action-oriented and involves working with farmers on their fields. This research is conducted across 110,000 acres of canal command area where one can find almost any type of delivery pattern, water table situation, farm size, tubewell augmentation or other physical aspect. The physical setup of MREP is ideal for water management research since its area of control is a large "laboratory," a portion of a live irrigation system. It has the drawback of being confined to a specific climatic zone of the Punjab, but more importantly to a specific canal system and also a SCARP-augmented system. This is the rationale for WAPDA's plans to create other Mona-type research operations in the other provinces.

STAFFING: The present staff includes a director, superintending research officer, executive engineer and senior research officers (SRO's) in soils & reclamation, agricultural economics, agronomy, extension, and hydrology and water management. Each of these SRO's has from 5 to 7 junior research officers. Out of a total present staff of 250, there are 90 professionals (including 1

Ph.D. 18 M.S., and 32 B.S.)

CURRENT ACTIVITIES: MREP's funding is a line item in WAPDA's budget. This basic funding has been augmented for the past 12 years through USAID support. This additional USAID funding has been directed toward water management research efforts. The project is operated on an average annual research budget of about Rs. 10 million. MREP has recently prepared a new PC-1 for USAID funding for the next 5 years since present USAID support is scheduled to end in 1984.

MREP has made, and continues to make significant contributions to improving water management in Pakistan. Its water management section, working cooperatively with its extension section, developed the program in which farmers cleaned and improved their own watercourses, a primary basis for the current OFWM watercourse improvement program.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: MREP staff are presently conducting applied research aimed at more efficient delivery and better utilization of water and related resources to improve crop production and to develop means for extending results to farmers.

Mona had an excellent history of collaboration with Colorado State University. A similar relationship could be developed under the ISM research project. WAPDA and Mona administrators seem anxious to have such cooperation begin again. There appears to have been regression to old research topics and methods since the termination of the CSU collaboration in 1979. This, to some degree, can be attributed to the fact that the program at that time was directed primarily at producing research results rather than at assistance in building a viable research institution. ISM/R involvement at MREP should place major emphasis on such institution- building.

Mona's staff should be encouraged to develop closer interaction with the water management program at the University of Agriculture at Faisalabad, with the OFWM and Extension programs, and with other research programs elsewhere in Pakistan to assure that Mona's research can help fill real needs, and to draw on a broader base of technical expertise. The ISM project can serve as a vehicle to help develop and reinforce such inter-institutional linkages.

Because of Mona's extensive experience in these areas it is essential that Mona be closely involved in the proposed ISM/R.

Recent high level GOP policy discussions have aimed at drawing appropriate lines between the research of Mona and other water-related research institutions. This seems to point to a policy conclusion that Mona should explicitly concentrate more closely on water management topics and leave non-irrigation research such as variety trials, fertilizer trials and other purely agronomic research to other research organizations.

LOWER INDUS WATER MANAGEMENT & RECLAMATION RESEARCH PROJECT (LIM)

OBJECTIVES: The general objectives are to identify the problems of irrigated agriculture in the Lower Indus, find their solutions, and increase agricultural production. Studies are planned in water, soil and crop management. Specific objectives are to: 1) find improved ways to utilize the brackish groundwaters that lie close to the surface in most of the irrigated area in the Lower Indus Basin to grow salt-tolerant crops and reclaim sodic soils; 2) develop guidelines for applying irrigation to crops on lands with shallow water tables; 3) determine effects of different sowing dates on crop water use; 4) development and evaluation of improved irrigation methods; 5) assess the benefits of land leveling; 6) develop and assess low discharge shallow wells for skimming fresh water; 7) find ways to effectively involve water users associations in the adoption of improved water, soil, and crop management technology.

ORGANIZATION: Conceived about ten years ago, this Centre was proposed by WAPDA to the GOP and CIDA (Canada) for funding. CIDA was positive to the proposal, but suggested a longer term and more costly project, financed about 50% from GOP funds. GOP was unable to make such a commitment of funds at that time. WAPDA still argues that a project such as LIM is needed to research water management problems specific to the lower Indus basin.

In 1983, a PC-1 was prepared for WAPDA to support the basic program for 5 years for a total of Rs. 20,000,000. Funding for lab equipment was a separate item of Rs. 850,000. The GOP has not yet approved this PC-1. Meanwhile, a skeleton program is being supported from other WAPDA funding sources.

STAFFING: At present this center consists of 2 Senior Research Officers stationed in Hyderabad, who commute to the Tando Adam area where their Junior Research Officers and field assistants are conducting studies on cooperating farmers' fields. Staff projected in the PC-1 include a project director, 3 senior research officer, 1 junior research officer, 5 junior ag officers, 2 junior engineers, and 1 sub-engineer.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The proposed project at LIM seems to have a broad base of support, especially within Sind. WAPDA's commitment to the project is evident in the effort that has gone into PC-1 development and in the partial support that is presently sustaining the programs now at Tando Adam. The project is described by the D.G. for Extension of the Sind Agriculture Department as essential to their needs. Staff at the Sind Agricultural University, Tando Jam would like to have access to such a facility, so they can take their students to it and cooperate in the research. There seems to be good prospects for technical support, cooperation, and staff interchange with the existing Mona project.

The PC-1 staffing chart includes expatriate advisors and Sind Agricultural University advisors. WAPDA is convinced that the use of both Pakistani and expatriate advisors are essential to getting the proposed research off to a good start.

Because this project is still in a formative stage, the ISM project can play a very important and very necessary role in shaping and building the institution, planning and supporting its research activities, and training its staff.

ON-FARM WATER MANAGEMENT PROGRAM (OFWM)

OBJECTIVES: The On-Farm Water Management Program is charged with making watercourse improvements, organizing water user associations for operations and maintenance as a prerequisite for watercourse improvements, and providing training to strengthen the institutional infrastructure.

ORGANIZATION: A unit within the Ministry of Food and Agriculture, the program is composed of a federal cell in Islamabad and four provincial directorates. The federal cell, which reports to the Secretary of Food and Agriculture, is responsible for setting general guidelines and coordinating the activities of the individual provincial directorates. These directorates are responsible to the provincial secretaries of agriculture and are the implementation units.

STAFF: The total number of professionals working in the Federal cell and four directorates is about 1000. They are mostly working in the field teams composed of field directors, agricultural officers, and field assistants. They contact farmers on the watercourses and arrange for the improvements to be done. In addition, there are the staffs of the three OFWM training institutes where project professionals are trained. To date, the institute in the Punjab is fully operative while those in Sind and NWFP are still being developed.

CURRENT ACTIVITIES: Funds have been provided by provincial governments as well as by numerous donors: World Bank, Asian Development Bank, USAID, UNDP and IFAD. Budgets vary among the directorates; in the Punjab, which has the largest program, the budget for the 1983-84 fiscal year is 200 million rupees. No money within the budgets is specifically allocated for research.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The role of research in the activities of the OFWM directorates is yet undecided, although many have called for a more active involvement in field experimentation. At present, limited research is being done when necessary to adapt the watercourse improvements to field conditions. The major research efforts to support and expand the work of the directorates have been done by the Mona Reclamation Experimental Project and by the Water Management Research and Training Project for Rural Development of the University of Agriculture at Faisalabad. However, many PID staff have expressed the view that such research results have few practical applications and are difficult to translate into recommendations to farmers. As a result, they are not being integrated into implementation plans. It is argued that research ought not to be disassociated from field work and that the OFWM directorates ought to do more structured adaptive research and monitoring and evaluation of their activities.

Practical and well-defined research may be encouraged through the OFWM training institutes as a way of joining research and extension efforts. In such a case, their staff would have to be enlarged and upgraded. This should not preclude research conducted at Mona and Faisalabad. The OFWM Training Directorate in Niazbeg, Punjab has an excellent record of training sub-professionals in water management. Collaboration with that center will be a vehicle for integrating applied research and extension efforts, particularly for obtaining increased benefits from watercourse improvement efforts.

PROVINCIAL IRRIGATION DEPARTMENTS (PIDs)

OBJECTIVES: The four Provincial Irrigation Departments have operational and maintenance (O&M) responsibilities for irrigation water delivery to a service area of 35.4 million acres. Operational responsibility begins with the main link and feeder canals and extends downward in the system terminating at the moghas. Legally, PIDs also have certain responsibilities at the level of farmer's watercourses. PIDs have responsibilities for O&M of public tubewells (SCARPs), for drainage, and for flood control.

ORGANIZATION: The four PIDs are located in Baluchistan, NWFP, Punjab, and Sind. Headquarter offices are in each of the capital cities, with regional offices located throughout each of the provinces. The PIDs are line institutions of the provinces responsible for irrigation and irrigation-related activities. PID's are headed by a secretary who reports to a minister who in turn reports to the governor of that province.

STAFF: In 1983/84, numbers of staff in each of the PIDs are as follows:

PID	Officers, engineers and sub-engineers	Total Staff
Baluchistan	255	3,114
NWFP	301	5,032
Punjab	3,092	50,277
Sind	1,240	23,706

CURRENT ACTIVITIES: The current research activity of the PIDs is negligible. Each PID derives its funding from line items in the provincial Non-Development Budget which funds recurrent cost items for all agencies in a province. In Punjab, the 1983/84 allocation to the PID totalled over $90 M (US dollars), of which less than $10,000 (U.S.) was used for research. The Baluchistan PID operated on a budget of about $7 M, none of which was formally allocated to research.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: Only the PIDs in Punjab and Sind have a formal research capability. And, that research is entirely confined to hydraulics, a research area to be covered by another ISM implementation team. While there is no field research performed, there is significant interest in applied research as it affects conveyance systems operations and maintenances. Any research that affects distribution of water (including that below the outlet) will interest PIDs and there is expressed interest in cooperating with the research project.

The PIDs are the largest and most important irrigation institutions in Pakistan. A water management research program conducted without their participation would be incomplete. Although numbers were difficult to determine, the PIDs have numerous individuals with advanced degrees, many with training overseas, who could be collaborators in a research planning sense. Several of the chief engineers have expressed their strong interest and support for conducting collaborative research under the proposed project, and sent representatives to assist the research design team in preparing research proposals. PIDs have numerous young engineers who would be willing collaborators in action research programs.

PROVINCIAL AGRICULTURAL RESEARCH INSTITUTES

OBJECTIVES: The objective of the Provincial Agricultural Research Institutes is to conduct applied research in crop development and crop and livestock production techniques.

ORGANIZATION: These institutes are under the direction of the Provincial Agriculture Departments (PADs). Each province has its own network of research stations and/or institutes in which there is generally a strong commodity orientation, for example, a focus on rice at Dokri, cotton, livestock, pulses, vegetables, elsewhere. While most of the crops and experiment stations are irrigated, water management or irrigation is not considered a researchable area of interest. Also it should be noted that extension of research findings is not within the purview of the research arm of the PAD, falling instead within the extension directorate.

Ayub Agricultural Research Institute (AARI) is the principal research arm of the Punjab PAD. Headquarters are in Faisalabad on an experimental property of almost 1100 acres. There are 11 research institutes, 4 stations, 2 substations, and 21 centers for variety and soil testing under AARI direction. In 1983-84, AARI's budget allocation covered $3.3M (U.S. dollars) in recurrent costs and $1.8M in development costs. Of the provinces, Punjab has by far the strongest provincial commitment to research.

Sind has a total of 14 agricultural research institutes, but only 5 in crops; the remainder are engaged in livestock or forestry research. Institutions worthy of note are the Agricultural Research Institute at Tando Jam, the Rice Research Institute at Dokri and the Horticultural Institute at Mirpur Khas.

NWFP has 5 agricultural research institutes, the principal one located at Tarnab. Baluchistan has one provincial research institute.

STAFF: AARI has a professional staff of 522. Twenty (20) hold the Ph.D. and 406 are M.Sc. By field, plant breeders and geneticists dominate the AARI staff, an indication of the relative importance given to varietal improvement vis-a-vis improved techniques and practices, not to mention water. Current figures on research staff in the other provinces were not available.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: Because of relatively little interest in water management research, it is unlikely that the PADs in Punjab, Sind and NWFP will be collaborators in ISM/R. The PAD in Baluchistan is hopeful of support from ISM/R and would be a willing cooperator, particularly for research involving drip irrigation. However, it is doubtful that Baluchistan can contribute much in the way of staff and facilities for true collaboration. Research results generated by the PADs will be used by ISM/R as a part of the package of practices developed for use in conjunction with improved water management practices.

UNIVERSITY OF AGRICULTURE, FAISALABAD (UAF)

OBJECTIVES: UAF is the agricultural university serving the Punjab. Before partition, it was the premier agricultural sciences institution for all of northern India. Its graduates hold a large portion of the administrative posts in agriculture and agricultural research in Pakistan. It offers both graduate and undergraduate degrees. The Ayub Agricultural Research Institute, which was split off in the sixties, took some of the agricultural researchers and research funding out of the University.

ORGANIZATION: The university's principal role is teaching, and its principal funding comes through the Ministry of Education. What research is done is either directly related to the teaching function, unfunded, or supported by outside funding sources.

UAF's water management activities started in 1978 when the University initiated, with USAID funding, a research project in water management training for extension and OFWM project personnel from all 4 provinces. Disciplines participating in the water management research include agricultural engineering, soil science, agronomy, sociology, agricultural economics and agricultural extension. The Vice Chancellor was designated as the project director, but actual project direction comes from the coordinator and joint coordinators.

STAFF: UAF employs about 40% of all the Ph.D. scientists and 13% of the M.Sc. scientists working in institutions doing agricultural research in Pakistan (95 Ph.D., 219 M.Sc., and 47 B.S.).

For the Water Management Training Program, a principal investigator heads up each of the research components. UAF staff serving as principal investigators devote about half-time on this project. Most of the project staff from each of the participating departments are M.Sc. trained individuals.

CURRENT ACTIVITIES: The activities of the UAF water management training and extension program are to: 1) determine the degree to which a high water table can satisfy crop needs as a function of water table depth; 2) develop management practices for utilization of saline water to optimize crop production; 3) select, develop and test equipment and procedures that will help farmers increase delivery efficiency of privately owned watercourse; 4) develop and evaluate effects of improved methods of irrigation and land leveling on crop production; 5) evaluate effects of improved water management technology on surface and subsurface hydrology and salt balances: 6) organize and test water users associations as self-sustaining enterprises; 7) develop effective extension methods for motivating farmers to adopt improved farm water management practices. Much of the research under this project has been done at Shahkot, to the east of Faisalabad.

USAID supported this program from 1979 until 1984. The UAF has prepared a new PC-1 for another 5-year program, with a budget of about Rs 15 million. Continued USAID assistance is being sought, and ISM is the logical vehicle for such support.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The UAF staff appear to have developed an understanding of the need for and potential of improved water management. They have skills that ought to be effectively utilized in any irrigation management research or implementation program.

There is considerable room for institutional improvement, especially in the form of staff training, and research and computer equipment.

The new PC-1 outlines a reasonably good series of objectives. There is considerable overlap with the objectives in the Mona PC-1, but their approaches are significantly different and such overlap might be synergistic. It should be remembered that a major original objective of this project was to help these teachers gain experience and knowledge of improved water management practices.

The UAF staff should also have knowledge of the research going on at Mona and Mona's administrators have expressed interest in having UAF staff as advisors to their projects. A significant role for ISM expatriate advisors would be to foster the greater cooperation and coordination needed between these and other institutions.

SIND AGRICULTURAL UNIVERSITY, TANDO JAM

OBJECTIVES: Teaching and research responsibilities in the fields of production agriculture, agricultural ecomomics, and agricultural engineering. This is the major institution in Sind Province having research/teaching responsibilities in these areas.

ORGANIZATION: The university receives primary funding from the Ministry of Education. It gets some research project support from PARC, IDFCRC, PL-480, etc. It has a relatively low student-faculty ratio, so that staff is expected to do some research. Staff in the fields related to ISM are expected to spend 25 percent of their time on research, although direct university funding of research is limited.

STAFF: The University staff consists of 16 Ph.D., 123 M.Sc. and 23 B.Sc. trained individuals. The staff interested in water management are the mixture of Ph.D. and M.S. degree holders (mostly with in-country degrees). The level of professional interchange with other universities and research institutions seems to be quite low -- but whether this is due to lack of funds and opportunities or lack of interest is difficult to discern. There were some indications that recent political problems and student strikes have adversely affected faculty and student morale and educational effectiveness.

CURRENT ACTIVITIES: The research budget is low but field laboratory facilities are reasonably good with 1600 acres of land in the campus vicinity and in proximity to DRIP. Researchers utilize the lysimeter facilities at DRIP however little direct collaboration with DRIP staff occurs. No computer facilities are available on-campus; however there is some opportunity for use of the computer center at Jamshiro University at Hyderabad. Extension effort is provided through local radio station programs managed by the Extension Service.

Primary research efforts are in consumptive use studies, drainage, drip and pitcher irrigation, conjunctive use and scheduling of irrigation application. Economic research studies have addressed issues in marketing, farm labor usage and, social and economic aspects of migratory labor, mechanization, small animal production, and farm management.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: As the major agricultural teaching institution in Sind Province, the University has valuable expertise that should be utilized in the ISM project, especially in any ISM activity involving Sind agriculture.

Staff of the agronomy, agricultural economics and agricultural engineering departments seem interested in research and have submitted proposals to PARC with somewhat mixed success. Staff from each of these departments have indicated a willingness to participate in ISM project efforts.

In order to increase the future capability to do irrigation management research in Sind, it is important to build up the University at Tando Jam. ISM can contribute to this process by, at a minimum, involving Tando Jam staff in research advisory committees, as collaborating researchers in other projects, and as instructors in training programs. There also may be a role for ISM in upgrading Tando Jam through more advanced training for its staff, and through helping it to acquire improved research and computing equipment.

NORTHWEST FRONTIER PROVINCE AGRICULTURAL UNIVERSITY (NWFP AU)

BACKGROUND: NWFP AU was established in Peshawar in 1981, an outgrowth of Islamia College (from 1930) and the College of Agriculture (formed in 1957) which also offered training in agriculture. The university offers B.Sc. and M.Sc. degrees and has an enrollment of 683 (1982-83). Student specialization has tended to be in agronomy and soil science followed in order by plant breeding and genetics, entomology, horticulture, agricultural chemistry, food technology, agricultural economics, rural sociology, extension education and animal husbandry.

OBJECTIVES: The single-purpose university mission has been one of teaching and to provide manpower for provincial government service. Like other universities in Pakistan, NWFP AU has not been expected to, or financed so they could have a significant research program. Beginning in 1985, USAID has agreed to provide $50 million in grant funding over seven years to upgrade the university. Modeled after the U.S. Land Grant system, funding will allow the university to add on additional objectives - those of research and outreach.

ORGANIZATION: The organization of the university is in transition with de facto organization consisting of the administration and fourteen department: agronomy, plant breeding, entomology, horticulture, soil science, animal husbandry, agricultural mechanization, food technology, agricultural economics and extension, agricultural chemistry, development studies, English, Islamic studies, and math-statistics-physics.

STAFF: NWFP AU has a staff of 94 professionals in grades 16 to 21 (lecturer and above, 1983). Included are 14 staff holding the Ph.D. and 19 staff with M.S.-level qualifications. One-third of the staff received their degrees outside of Pakistan with approximately half of those individuals having studied in the U.S.A.

CURRENT ACTIVITIES: Very few staff are engaged in research in any substantive way. It has been estimated that not more than 20% of staff time is devoted to research. (1) The Agricultural Chemistry Department is doing some good research in human nutrition and the Institute of Development Studies has had a good record for obtaining research funding from outside sources. The Soil Science Department has two ongoing projects that are in cooperation with PARC. The designated experimental farm is undeveloped.

---

(1) Report of the Design Team for NWFP AU, submitted to USAID by the University of Illinois and Southern Illinois University, 1983, p. 39.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: A personnel upgrading schedule has been proposed for NWFP AU that calls for training 205 staff: 70-Ph.D.; 70-M.S.; 65-non-degree. Of the 205, only one individual was proposed for training in soil and water management (engineering). Others are proposed in related areas of agronomy. These individuals could be encouraged to do their thesis work in Pakistan on water-related topics in collaboration with ISM/R. This would appear to be the quickest and most logical way to secure NWFP AU involvement in water management in the province, since there is no research or extension work in water management that is presently underway.

PUNJAB ENGINEERING ACADEMY, LAHORE

OBJECTIVES: Although it offers some technical course, the academy was primarily created to provide training in public administration and project management to all entry level engineers and to middle and senior level engineers in the Government of the Punjab. It was perceived that engineers needed specialized training to improve their managerial abilities to deal with their clients, colleagues, and superiors and assistance in organizing their thoughts for public presentation.

ORGANIZATION: The academy was organized through the Provincial Irrigation Department but is now a semi-autonomous institution in the Government of the Punjab. The chairman of its board of governors is the Provincial Minister for Irrigation and Agriculture. Its trainees are drawn from all provincial departments employing engineers which include irrigation, agriculture, local government and rural development, housing, industry, labor and communication.

STAFF: The academy's permanent staff is small at present. Only seven professionals are employed. Teaching will be done largely by visiting professors and the staff of NESPAK and WAPDA. It is directed by a principal, Mian Khalil ur-Rehman, formerly Secretary of Irrigation in the Punjab.

CURRENT ACTIVITIES: The academy offered its first course, six weeks of inservice training, in October, 1984. It is mandated to provide a six-month preservice training course to all new Government of the Punjab engineers. The trainees will be given four months of training at the academy and two months of practical training in the field on projects of their respective departments. Training at the academy will include Islamic and Pakistani studies, management and public administration, economic development, financial management, department rules and regulations, and technical training in engineering (project planning, infrastructural support, and introduction to computers and statistics). Lectures on water resource management will be given as part of the program. Many field trips will also be included.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: As a new and still developing training center, it is unlikely that there will be an opportunity for the ISM Research Project to be involved with the academy to any substantial degree. With an already large number of potential participants, it cannot include others in its training program. However, the project might want to offer assistance with those few sessions related to water management issues.

NORTHWEST FRONTIER PROVINCE UNIVERSITY OF ENGINEERING AND TECHNOLOGY (NWFP UET), PESHAWAR

BACKGROUND: Founded in 1952, NWFP UET became an independent university in 1980. The university has an enrollment of approximately 1100 students. Within the last two years, M.S. programs have been established in both structural and water resources engineering. It was estimated that 80% of the engineers employed by the NWFP PID are graduates of NWFP UET.

OBJECTIVES:

1. To provide undergraduate and post-graduate instruction leading to B.S. and M.S. degrees.

2. To encourage scholarship and character among its students.

3. To conduct research in engineering.

4. To be of service in the solution of community and regional problems.

ORGANIZATION: The university is organized into 6 departments: Civil, Electrical, Mechanical, Agricultural, Mining, and Basic Sciences. Additional supporting facilities are the University workshop, library, scientific instrumentation center and the research cell. The latter encourages and organizes applied research projects. Research is also carried out by individuals in the various departments. PARC is currently supporting one project in Standards and Specifications for watercourses.

STAFF: NWFP UET has a staff of 93, including 4 individuals with Ph.D.'s and 40 at the M.S. level. The largest, the Basic Sciences Department has a staff of 24, followed by Civil Engineering with a staff of 20. Only three of the professional staff, one in Civil Engineering and two in Ag Engineering, have teaching responsibilities in irrigation and drainage.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The workload is primarily directed to teaching with little attention devoted to research. However, with the initiation of the M.S. degree, there will be opportunities for research projects and for possible collaboration with ISM/R. Several of the faculty were familiar with the previous CSU support to water management research and these individuals and others were very interested in potential collaboration.

WAPDA ACADEMY IN TARBELA

OBJECTIVES: The academy was established in 1977 to introduce basic management principles to WAPDA's technical staff. It also provides technical training to WAPDA engineers on special subjects related to water and power engineering from an organization perspective. Last year, the academy was chosen by World Bank to be its regional center in the Middle East and Asia for project management training. Courses for federal and provincial government employees and foreign participants started this fall.

ORGANIZATION: The academy is presently the only training center within WAPDA, although one specifically created for entry level engineers may be opened in the future. WAPDA provides roughly 95% of the support. Its 1984-85 operating budget is 270,000 rupees. The academy is directed by a principal and a professor of management and economics. Its activities in curriculum development and teaching are divided among five units: water, power, finance, training and research, each with a director.

STAFF: To date, the academy has had only 40% of its staff positions filled. A professor of management and economics and a director of training were not recruited until September, 1984. A director of research is unlikely to be hired until his responsibilities have been more carefully defined. Teaching is done by all permanent staff including the principal, although there is a heavy reliance on outside specialists who are local professors and occasional foreign experts.

CURRENT ACTIVITIES: During its seven years of operation, the academy has trained nearly 2,000 senior, middle, and entry level WAPDA engineers. In a recent directive, the Chairman of WAPDA has made promotion across grades for all professional staff contingent upon completion of the academy's management courses. The academy's program for WAPDA engineers and scientists covers five modules: basic management principles in decision-making and leadership, financial management, project management, organizational development and behavior, and WAPDA's own organizational objectives. Two ten-week courses for senior and middle level staff and two five-week courses for new employees will be offered this year. One six-week course in project management will be taught in cooperation with and partly staffed by the World Bank. In addition, special seminars in technical training are offered irregularly.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The academy will not conduct research in water management but appears to be an excellent location for training WAPDA staff, government officials, and others in technical and organizational aspects of water management issues and approaches to research management. Staff of Mona and LIM, both WAPDA institutions, may be trained here to advantage. The academy's principal, Khalil Mohtadullah, has an M.A. in civil engineering and water resource management from the Massachusetts Institute of Technology (M.I.T.) and a received advanced management training at the World Bank and

Harvard. He has been instrumental in holding technical training on water resource management at the academy. A ten-day seminar on river mechanics engineering, to be held in February, 1985, will be given by John F. Kennedy of the Iowa Institute of Hydraulic Research. There is an interest in holding future training courses on groundwater modeling, drainage design, hydrologic analysis, and free surface flow from both technical and organizational perspectives. However, the academy does not have funds to cover the expenses of foreign specialists who will lead these seminars. With the appropriate support, the principal would also like to include research management as an additional, brief module into his training program for WAPDA professionals which would focus on how they might determine areas for research and how research results might be incorporated into implementation programs.

QUAID-I-AZAM UNIVERSITY, DEPARTMENT OF ANTHROPOLOGY

OBJECTIVES: The department was established in 1974 to provide graduate training in anthropological theory in preparation for field research and subsequent employment in government, international and privately-sponsored programs requiring a sociological perspective.

ORGANIZATION: The department, like others in the university, follows a semester system with emphasis placed on class participation, term papers, and tests. It is a radical departure from the widespread pattern of final written examinations.

STAFF: The department is headed by a chairman, Dr. Mohammed Abdel Raoof, who has a Ph.D. in Anthropology from the United States. Other teaching staff include Dr. Doris Nayyar, a German citizen, and M.Sc. graduates. For five years, the Fulbright Commission supplied visiting scholars. It is anticipated that department graduates now working overseas on Ph.D. degrees will soon take up faculty positions.

CURRENT ACTIVITIES: The department has produced 62 M.Sc. graduates, 41 of whom have positions requiring anthropological expertise. At present, there are 21 enrolled students. Fifteen students were selected this year for admission from sixty applicants. All are required to take three semesters of coursework and do six months of rural fieldwork on the basis of which a thesis is written and submitted for approval. The department is financed primarily by the university which provides stipends to students for field research. In the past, the department has undertaken contract research on rural electrification, forestry development, rural-to-urban migration, and women. Students and department graduates have conducted studies with the chairman serving as principal investigator.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: The Department of Anthropology at Quaid-i-Azam University is the only social science department in Pakistan which has integrated actual field research into its program. It is proposed that the department will work jointly with the ISM Research Project on a study of watercourse dynamics. A long-term team member will teach two courses in the department in preparation for students to conduct studies of individual watercourses throughout Pakistan. The research will serve as the basis of their master's theses. A summary volume integrating the findings will be prepared by the department's faculty and the long-term team social scientist. It is anticipated that the department's ethnographic laboratory will be a future focal point of water management research in Pakistan.

CENTER FOR EXCELLENCE IN WATER RESOURCES ENGINEERING

OBJECTIVES: The Center was established to provide teaching and research, promote co-operation in interdisciplinary relationships with other organizations, and arrange conferences, seminars and courses for training of water resources personnel. Two year Master of Philosophy degrees in water resources management and hydrology are offered and a Doctor of Philosophy can be obtained without additional course work by submission of an acceptable dissertation. Agreements with WAPDA and other GOP agencies allow employees educational leave with pay to attend the courses.

ORGANIZATION: The center was established by the GOP in 1976 to provide training of water resources experts. Facilities are located at the University of Engineering and Technology in Lahore. The Center is separate from the University in that it is governed by an 11 member Board of Governors with the Vice Chancellor of the University of Engineering and Technology as the Chairman. The Director is responsible for academic affairs, and carrying out objectives of the Center within the policies and budget established by the Board. Funding is through the University Grants Commission but it is academically linked with the University.

STAFF: There are 10 faculty positions including 4 Ph.D. and 3 M.Sc. in various disciplines including hydrology, water resources, groundwater hydrology, soil science, and irrigation and drainage. There are no resource economists or social scientists although some research in socio-economic aspects of water management have been cited. Fourteen (14) visiting faculty are listed, primarily from WAPDA, NESPAK, and other GOP agencies.

CURRENT ACTIVITIES: The center has conducted short courses and international seminars in water resources and irrigation and drainage and has provided assistance to GOP agencies on groundwater modeling in the SCARP -1 area , sprinkler irrigation feasibility and micro-hydro development. A project on conjunctive use of surface and groundwater for orchards in Baluchistan was begun in 1983. Currently, the hydraulics laboratory with new equipment is being developed with plans to add additional curriculum in Hydraulics Engineering and Water Resources Engineering.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: There are capable staff at the Center to perform or collaborate on proposed ISM/R programs. Published works indicate competence in various fields. The Director of the Center has indicated a willingness to be involved. The most likely area of involvement would be in training of technicians or engineers through the current programs or special programs funded through ISM/R. Involvement of faculty in specific research programs should be pursued, particularly in the area of groundwater modeling and systems analysis. The Center's close affiliation with WAPDA in their training programs can facilitate cooperation in proposed research programs.

APPLIED ECONOMICS RESEARCH CENTER, UNIVERSITY OF KARACHI (AERC)

OBJECTIVES: The AERC has been designated as a "Centre of Excellence" and plays an important national role in economics education and research. The Centre offers a Master of Applied Science (AAS) degree in cooperation with the Economics Department of the University of Karachi. It conducts applied research on a wide range of economic issues. A significant part of Centre research is agriculture related, both in-house and done under contract to PARC, the Ministry of Agriculture, the Ministry of Planning, the Agricultural Prices Commission, the Agricultural Development Bank, the Sind Planning Commission, The U.N., World Bank and the International Labor Organization.

ORGANIZATION: While the Centre is physically located on the campus of the University of Karachi, it is financially and administratively separate because of its national Centre of Excellence mandate. The Centre received a development grant of Rs. 2 to 2.5 million per year over five years, which ends this year. It receives basic funds of Rs. 3 million annually from the University Grants Commission and the Ministry of Education, along with support funds (for library, etc.) from donor foundations.

STAFFING: The Centre staff consists of about 2 dozen professionals, with 6 Ph.D.'s. Many of the staff hold non-Pakistani post-graduate degrees. The Centre has close ties to the Economics Department at the University of Karachi, with many staffers holding joint appointments in both.

CURRENT ACTIVITIES: Because of its ties to a general economics department, its greater financial resources and staff with many foreign degrees, the Centre takes a broader perspective on water economics issues than is true at the agricultural economics departments at Faisalabad or Tando Jam. They attempt to not only understand the farmer's reaction to economic forces but also to place water projects in the context of overall Pakistan economic development. Centre has some contacts with Faisalabad and Tando Jam, but differences in interests and training restricts cooperation. Centre has an international perspective, with many foreign degrees, foreign visits and visitors, and publication in international journals.

The Centre has recently participated in studies of water pricing, factors affecting the success of water management programs, and the Left Bank Outfall Drain.

A major activity of the Centre is the publishing of a Journal, the Pakistani Journal of Applied Economics, which publishes both foreign and Pakistani papers.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: Clearly the Centre is one of the more talented and active groups of economists in Pakistan. They have had experience in water research, and a useful breadth of perspective. ISM should find ways to take advantage of this expertise. This involvement could at a

minimum mean use of AERC staff as members of research advisory boards, and as collaborators on some of the proposed ISM research, or on additional research projects developed during ISM implementation. It might be especially appropriate to utilize the AERC in in-country training of water management economists. Their broader perspective, and their history of cooperative work with the Agricultural Universities at Faisalabad and Tando Jam should also suit them to play an important role in any economist training activities such as degree programs or short courses.

The Centre library is one of the best economics subject-area libraries in Pakistan, and certainly should be lined to any information dispersion activities under ISM/R.

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS (PIDE)

OBJECTIVES: PIDE conducts policy-related research for the Ministry of Planning and Development. As a "Centre of Excellence," it has also been given a broad mandate to conduct research on general issues in the field of development economics. This research forms the basis of the Institute's internationally refereed journal, The Pakistan Development Review, now in its twenty-third volume. The Institute also provides short-course training in cost-benefit analysis to government officials from different departments. Although not a priority, PIDE has contracted with a number of government agencies and donors to undertake research; these include the Ministries of Finance and Agriculture, the World Bank, and USAID.

ORGANIZATION: Although housed on the campus of Quaid-i-Azam University in Islamabad, PIDE is formally under the Federal Ministry of Planning and Development. Unlike most research institutions in Pakistan, PIDE's activities are largely supported by an endowment of 20 million rupees. With the addition of outside contracts, it is estimated that the yearly operating budget is roughly 8 million rupees.

STAFF: PIDE's senior staff is composed of eleven Ph.D. full-time researchers, all of whom have degrees from foreign universities. Of these, ten are economists and one is a demographer. M.Sc. research assistants, ten of whom also have foreign degrees, are responsible for teaching the short courses.

CURRENT ACTIVITIES: With a large staff of full-time, well-trained researchers, PIDE has a strong economic research capability. Its endowment has enabled it to be relatively independent of outside donors. Most of the research conducted to date has been in-house, supported out of PIDE's own funds and directed towards the publication of articles for its own journal. Providing contributions to The Pakistan Development Review is said to be among the highest priorities for the staff. In the past, PIDE has conducted research in the area of water management. One of PIDE's senior researchers has a particular interest in water management. His publications include studies of the cost of tubewell water, estimates of economic rent from canal irrigation an economic analysis of the level and structure of irrigation water charges.

PIDE appears to have no in-house capacity to conduct sociological research in water management.

POTENTIAL FOR INVOLVEMENT IN WATER MANAGEMENT RESEARCH: There is an interest among some members of PIDE's staff to continue previous research in water costing. Although hesitant at present, they might be encouraged to expand this narrow focus into other areas requiring economic research.

The expertise present at PIDE should, at a minimum, be utilized as members of research advisory boards, as research collaborators, and in programs to train water management economists.

ANNEX D

AN EVALUATION OF THE MONA AND LIM PROJECTS

INTRODUCTION

The ISM Research Definition team was requested to provide AID with an evaluation of the Mona Reclamation Experimental Project (MREP) and the Lower Indus Water Management and Reclamation Research Project (LIM). The objective of this evaluation is to draw conclusions regarding the desirability and extent of AID support of research at these two research stations.

To this end the centers were visited during August 1984 by members of the definition team. Additional consultations were held with Mona and LIM personnel during their trip to the U.S. in September, 1984. In addition the project PC-1's were reviewed by various team members. This annex results from these reviews and evaluations.

BACKGROUND AND CURRENT SITUATION

The Mona Reclamation Experimental Project:

The original objectives of the Mona project were to monitor the effectiveness of the Salinity Control and Reclamation Project (SCARP) tubewell program in lowering the water table, reclaiming salinized and sodic soils, and increasing cropping intensity and yields. Mona was also charged with developing improved water, soil and crop management techniques to enable farmers to effectively use the extra water received from the SCARP wells.

The objective of developing and evaluating types of watercourses to convey more of the water to the field was added when it was found that watercourse losses were excessive. Researchers found that cleaning and maintenance were cost effective means of increasing water deliveries to the field, so a major new objective has been to find ways to motivate farmers to participate actively in watercourse operation and maintenance. Other additional research objectives which have been added over time are to:

1) develop tubewells to skim fresh water off aquifers where deeper waters are saline,

2) determine the extent to which saline waters can be used for crop production, and

3) determine the effect of irrigation method and amount on nitrate fertilizer recovery.

The MREP is headed by a director who reports to the Chief Engineer of the Planning and Investigation Organization in the Water and Power Development Authority (WAPDA), who is responsible to the General Manager, Planning Division. WAPDA is a semi-autono-

mous agency which receives its funds from the Ministry of Water and Power of the GOP.

The Mona project is located within SCARP-II in the Bhalwal and Sargodha areas of the Punjab. MREP's research is conducted in two ways. There is a research farm under operational control of MREP scientists. Here plot type research is conducted as it is on any experiment station. Other MREP research is applied, action-oriented and involves working with farmers on their fields. This research is conducted across 110,000 acres of canal command area where one can find almost any type of delivery pattern, water table situation, farm size, tubewell augmentation or other physical aspect. The physical setup of MREP is ideal for water management research since its area of control is a large "laboratory," a portion of a live irrigation system. It has the drawback of being confined to a specific climatic zone of the Punjab, and to a specific SCARP-augmented canal system. This is the rationale for WAPDA's plans to create other Mona-type research operations in the other provinces.

The present staff includes a director, superintending research officer, executive engineer and senior research officers (SRO's) in soils & reclamation, agricultural economics, agronomy, extension, and hydrology and water management. Each of these SRO's has from 5 to 7 junior research officers. Out of a total present staff of 250, there are 90 professionals (including 1 Ph.D. 18 M.S., and 32 B.S.)

MREP's funding is a line item in WAPDA's budget. This basic funding has been augmented for the past 12 years through USAID support. This additional USAID funding has been directed toward water management research efforts. The project is operated on an average annual research budget of about Rs 10 million. MREP has recently prepared a new PC-1 for USAID funding for the next 5 years since present USAID support is scheduled to end in 1984.

MREP has made, and continues to make significant contributions to improving water management in Pakistan. Its water management section, working cooperatively with its extension section, developed the program in which farmers cleaned and improved their own watercourses, a primary basis for the current OFWM watercourse improvement program.

MREP staff are presently conducting applied research for better utilization of water and related resources to improve crop production and to develop means for extending results to farmers. Mona had an excellent history of collaboration with Colorado State University. A similar relationship could be developed under the ISM research project. WAPDA and Mona administrators seem anxious to have such cooperation begin again.

There appears to have been regression to old research topics and methods since the termination of the CSU collaboration in 1979. This, in some degree, can be attributed to the fact that the program at that time was directed primarily at producing research

results rather than at assistance in building a viable research institution. ISM/R involvement at MREP should place major emphasis on such institution- building.

Mona's staff should be encouraged to develop closer interaction with the water management program at the University of Agriculture at Faisalabad, with the OFWM and Extension programs, and with other research programs elsewhere in Pakistan to assure that Mona's research can help fill real needs, and to draw on a broader base of technical expertise. The ISM project can serve as a vehicle to help develop and reinforce such inter-institutional linkages.

Recent high level GOP policy discussions have aimed at drawing appropriate lines between the research of Mona and other water related research institutions. This seems to point to a policy conclusion that Mona should concentrate more closely on explicitly water management topics and leave non-irrigation research such as variety trials, fertilizer trials and other purely agronomic research to other research organizations.

The Lower Indus Water Management and Reclamation Research Project:

The On-Farm Water Management Program and associated WAPDA monitoring and evaluation teams have collected considerable information on the irrigation water management system in the Lower Indus basin. Based on these data and long-term observations by agronomists and agricultural engineers in the Sind, it was concluded that substantial portions of the water management technology developed under Punjab conditions needs little adaptation to fit the needs of the Lower Indus area. However, many specific differences (in climate, soil, aquifer water quality, farm size, soil texture, labor prices, tenancy percentage, etc.) do require considerable adaption to fit Punjab solutions to Lower Indus problems. Some of these independent variables are sufficiently different (e.g. most of the groundwater in the Lower Indus is brackish, but much of the area should have the benefit of outfall drains within 20 years) to provide radically different research needs and potentials for improvement.

To adapt water management technology developed in the Punjab, to develop improvements of water management technology specific to the Lower Indus, and to develop means for achieving the full potential of these improvements, a Lower Indus research centre similar to Mona was proposed by WAPDA Monitoring and Planning to GOP and CIDA (Canadian International Development Agency). CIDA was positive to the proposal, but suggested a longer term and more cost-intensive development to be financed about 50% from GOP funds. The GOP did not feel they could make such a large investment at that time, so CIDA funding was not implemented.

As a temporary alternative to full implementation of the LIM proposal, WAPDA stationed one research scientist in Hyderabad.

He has been commuting from there to several research plots which he has installed on the fields of farmer cooperators in the vicinity of Tando Adam (about 1 1/2 hours drive north of Hyderabad). This SRO and his assistants are conducting several field studies, including evaluation of irrigation methods (basin vs. furrows and broad beds), and evaluation of brackish groundwater for soil reclamation and growth of crops. They were joined early this spring by an SRO agronomist. The work that has been done is impressive in view of funding limitations and the absence of facilities. Planting cotton on broad beds between furrows shows considerable promise for both increasing yields and saving water when compared to normal flat basin culture and irri- gation. The highly brackish water appears to be doing about as well as canal water in growing cotton this year.

The Tando Adam site originally proposed by CIDA and WAPDA is a picturesque old resthouse on 8 acres of land owned by the Irrigation Department. Its walls have deteriorated badly, having been built partly of katcha (unfired earth bricks) which were covered with cement plaster. It has been used as quarters for some of the field staff, but good drinking water is not available there. This location was selected partially because it is in a SCARP area, and partly on the assumption that the Sind Irrigation Department would agree to relinquish control of the resthouse to WAPDA for such a purpose. Such an agreement on acceptable terms has not yet been reached. Discussions with personnel of WAPDA, LIM, and Agricultural University at Tando Jam led to the conclusion that a better area for this center would be between Hyderabad and Tando Jam. Reasons in favor of this alternative location are:

1) Much better access roads and consequent savings of time for staff and visitors.

2) Better schools for children, so that good professional staff with families could be more easily recruited to the project and be more likely to stay.

3) About 1 1/4 hours closer for consultants, visitors, supervisors, and supplies coming from Karachi or Hyderabad.

4) More accessible for bringing students and staff from the Agriculture and Engineering Universities to observe results of various types of water management and to consult and participate in the research.

5) The SCARP program is scheduled to come to this area soon and a good set of pre-SCARP base data could be obtained against which changes due to the SCARP program could be evaluated.

6) No investment in property or construction has been made at the Tando Adam site, so no fixed investment would be abandoned by such a move.

7) The proposed Sind On-Farm Water Management Training Institute will be in the Tando Jam-Hyderabad area and cooperation between the University, the OFWM Training Center and the proposed Water Management Research Center could be optimized if they were in close proximity.

Often there is a tendency for existing research organizations to protect their turf from intruding organizations such as the proposed WAPDA Lower Indus Water Management and Reclamation Research Project. However, the University, the Extension-Adaptive Research program, and the On-Farm Water Management people contacted all seemed essentially free of such protectionist attitudes. There was a general feeling that research at a station such as LIM would improve water management as an essential step to increasing crop production and making better use of the limited and low quality water supplies.

CONCLUSIONS AND RECOMMENDATIONS

Mona Conclusions and Recommendations

1. We concur with emerging GOP policy that would focus the Mona research mandate more clearly on water management needs, with other agricultural research such as variety trials, fertilizer trials, and mechanization work reverting to other institutions. This implies that ongoing work at Mona needs to develop a much closer and more effective coordination with those other research organizations, universities, and implementation agencies.

2. Partially as a result of promotion of many of its experienced research personnel to administrative positions at other locations, the Mona Reclamation Experimental Project research program needs assistance in planning, conducting, and publishing its research to bring it up to the levels of enthusiasm and productivity achieved in the past. The need for some expatriate assistance will persist until a research evaluation system is developed which recognizes good research and allows good researchers to stay in research and be promoted.

3. Mona is one of the best places to do water management research in Pakistan because of its physical facilities, previous track record in water management research, and unique mission and location which allow it to work directly with farmers to ascertain their needs and solve their problems and have the required control of the water delivery system.

4. The Mona project is sufficiently important to development of the agricultural productivity of Pakistan that it should have strengthened on-site leadership. It is suggested that it be upgraded to the level of an Institute with a Director-General.

5. The research studies proposed in the PC-1 are generally directed toward developing improved water management technology and means for adopting and transferring this technology to farmers to enable them to improve their water management and crop production. The proposed studies form a reasonable starting point for development of a productive research program for the next five years. Evaluation of and suggestions designed to improve some of the studies are presented in a later section of this annex.

6. Training of junior research officers is suggested as a means of strengthening the MREP research capability. Such training, designed to develop specific research capability should be combined with a commitment on the part of the administration to provide an opportunity for those individuals to be promoted while continuing to play an active role

in research. Directorships in research at Mona may be one way to accomplish this need.

7. Any funding of the PC-1 by USAID should support training, equipment, and costs of research that are difficult to fund from WAPDA sources. However, WAPDA should fund salaries of staff and basic operating costs. Otherwise the job security of the staff and long term viability of the research institution are not assured.

8. Unless WAPDA administrators involved with this project participate actively in the development of the arguments needed to justify financial support, they will not fully understand its purpose or objectives, or provide the in-country evaluation needed to assure the continued productivity and strengthening of the MREP.

LIM Conclusions and Recommendations:

1. There are significant specific water management problems in the Lower Indus Basin which cannot be effectively solved by research conducted in the Punjab, but can be addressed at a station such as the one proposed at LIM.

2. It is important that the LIM mandate (like Mona's) be focused specifically on irrigation water management. Other unrelated agronomic or cultural research should be conducted by other institutions in the Sind, but be closely coordinated with the LIM work.

3. Other agencies in the Sind such as the University at Tando Jam and the Extension, Research and On-Farm Water Management Projects of the Agriculture Department feel a need for the Lower Indus Water Management and Reclamation Research Project and would support and work with such a center.

4. There are several good reasons for changing the proposed location of this research center from Tando Adam to the Hyderabad - Tando Jam area. The primary and original reason for locating it at Tando Adam (being within a SCARP area) should apply to the Hyderabad-Tando Jam area within a couple of years, giving enough time to get a pre-SCARP baseline survey of management practices. No permanent facilities or property have been committed to the Tando Adam site.

5. Most of the studies proposed in the PC-1 have potential to significantly improve water management and crop production in the Lower Indus Basin. Specific suggestions regarding the various studies are at the conclusion of this assessment.

6. Various aspects of this project should be coordinated with Mona, PARC, IDFCRC, the University of Agriculture at Tando Jam, the Farm Machinery Institute (NARC) at Islamabad, and

the Research, Extension and On-Farm Water Management units of the Sind Department of Agriculture.

7. The Lower Indus Water Management Reclamation and Research Project should be funded by USAID to the extent of construction of the needed buildings, research equipment and vehicles. WAPDA and the GOP should fund the salaries of the staff. Operating costs might be shared by AID and GOP, with the AID share perhaps being 75% in year 1, declining to none in year 4. Expatriate cooperation and consultation could be furnished through the ISM/R team.

EVALUATION OF AND SUGGESTIONS FOR IMPROVING THE RESEARCH PROPOSED IN THE MONA PC-1

A. Surface Water Management

Study 1: Development and Testing of Watercourse Improvement Techniques

This study is needed. However, the objectives can be achieved by improving only a few farmers branches for experimental purposes and using these results to predict the effects of improving all branches. Improvements of farmers branches should probably be done with only engineering assistance from the MREP, with farmers providing the manual labor. In construction of masonry or plastered sections, a research officer should assure the specified cement-sand mix and adequate mixing. We also suggest that the pipeline study evaluate both concrete and PVC pipe, since both are now manufactured in Pakistan.

Study 2: Monitoring and Evaluation of Improved Watercourses

This evaluation should be expanded to include measurement of the impact of increased water supply on cropping intensity and yields, so that economic benefits can be evaluated. This study should be coordinated, planned and reviewed with the WAPDA monitoring and evaluation cell. Participation in the study by university scientists might also prove constructive.

Study 3: Improvement in the Design of Irrigation Control Structures for Water Use on the Farm/Watercourse Level

To the extent possible, this study should be turned over to, or done in cooperation with the private sector, which is making substantial progress on structure improvement. Specific procedures for objectively evaluating products developed in the private sector should be outlined. Actual assessment could be done in cooperation with the OFWM section of the Agriculture Department.

Study 4: Development, Testing and Evaluation of Various Irrigation Methods by Using Indigenous Material

This study should probably concentrate on surface methods rather than sprinkler methods because the high energy inputs and high equipment costs required for sprinkler systems could not be paid for by current crop values. The surface shaping and furrow results of previous years are highly encouraging and deserve intense study. Cooperation is suggested with the Farm Machinery Institute at NARC and UAF to develop effective implements for making ridges and beds between furrows. It is also suggested that the officer conducting this study contact progressive farmers in the area, some of whom plant cotton on ridges between furrows and obtain some very high yields.

Normally, the cost of adequately filtering water to prevent clogging of trickle irrigation systems is so high that high value crops are needed. However, the combination of clean tubewell water and a low cost bubbler-type trickle system may allow economic feasibility in kino groves. This could be particularly true on sandy lands which are not under canal command, so the farmer pays the full pumping cost of the water. If such locations can be found in the project, there is a good probability that trickle systems could be both physically and economically feasible.

Study 5: Calibration of Irrigation Control Structures and Measuring Devices

The importance of this study is not immediately apparent. It would be strengthened if the reader were explicitly told that the purpose of these calibration and head loss measurements is to provide quantitative data for: head loss of structures to be used in designing water course improvements, reductions in head loss that can be achieved by streamlining structures when available head is limited and calibrations of flumes weirs, orifices and watercourse structures which can be used to estimate flows in water courses to help the farmer improve his water management.

Study 6: Irrigation Scheduling

This term has a connotation in the minds of many scientists that requires flexibility of timing not available in a warabandi. Consequently, it is suggested that this be titled "Irrigation determined by crop water need". Methods to be tested should include both soil moisture monitoring and pan evaporation.

Study 7: Water Balance Studies at Farm Watercourse and Minor Level

This study has no stated objective and consequently is difficult to justify. It could be combined with Study 13.

B. Ground Water Management

Study 8: Skimming Wells

Other types of gallery collectors (e.g. a horizontal collector below the water table) would be better "skimming wells" than these multiple vertical wells. Consequently, the possibility of studying response of additional types of collectors should be included.

Study 9: Fractional Wells

The term "fractional wells" is used to describe small wells producing only a fraction of a cubic foot of water per second. The objectives of this study should explicitly include evaluation of increases in crop production due to the water supplied

by these small wells. This study should be linked to Study 8, since these fractional wells could be good skimming wells.

Study 10: Solar Powered Micro Pumps for Low Lift Irrigation

An economic evaluation should be conducted on these pumps, including their costs and the benefits derived. Perhaps this could be done now, based on cost and performance for the pump to date. These extremely low capacity pumps could also work well as skimming wells and could be linked to Study 8.

Study 11: Preventive Maintenance of Tubewells

Although it can be inferred from the PC-1, it would be good to state explicitly that the specific causes of failure and means for anticipating and/or avoiding them will be determined.

Do the authors of this proposal know what the primary causes for past failures have been? Provincial Irrigation Department data could help estimate this. Such information could get researchers off to a good start on this study.

Study 12: Compound Wells for Controlling Saline-Fresh Water Interface

The system is amenable to computer modeling to simulate system performance and produce benefit and cost analyses. Since microcomputers and training to use them will be available within the next few years, it is suggested that this study be shelved, and that the personnel and fiscal resources be concentrated on the other studies proposed.

Study 13: Conjunctive Use of Surface and Ground Water

As stated under Study 7, these two studies should be combined, since complete water budgets are planned for each. Intensive involvement of the extension unit to gain needed information and cooperation of the farmers is vital to this study. Computer facilities would facilitate these studies. The computer facilities and training proposed for study 19 could be utilized in this study.

C. Surface Drainage Development

Study 14: Tile Drainage
Study 15: Development of Farm Drainage and Re-use of Drainage Water for Crop Production
Study 16: Drainage Development at Watercourse Level

There is some question as to whether Mona should have a full fledged research program on drainage when the Drainage Research Institute of Pakistan (Tando Jam) has a specific mission to study drainage. Justification for research on drainage at Mona could be strengthened by recognizing the DRIP program and its activities and objectives, and pointing out how the Mona drainage

program would address objectives not being addressed by DRIP activities. Re-use of the drainage water is an aspect of drainage that is related to Mona's overall water management interests. The surface drains in the Mona Project area are carrying water that is often relatively good quality. A survey c. the quality of water in those drains would provide a good basis for further study in this subject area. At many locations along those drains there are large acreages of uncultivated lands. Reasons for those lands being uncultivated should be determined (i.e. little water reaching them because they are at the tail end of their respective watercourses, water table too high to grow economic crops, etc.). Means for putting those lands into cultivation should be discussed with their owners. These could include improved drainage by cooperative cleaning and deepening the main drain. installing tile drainage from the main drains to their fields. Installing shallow wells with pumps in the lower quadrant of the watercourse might provide some lowering of the water table and supplemental water for growing upland crops, etc. Pumping from the main drain in some areas to provide supplemental water for paddy rice and raising the water table might also be discussed. The role of MREP could be technical assistance such as determining: the water table height, surface elevations, permeability of the aquifer near the surface, and salinity of underlying waters and predicting effects of these factors coupled with drains, wells and pumps on the water table and the quantity and quality of water supply. Costs and returns and general long term economics should be a part of such discussions. MREP might consider installation of an electric power line along the drain to facilitate such pumps in return for an agreement by the affected farmers to clean and maintain the drain at a given level, and install some of these water table control measures.

General condition of those open drains and amount of maintenance required could also be considered. Maintaining steep banks of open drains against positive water pressure is a time consuming and never ending task because of continual sloughing. Underground tile drains, running back from the main drains would serve the double purpose of helping keep the water table down for better crop growth and reducing the sloughing of soil into the drain. The underground tile drains, by lowering the water table, would also make more room for good quality monsoon rain water and reduce the amount of surface runoff into the drains - which is another primary source of sediment that clogs drain channels. These factors could be assessed following installation of tile drainage.

Because of the relatively small differences in elevation between the soil surface and the bottoms of the drain channel, tile drains leading into that channel will generally be fairly shallow. While shallow tile drains do not lower the water table as much as deeper drains, they can often be installed by the farmers. This is an important factor which is not being addressed by the DRIP studies. Costs of the systems being studied by DRIP are high (of the order of Rs 10,000/acre) and the

drains are so deep that costly special equipment from outside the country is required for their installation. This leaves little opportunity for the farmers to make major input (especially of their own labor) to the installation of the drains and thereby keep the price down to where drainage is economically feasible.

Of course, drains must increase crop production and have low cost if they are to be a good investment for the country. Crop performance on fields with drains at shallow depths (2 to 4 feet below the surface) and on crop production under the climatic and management conditions which the farmer can supply would be valuable information for Pakistan. This information is not accurately predictable from drainage equations alone. Some studies in the U.S. have shown that over 90% of the yield increase from tile drainage of corn and soybean fields can be achieved with drains at 3 foot depths. It is not certain, but is likely that such shallow drains, accompanied by improved surface drainage can achieve much of the potential increases in crop production that drainage might provide.

If farmers can dig the trench, lay the tile, provide a low cost envelope such as rice straw and cover the tile, the required financing is primarily the cost of the tile. In the U.S., corrugated plastic drain tile (4" diameter) costs less than Rs 6/foot. Current costs of corrugated plastic tile may be higher in Pakistan since it is not yet mass produced for this purpose. Possibilities of using locally produced clay or concrete tile should also be considered. A man-powered extrusion system for forming clay tile is not too expensive and could turn a local brick kiln into a tile factory. Assuming that tile of some kind can eventually be bought for Rs. 6/foot and considering drains spaced 210 feet (one "acre") apart, the tile cost would be about Rs. 1250/acre. Farmers could install the tile just before the monsoon rains (June and early July) when the water tables reach their lowest levels. Temperatures are high at this time, but having one's feet in cool mud in those trenches may make working conditions bearable! The installation might also be phased over time to match labor and capital availability and avoid constraints.

In essence, this drainage research would be designed to see whether utilization of local resources, particularly those readily available to the farmer, can achieve the drainage needed to increase crop yields and achieve benefits substantially greater than costs. Involvement of the farmers and resources available to them is the primary factor differentiating this research from that being done by DRIP. Experience with the watercourse improvement program indicates that involvement of the farmer is a vital factor in achieving benefits in excess of costs.

A substantial involvement of the Mona extension wing would be needed to achieve broad scale involvement of the farmers. For the extension workers to be effective, they will need to learn

about the benefits of drainage by being associated with the project as the agronomists and engineers help the farmers achieve the higher yields attainable under improved practices.

An integrated drainage study of this type which would involve the hydrology, agronomy, extension and economic wings of Mona working with farmers along one of the major drains in the Mona project area could be one of Pakistan's most productive research investments, providing an alternative to the capital, energy, and maintenance intensive SCARP system which is presently providing less than anticipated levels of benefits.

D. Management of Salt Affected Soils and Water

Study 17: Stand Establishment on Salt-Affected Soils

This study could produce valuable guidelines to increase yields when salt affected soils and saline water are the resources available to the farmers.

Study 18: Commercial Use of Gypsum Stones to Improve Irrigation Water Quality (Long Term Trial)

A major portion of gypsum cost is the cost of crushing the stone. The alternative of dissolving the gypsum from stones in the water courses was first proposed and equations were developed at Mona. These equations involve length and breadth of water course required to be filled with stones, depending on stone size and flow rate of water to desired levels of Ca in the irrigation water. While initial results have been encouraging, long term testing is needed to convince government decision makers that this is a viable alternative. Potential savings of crushing costs could be over Rs 50/ton with additional savings possible from reduced application costs.

Study 19: Use of Saline Groundwater for Reclamation of Saline Sodic Soils

This is a worthwhile study, but its utility could be expanded by development of a complementary computer model which could be validated and refined by the results of the proposed field study. Dr. C. W. Robbins at the USDA Snake River Conservation Research Center in Idaho has the basics of such a model. A junior research officer with a B.Sc. in soils could be sent to work with Dr. Robbins and others at the Center to adapt this model to the specific conditions encountered in Pakistan. Computer training is available at either the U of I or CSI in Twin Falls, Idaho. A microcomputer could be provided for the trainee's use while at the SRCRC and could be sent back to Mona with him. The computer capability thus developed could also be utilized on many other aspects of the research program at Mona, such as the salt and water balance studies.

Study 20: Determination of Best Suited Fertilizer and its Dose for Crop Production in Saline/Sodic Irrigation Conditions

The study has merit. One of the crop physiological necessities involved in using saline water is displacement of concentrated salt solution by use of a higher leaching fraction. This greater leaching tends to move nitrogen beyond the reach of the plant roots. However, if the N is applied (as urea or nitrate fertilizers) in small amounts with the irrigation water, plant root systems have a better chance of absorbing the N before it leaves the system. A simple system for metering granular urea into irrigation water can easily be built. It is suggested that one of these systems be built and be used for one treatment of this study to improve nitrogen recovery under the higher leaching required for good crop production when saline waters are used.

Study 21: Salt Balance Studies at Field, Watercourse and Minor Level

This salt balance study could be effectively combined with the water balance studies proposed in Study 7 and could be facilitated by the microcomputer expertise developed under Study 19.

E. Soil Water and Crop Management

Study 22: Nitrogen Use Efficiency Under High Water Table Conditions

This study would be strongly complementary to the proposed drainage studies. Assuming the availability of a system to meter small amounts of granular urea fertilizer into the irrigation water, this means of N application to the soil should be considered as one of the treatments because of its potential for providing the root zone with a more uniform and accessible N supply.

Study 23: Role of Potassium in Regulating Water Economy in Maize Production

Is there any indication in previous data which would lead us to believe that K plays a role in regulating "Water Economy"? We do not know of any and would suggest that, unless the authors knew of some, this study should be trimmed down to a low cost exploratory study.

Study 24: The Effect of Different Depths of Flooding on Rice Production

Do they not have good indications of this at IRRI or at the Rice Research station at Kalaka Shaku in Pakistan? We would suggest close consultation with scientists from those locations before the investment is made in this study.

Study 25: The Effect of Surface Drainage on Wheat Production in High Water Table Areas

This study would be highly complementary to the shallow drains portion of the proposed drainage study. A kharif crop such as maize on somewhat narrower beds would be a logical extension of this study. The power requirements of making such beds might be amortized over additional seasons by using the same beds and just cleaning out the furrow each year. Chemical weed control might be used.

Spring and fall maize might also be tried. Then low cost atrazene could be used for weed control, as proposed in the LIM research.

Study 26: Effect of Pre-sowing Tillage Practices on Water Application, Fertilizer Use Efficiency and Crop Yields

If the deeper tillage actually causes roots to go appreciably deeper, some of the potential benefits may be achieved. This is such a large study (108 plots) requiring such a major investment that we would suggest that first a small preliminary study should be conducted to determine how much effect deep tillage has on rooting depth.

E. Extension of Water and Crop Management

The general objectives of this section are good. However, the extension wing at Mona has the additional opportunity and responsibility of working with the other wings to find out what farmers want to do, what they can do with their own resources, and what they need from the government to help them improve their productive capacity. In water course improvement, the government's input was pucca nuccas and engineering design. In some cases, the farmers may need education, in others furrow making bed shapers, or machines to meter fertilizer into their irrigation water. For drainage, we're not sure what they need or can do for themselves. The engineers and agronomists need the cooperation of the extension agents to develop programs which will help farmers to help themselves. This starts with understanding farmers, appreciating their points of view, incorporating their ideas into the program until they are convinced it is their program, designed to fill their needs. In short, a third objective is to work with farmers and other Mona wings to develop improvement programs that will utilize farmers inputs and fill farmers needs.

Study 27: Motivation of Farmers for Watercourse Improvement

This appears to be a generally good study. We have one question regarding improving all the watercourses: Who will improve the farmers' branches? The farmers who own them should improve them. If all of the farmers are not willing to improve their branches, the benefits of "complete improvement" can still be evaluated based on the branches which are improved.

Study 28: Water Course Cleaning and Maintenance

This study addresses the issue of how to motivate farmers to clean and maintain their water courses. This issue is vital to effective, long term use of katcha water courses.

Study 29: Organization and Evaluation of Water Users Association
Study 30: Irrigation Advisory Services to Farmers

These two studies appear to be directed to strengthening, broadening the scope of, and evaluating water users associations. To obtain statistically significant results, more associations need to be involved.

The equipment library concept could strengthen the water users associations. Additional types of equipment more directly associated with water management might be considered, such as good furrow-bed makers with seeders built in, land levelers, devices to incorporate urea granules into the irrigation water, etc.

The idea of an irrigation advisory service expressed in Study 30 should be further developed with the hydrology and agronomy wings. This could be based on pan evaporation or on soil water content, or both. When water tables are high only soil water content is meaningful.

The basic purposes expressed in studies 29 and 30 are sound. The studies should be developed more fully with the agronomy, hydrology, and agricultural economics wings. Input from the NARC Farm Machinery Institute should be sought on the equipment libraries. Many of the other studies (1-26) are designed to develop and evaluate improved water management guidelines and equipment. This project could be the final stage in evaluating those guidelines and equipment and adapting them to farmers needs. If the guidelines and equipment can substantially increase yields and cropping intensity, they should strengthen the water users associations.

G. Economics of Water and Crop Management

Study 31: Creation of Water User's Associations Matching Socio-Economic Set Up of Punjab Pakistan

This study is similar to Studies 29 and 30. The two wings should integrate the studies and work on them cooperatively. They should also be coordinated with the UAF Shahkot water users study, interchanging ideas, plans, observations, and evaluations at least yearly.

Study 32: Economic Feasibility of Utilizing Solar Energy for Low Lift Irrigation

This economic evaluation should be made, but the close linkage to Study 10 should be recognized. However, the scope should be broadened to include other methods of low lift irrigation and to do this for various crops and other irrigation alternatives (i.e. land that has non-perennial supply or is uncommanded). Costs, feasibilities, and time delays involved in bringing electric power are factors which would strongly affect the benefit/cost ratios.

Study 33: Economic Evaluation of Water Management Research Planned For the Study Period

This study is an essential step in technology development. The study should be conducted under conditions where a typical set of constraints limit other crop production factors and also under conditions where these other constraints are removed. The objective here would be to determine whether the specific technology can be introduced independently, or whether it needs to be introduced as part of a package which might also involve training, credit availability, etc. This study should be closely coordinated with all wings of the project, including extension. Plans and results should be discussed with the OFWM and Extension sections of the Agriculture Department and joint publications and training manuals should be planned.

Evaluation of and Suggestions for Improving
the Research Proposed in the LIM PC-1

A. Soil Management

Study 1: Using Saline Groundwater for Crop Production
Study 2: Use of Saline Groundwater for Growing Salt Tolerant Crops

These two studies are highly relevant to needs of the lower basin. They are similar, the only difference being that in the second, non- tolerant as well as tolerant species are to be grown. Given limitations of time, and the immediate need for means to help farmers use this saline groundwater, these two studies should be combined, concentrating on a few of the most salt tolerant and commercially valuable crops. Cotton has shown sufficient promise at this and other locations to be the primary candidate. A salt tolerant winter crop is also needed to provide a pair whose yields under the most promising economically feasible surface irrigation method (probably broad beds between furrows) could be determined. The variable upon which information is most needed at each salinity level is how much water is needed to keep the salt sufficiently diluted so the osmotic stress will not reduce yields. On the other hand, too much water applied could result in removal of nitrate from the root zone before the roots are able to absorb it. Consequently, time and amount of irrigation will be critical. After successful management practices have been developed for these best candidates, other species could be studied.

Salt tolerance at different growth stages can be different. Dr. Jim Rhoades, of the U.S. Salinity Laboratory has been able to grow excellent cotton crops by using low saltwater during germination and seedling emergence, followed by 4000 ppm or more of salt during latter stages of growth. He could be brought to Pakistan to share his extensive experience and knowledge with this and other research centers.

Study 3: Reclamation of Salt Affected Soils by Using Saline Groundwater

This title should be changed to "Na-Affected" rather than "Salt Affected," since the type of reclamation proposed is specifically removal of sodium from the soil. The purpose of such reclamation is basically to reverse the permeability problems caused by high levels of Na in the soil. Consequently, infiltration rates should be measured prior to, during, and after reclamation to provide the most important assessment of this type of reclamation. This study should be closely coordinated with related work at Mona.

Study 4: Management of Poor Quality Groundwater by Using Chemical Amendments

As in Study 3, the objectives are to lower the amount of sodium absorbed by the soil, increase the amount of calcium absorbed by the soil, and keep infiltration rates at adequately high levels. Consequently, the relevant measure of success of the treatments is the amount of sodium in the soil and the infiltration rate. This study is closely related to Study 7 and to work at Mona.

Study 5: Development of Optimum Management Practices for Using Poor Quality Groundwater

This is a broad catch-all type of study that is not well-defined. Some aspects of it may be valuable. Concentration on one or two of the most promising aspects to the point where they are ready for farmer use, or consolidation of this study with others is suggested.

Study 6: Development of Water Quality Guidelines

While it is true that utility of saline water depends to some degree on site-specific factors, the site-specific factors are secondary in importance. Moreover, the site-specific factors in the Lower Indus are sufficiently close to those in the Punjab that guidelines from the Punjab (Mona) should be adequate for most practical purposes. Conse- quently it is suggested that this study be put near the bottom of the priority list. Mean-while the specific criteria for designing these guidelines should be carefully spelled out and the Mona guidelines should be evaluated based on these specific criteria.

Study 7: Efficiency and Economics of Various Reclamation Methods

The economic analyses contemplated as part of this study would be equally appropriate in Study 4. In fact, the two studies are closely related. Study 4 deals with preventing soil from accumu-lating too much sodium when sodic water is being used. Study 7 deals with removing Na from a soil after it has accumulated appreciably. The basic processes, theory and techniques likely to be most effective are the same. Consequently they should be combined.

The study should include evaluation of reclamation of sodic soils by growing forage crops which produce high levels of carbon dioxide from their decaying roots, which when trapped by surface irrigation produces bicarbonate, solubilizes Ca from calcium carbonate, which helps displace Na from the soil. (Dr. C.W. Robbins from the USDA Snake River Conservation Research Center has studied this method and could serve as a TDY consultant.)

Study 8: Management of Salt Affected Soils by Growing Salt Tolerant Crops

Substantial portions of Studies 4 and 7 are closely related to this study because the plant cannot tell whether the salt comes from the soil or from the water - and in fact, it all came originally from the water. This study could and should be combined with Study 7.

Study 9: Salinity/Fertility Interaction

A substantial number of interactions between fertility and salinity have been investigated by the U.S. Salinity laboratory. Most of these interactions were small. Quantifying the relatively small interactions that are expected between fertility and salinity would be time-consuming and would require carefully controlled conditions which will not be available at this location within the next few years. Consequently, early efforts should concentrate on the other studies where substantial practical payoffs are probable.

Study 10: Management of Reclaimed Land

Variability within plots will be a major factor in this study. Differences of an inch or two in elevation within the plots can tip the balance toward, or away from salt accumulation. Consequently, leveling the plots or monitoring differences in elevation and associating them with salinity trends should be a part of the study.

B. Crop Management

Study 1: Effect of Different Methods of Planting on Crop Yield and Water Use Efficiency

This is an excellent study which has already indicated that planting on beds between furrows can provide substantial yield increases and can decrease water use. Equipment to do this earth shaping can be developed by the Farm Machinery Institute in cooperation with LIM, Mona, and UAF.

An additional suggestion for this study would be to lengthen some of the furrows from the standard 220 feet to 660 feet, leaving a slight grade (i.e. 0.001) on them so that water can get to the bottom end during irrigation. The tail end of part of these long furrows should be provided with an escape channel where monsoon rainwater could drain to lower lying rice fields or drains. Even though rainfall is generally low in the Lower Indus basin, surface drainage of heavy rains is needed about five years out of ten.

Irrigation intake uniformity, yields and time required for tractor operations should be measured on the plots with 220 and 660 foot furrows. LIM personnel should be encouraged to consult with progress- sive farmers who are using furrows and producing high cotton yields.

Study 2: Evaluation of Water Requirements of Major Crops Grown on Soils of Different Water Table Depth

This information is needed by the farmers. However, the results from the Mona studies should be reasonably transferable. In general, studies from other locations show little or no supply of water to the plants when water tables are more than 3.75 meters below the surface. Consequently, the studies should focus on water tables at shallower depths. For instance, information on a depth about 1.5M below the surface is needed to fill the large gap between 0.75 and 2.25 M. Regarding tensions at which water will be applied, it is difficult to distinguish between tensions of 5 and 7 bars. Equivalent water con- tents are often only 1 or 2% different. It is suggested that only 4 irrigation treatments be studied and that they should be "traditional" and 1, 3 and 7 bars.

Study 3: Effects of Different Dates of Sowing on Water Requirements and Yield of Cotton

This study is needed. It should also determine why farmers have been planting cotton late. A primary factor in late cotton planting is probably the time required to prepare the land following harvest of wheat. If this is the case, studies should be conducted on how to decrease the time interval between wheat harvest and cotton planting. One possibility for doing this would be to plant wheat on beds between furrows (as is done in Idaho where yields of over 100 maunds/acre are obtained). Another possibility would be to harvest the grain and straw from these lands and plant cotton immediately without cultivation, into the wheat stubble. Studies at Colorado State University showed much improved cotton germination and emergence at lower temperatures, which may be a factor contributing to the better yields from earlier seeded cotton observed at Mona.

Study 4: Determination of Relation Between the Irrigation Data and the Fertilizer Rate for Different Crops

Many studies conducted on crop water needs in other countries and at Mona have shown that higher fertilization does not increase water needs appreciably. There is a need to find the moisture depletion level which can be allowed before yields are reduced. However, it is suggested that this be done first at a single recommended fertilizer rate with irrigation planned when tensions get to water contents equivalent to 1, 3 and 7 bars. This can cut the size of this study (assuming 3 replications) down from 204 plots to 36 plots which will allow the investigators time to work on other high priority research.

Study 5: Performance and Yield of Soybeans Under Different Crop Rotations

A recent GOP committee recommended that research at Mona be focussed primarily on water management. This recommendation should also hold for LIM. To relate this study to water management, it is suggested that different methods of irrigation be evaluated. In countries where good soybean yields are obtained under irrigation, they are generally grown between furrows. It is likely that they will yield better when planted on the shoulders of furrows than when planted in flat basins. Moreover, there will be some saving of water. Cropping intensity is low in the Sind which indicates that factors other than land are primary constraints to production. Consequently, rotations of two crops per year such as wheat and soybeans should be evaluated. Another reason for leaving rice out of the rotation is that the submerged anaerobic conditions involved with paddy rice will denitrify the nitrate which was left in the ground by the decomposing soybean roots, nodules and residues.

Study 6: Studies into Production Potential of Improved Varieties of Major Crops in SCARP Area

In view of recent decisions to have Mona specialize in water manage- ment research, this variety trial is not appropriate for this center. These trials can be conducted by the Provincial Research and Extension organizations which have been given this responsibility.

Study 7: Selection of Crop Species for Different Levels of Salinity

Suitability of this study for LIM is questionable on the basis that these trials 1) have been conducted extensively elsewhere, 2) have no expressed relationship to water management, and 3) could be done by other research and extension institutes in the Province.

Study 8: Study on Replacement of Rice with Other Suitable Crops

The research that is needed is to identify crops and crop combinations that will more efficiently use Lower Indus Basin water. One other rotation that might be evaluated is maize (Jan. - April) soybean (May-August) and maize (Sept. - Dec.). These could all be planted on beds between furrows with no tillage between crops as discussed in Study 3.

Study 9: Effect of Method of Sowing on Rice Yield
Study 10: Study of Pancho Irrigation System for Rice

Both of these studies are essentially studies of irrigation methods for rice and they could be combined and save considerable duplication.

Study 11: Effect of Irrigation Stress at Different Stages of Growth on the Yield of Major Crops

Study 12: Estimation of Consumptive Use of Water of Major Field Crops

The agronomy department at the University of Agriculture, Tando Jam has done extensive work in both of these areas. This work should be studied to determine whether studies 11 and 12 are needed at this time. If studies 11 and 12 are undertaken, the University should be a cooperator in the study.

C. Water Management

Study 1: Watercourse Improvement and Management

This study is needed. The Agricultural Engineering Department at the University should be asked to cooperate on it. Identifying improved management and cleaning methods and schedules in this study will be helpful in Study 7.

Study 2: Seasonal Irrigation Efficiency

This study to evaluate delivery and application efficiencies throughout the year could be even more productive if some measure of potential evapotranspiration (e.g. pan evaporation) were measured throughout the year. In the Lower Indus Basin where many crops can be grown during a wide range of seasons, and evapotranspiration is different in the different seasons, it may be possible to shift crops into lower ET seasons and increase cropping intensity.

Study 3: Development and Evaluation of Irrigation Methods

This study is needed. There is some question as to whether particulate matter in water supplies can be removed sufficiently to keep the small orifices normally used in trickle systems from plugging. The bubbler type distribution system developed by Steve Rawlins, (Agricultural Research Service, USDA), uses larger orifices which do not plug as easily. It is especially adapted to tree crops which appear to be on the increase in the Hyderabad area.

Low rates of supply and need of the trickle systems for clean, well water may make this part of the study a good complement to the skimming well study (Study 6).

Any trickle research undertaken at LIM should be coordinated with the many related projects now underway in Pakistan.

The study of longer, slightly sloped furrows suggested in Study 1 (Crop Management) might be complementary to the studies proposed in this section. Availability of larger land holdings in the Sind and a higher proportion of tractor cultivation makes these long runs more applicable.

Study 4: Precision Land Leveling

Significant benefits derived from land leveling or "planing" are indicated by previous studies at Mona. However, they need to be carefully quantified and documented so they can be demonstrated to the farmers in the Lower Indus basin to motivate farmers to make the investment necessary to achieve the benefits.

Evaluating improved fertilizer efficiency should definitely be a part of this study and should be carefully planned. Nitrate is the fertilizer component that generally slips away with percolating water and it should be followed to document the extent to which this is happening. Work is being done on this at the Snake River Conservation Research Center in Idaho and a training/study tour by a JRO may allow him to learn how to utilize the research tools needed which as nitrate electrodes, microkjeldal analyses, sampling procedures, etc. Farmers' investments in fertilizer are often large (Rs. 250 to 300 per acre) and the cost of land planing may be returned in terms of better fertilizer efficiency alone!

Since it is likely that furrow irrigation will prove to be a profitable alternative to basin irrigation, planing followed by furrow irrigation should be one treatment evaluated by this study.

Study 5: Ground Water Management

An additional groundwater management matter that should be considered in this study is the benefit that might be derived from delivering slightly saline tubewell water separately rather than mixing it with the canal water. The ability of different crops to tolerate salinity varies from citrus which is damaged by small amounts of chloride to cotton which can take as much as 4000 ppm salt. Tolerance also varies by crop variety and stage of maturity. Many citrus growers in the Punjab who are served by SCARP wells that pump slightly saline water have the tubewell operators turn off the wells during their Warabandi turn because they believe their citrus is damaged by the well water. Since some crops are damaged by saline water and some are not, it is certain that some yield increases could be achieved by keeping the tubewell water separate from the canal water. Additional investment would be required for such a dual delivery system. The clean but slightly saline tubewell water might be piped underground to the main junctions of the watercourse. Since the pipeline would lose essentially no water, the farmers could be allowed to trade Warabandi turns on their tubewell supply and use their water mixed or unmixed depending on their crop needs. Yields could be determined and related to the quality of water delivered.

Study 6: Development of Low Discharge Shallow Wells for Skimming Fresh Water

This objective is highly appropriate for the Sind. However, theory tells us that the most effective well for skimming would be a horizontal bore below the level of the lowest water table. Could such wells be bored from a cased dug well (that is, dug at the same time the cylindrical brick and mortar casing is constructed on a reinforced concrete base, that settles as soil is dug away around the bottom of the casing? The technology for installing cased dug wells is available in Pakistan. One was installed at Mona.) High pressure jetting equipment could be used to push pipes out horizontally from near the bottom of the well. Development of this technology would require some ingenuity and perhaps collaboration of persons acquainted with jetting equipment, etc. However, it could produce a much better skimming well than the shallow vertical wells which have been tried to date. Such skimming wells, if they can be developed, allow much better separation and broader use of the thin layer of nonsaline water which normally overlies most of the deeper saline water. Technology to produce shallow horizontal wells at a reasonable costs could be worth many crore of rupees to the agriculture of the Indus Basin.

Study 7: Role of Water User's Association in Adoption of Improved Farm Technology

This study addresses the need for a payoff on the investment in research and proposes research to find ways to enable the executive committees of the water users associations to get the farmers organized to utilize good investment opportunities that have been identified by research, such as cleaning and maintaining their water courses, and to play a direct role in other group improvement programs such as cooperative purchase of quality seed, fertilizer, equipment, etc. To gain stature to effectively play this role, the committee needs to be involved in a series of successes. The LIM research should aim to produce packaged successes. For instance, if shaping furrows and beds and seeding in the beds and irrigating in the furrows pays higher returns and saves water, improved bed shaper-seeders that are compatible with draft power available in the villages should be made available to the executive committee of the water users associations for testing under their direction. Assuming that the test goes well, the shaper-seeder could then be made available to the executive committee at cost, or on credit, and they could regain the purchase price and maintain the equipment by loaning it to members of their association.

Another example may be the utilization of irrigation water to carry urea to where it will do the most good on the root zone of crops. If significantly higher yields are obtained, the instruments which apply fertilizer to the flowing water could also be manufactured and pro- vided to the water users associations, and could be used in turn by each water user in his warabandi turn.

Economic Studies

Since there is no economist proposed for the project, the scope of Economic Studies proposed appears to be excessively broad. However, this view may be due to not knowing what commitments this project has to WAPDA to monitor physical, biological, economic and sociological effects of the SCARP well program. Perhaps it would be possible to utilize economic expertise now available or that could be developed at the Agricultural University at Tando Jam and at the Applied Economics Research Institute at Karachi.

ANNEX E

EQUIPMENT LIST
WATER MANAGEMENT RESEARCH PROGRAM

ITEM CLASS	UNIT COST	RESEARCH COMPONENT 1	2	3	4	5	6	7	8	9	10	TOTAL UNITS	TOTAL COST
VEHICLES													
Sedan(Toyota)	8500						2					2	17000
Land Cruiser 4wd(Toyota)	12000	3			2	1	1		1	2		10	120000
Pickup	10000		2					1				3	30000
Van(15 Passenger)	12000						1					1	12000
Jeep (4wd)	5000		2			1		1				4	20000
Motor bikes	750		6			2		5		2		15	11250
Shop tools and spare parts	3000		1		1	1			1	1		5	15000

													225250
COMPUTERS (PC TYPE)													
Personal Computer (512kb)	6500	5	2	4	1	1	1		1	1	4	20	130000
Portable personal computer	4000	2										2	8000
Volt. Regulator w/battery	700	5	2	4	1	1	1		1	1	4	20	14000
Monitor	400	5	2	4	1	1	1		1	1	4	20	8000
Printer (dot matrix)	650	4	2	4	1	1	1		1	1	4	19	12350
Printer (impact let. qual.)	900	1									4	5	4500
Plotter x-y type	1200					1				1		2	2400
Memory upgrade	1100	5		4	1	1				1		12	13200
Software (DOS, W. p. etc.)	2000	5	2	4	1	1	1		1	1	4	20	40000
Spare Parts	1000	5		4	1	1	1		1	1	4	18	18000
Tool Kit	200	2		4	1	1	1		1	1	4	15	3000

													253450
FIELD EQUIPMENT													
Current meter(manual read)	750		1									1	750
Current meter(LED readout)	1500	2			2			4				8	12000
Flumes (Parshall et al)	900	6	2		1	2		4		3		18	16200
Pipe flow meter	650	2			1	2		1				6	3900
Engr. level w/rod, tripod	1000	1	1		1	1	1	2		2		9	9000
Engr. transit w/tripod	1000	1			1		1	1		2		6	6000
Steel tape	400	2	1		1	1	1	2		1		9	3600
Water stage recorder	2000	10	3		4	6		6		6		35	70000
Recorder charts	400	2	1		1	1		1		1		7	2800
Elec. well sounder	350	2			2	1						5	1750
Downhole TV camera	6000					1						1	6000
Downhole vert. vel. meter	800					1						1	800
Piezometer jetting appar.	1500					1				1		2	3000
Piezometer driving appar.	1000					1				1		2	2000
Soil auger	50	1			2							3	150
Pump,portable centrifugal	1500					3				1		4	6000
Portable sprinkler system	5000		3									3	15000
Tool kit	300	2			1	1		1		1		6	1800
Tractor(med)	25000		2					1				3	75000
Tillage Equip.	10000		1									1	10000
Sed. samp., infilt. equip.	1500				1							1	1500

													247250

METEROLOGICAL EQUIPMENT													
Rain gage(Std. USWS)	240		3									3	720
Rain gage(recording)	360				2						5	7	2520
Psychrometer(recording)	200		3									3	600
Evap. pan(w/ gage & well)	625		3		2							5	3125
Net radiometer(Fritschen)	600		3									3	1800
Hygrothermograph(recording)	700		3									3	2100
Sunshine recorder	1000		3									3	3000
Anemometer, integrating	600		3									3	1800
Chart and spare parts	200		3									3	600
w/probes and recorder)	6500	2										2	13000
Spare parts for station	1200	2										2	2400
Eprom or tape reader	2000	1										1	2000
Thermometers,psychrometers	600	1	3		2							6	3600
Enclosure,std. U.S.W.S.	400	1	3		2							6	2400

													39665
LABORATORY EQUIPMENT													
pH meter	600	1	4			1				1		7	4200
Flame photometer	2000	1										1	2000
Nitrate electrode	350	2	6									8	2800
Elec. Conductivity meter	1000	2	4							2		8	8000
Sed. filtration apparatus	800				1							1	800
Soil seive set w/shaker	1000				1							1	1000
Glassware	1000		1		1							2	2000
Digester unit	700		2									2	1400
Gas analyzer	150		3									3	450
Microkjeldal unit	1250		2									2	2500
Gas standard samples	20		15									15	300
Misc. and spare parts	5800		1									1	5800

													31250
OFFICE EQUIPMENT													
Photocopier	6000	1			1		1	1			3	7	42000
Overhead projector	300						1	1			2	4	1200
Camera 35 mm	800	1			1	1	1	1	1	1		7	5600
Projector 35mm	550	1			1	1	2	1	1	1	1	9	4950
Movie camera 16mm	500								1			1	500
Movie Proj. 16mm	1200						1		1			2	2400
Projection screen	150	1			1			1	1			4	600
B&W Darkroom equipment	3000								1			1	3000
Field taping units	200								5			5	1000
VHS video system and tape	2000								1			1	2000
Film ,tape storage cabinet	100								10			10	1000
Programmable calculators	200								10			10	2000
Flip chart-chalk board	100	1			1							2	200
Drafting or printing equip.	1000	1			2		1		1			5	5000
Transformer	150	2	2		1	1			2	1		9	1350
Safe	1500						1					1	1500

													74300

LIBRARY EQUIPMENT

Microfilm/microfiche reader	450	3	3	1350
Portable microfiche reader	250	6	6	1500
Microformat reader/printer	3000	3	3	9000
Catalog card duplicators	1000	11	11	11000
Air conditioners	1100	6	6	6600
Vacuum cleaner	200	1	1	200
Microform storage cabinet	1200	1	1	1200
Card catalog(60 tray)	1800	1	1	1800
Journal display rack	300	1	1	300
Numbering machine	150	1	1	150
Cardex,guides,boxes	800	1	1	800
Microfilm camera	15000	1	1	15000
Microfiche duplicator	5000	1	1	5000
IBM mag card composer	5000	1	1	5000
Electric typewriters	1000	2	2	2000
Stencil machine	3000	1	1	3000
Thermal binding machine	700	1	1	700
Ring binding punch	330	1	1	330
Punching/stapling machine	210	1	1	210
Mini-offset press & scanner	15000	1	1	15000
Functional color darkroom	5000	1	1	5000
Commercial video studio	40000	1	1	40000

				125140
				========

PROJECT TOTAL W/O VEHICLES	771055
UNSPECIFIED EQUIPMENT	200000
PROCUREMENT COSTS(5%)	48553
PACKING/FREIGHT(5%)	48553
TOTAL COSTS W/O VEHICLES	1068161
VEHICLE COST	225250
PROJECT TOTAL W/VEHICLES	1293411

NOTE: COLUMN HEADINGS

1. Groundwater-surface models
2. Farm water management
3. Beyond water course improvement
4. Irrigation systems out of Indus
5. Tubewell technology
6. In-country office
7. Integrated watercourse management
8. Encouraging water users
9. Drainage
10. Information management

EQUIPMENT LIST
IN-COUNTRY OFFICE

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
VEHICLES			
Sedan(Toyota)	8,500	2	17,000
Land Cruiser 4wd(Toyota)	12,000	1	12,000
Van(15 Passenger)	12,000	1	12,000
			41,000
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	1	6,500
Volt. Regulator w/battery	700	1	700
Monitor	400	1	400
Printer (dot matrix)	650	1	650
Software (DOS, W. P. etc.)	2000	1	2,000
Spare Parts	1000	1	1,000
Tool Kit	200	1	200
			11,450
FIELD EQUIPMENT			
Engr. level w/rod, tripod	1000	1	1,000
Engr. transit w/tripod	1000	1	1,000
Steel tape	400	1	400
			2,400
OFFICE EQUIPMENT			
Photocopier	6000	1	6,000
Overhead projector	300	1	300
Camera 35 mm	800	1	800
Projector 35mm	550	2	1,100
Movie Proj. 16mm	1200	1	1,200
Drafting or printing equip.	1000	1	1,000
Safe	1500	1	1,500
			11,900
OFFICE/HOUSEHOLD EQUIPMENT			
Household appliances and equipment, furniture,rugs, office equipment, furniture and vehicles			230,000
			230,000

PROJECT TOTAL W/O VEHICLES	255750
PROCUREMENT COSTS(5%)	1288
PACKING/FREIGHT(5%)	1288
TOTAL COSTS W/O VEHICLES	258325
VEHICLE COST	41000
PROJECT TOTAL W/VEHICLES	299325

Note: procurement and packing/freight charges not applied to office and household equipment.

ANNEX F

LONG-TERM AND SHORT-TERM TEAM COMPOSITION

ANNEX F

THE LONG AND SHORT-TERM TEAM

Introduction

This Program in water management will require a wide variety of specialists working in water management including agricultural and irrigation engineers, hydrologists, irrigation agronomists, extension specialists, and social scientists. Institution-building activities in training, the creation of a competitive grants program and research management will draw upon many of these experts while they are on assignment in Pakistan and will provide additional expertise in information management. They will be recruited largely from the staffs of the University of Idaho, Washington State University, and Development Alternatives, Inc. which jointly have most of the expertise required by the program.

1. Long-Term Team Requirements

The long-term team will be composed of a small number of core members including the Chief-of-Party, Social Scientist, Research Program Specialist, Irrigation Agronomist, and Groundwater Modeler. The Chief-of-Party will have primary responsibility for implementing the program. The remaining core team members represent area specialities which the Research Definition Team identified as requiring intensive assistance in order for the research program to be properly developed and implemented. They indicate areas in which Pakistani research efforts have been noticably weak. Long-term team members in social science, irrigation agronomy, and groundwater modeling will directly strengthen the Pakistani research institutions and enable them to have a self-sustaining capacity in these areas. Certainly, additional responsibility falls on the long-term team members to improve and institutionalize these areas in the Pakistani research system. Detailed scopes of work follow for each of these four long-term positions.

SCOPE OF WORK

CHIEF-OF-PARTY

The Chief-of-Party, stationed in Lahore, has the primary responsibility to implement the program in the field, and he is leader of the field team. He is responsible for the management of the field office, the field program and the personnel associated with both. He will provide official liaison on matters relating to the field program between the contractor and USAID, the Government of Pakistan, and other institutions and contractors dealing with irrigation management in Pakistan.

Detailed Responsibilities and Duties

1. Provide technical input on all projects where his experience and expertise are relevant.

2. Assist with development of needed project agreements between the Governments of Pakistan and the United States.

3. Establish methodology and maintain detailed records on all field activities so that projects and programs can be carefully and critically analyzed regarding expenditures of funds, time and effort.

4. Responsible for preparation of:

   - annual budgets for field program

   - all field reports

   - the annual report

   - technical reports

   - special statements/analyses requested by USAID and/or GOP

5. Responsible for the performance evaluations of all personnel stationed in the field and with the field performance of the short-term assistants.

6. Make continued and special effort to maintain open communication and understanding between the field party and USAID, the GOP, and the campus coordinator.

7. Assist with review, assessment and/or redesign of the various components of the program.

8. Assist with training programs, lectures, seminars and workshops in areas of expertise and experience.

9. Be concerned with and provide assistance to all field staff and their families regarding their personal needs and comforts.

Qualifications

1. Ph.D. in an area related to irrigation management.

2. Minimum of 15 years work experience in irrigation, including

   - experience working in a developing country,

   - working in arid zone agriculture where salinity, alkalinity and waterlogging are common,

   - in charge of a group of professionals, and

   - at least some short-term experience in Asia agriculture (preferably the sub-continent).

3. Familiarity and experience with USAID program methodologies and administration; having either served under a previous AID contract or worked directly in AID.

4. Work experience at a land grant university (at least 2 years). Have a thorough understanding of the makeup of a university, its administration and its procedures (financial, personnel, purchasing, etc.)

5. Experience with interdisciplinary team work.

6. Experience in conducting and/or administrating agricultural research.

SCOPE OF WORK

SOCIAL SCIENTIST

The team's long-term social scientist will be primarily responsible for working with local investigators conducting research on the sociological aspects of water management. S/He will take part in the training and research management activities of the project and provide technical assistance to engineers and agronomists on how to integrate a social science perspective into their studies. As a core team member, he will perform administrative duties as required by the team leader.

Detailed Responsibilities

1. Provide lead technical assistance to the three projects in the Encouraging Water User Involvement in Better Water Management series. The social scientist will recruit Pakistani investigators and work with them in designing and testing research instruments and will make regular trips to research sites during data-collection.

2. Teach courses to graduate students in social theory and methodology in the Department of Anthropology at Quaid-i-Azam University in preparation for their case studies of watercourses. S/he will work with a field supervisor in selecting research sites and directing data-collection, analysis, and writing. S/he will serve as a member of the department's committee which reviews the theses. S/he will prepare with the faculty of the Department of Anthropology a series of comparative, analytical volumes on the dynamics of watercourse organization based on the case studies.

3. Work with principal investigators in the preparation of technical reports based on the designated research projects, ensuring their relevance to next users of the findings.

4. Collaborate with researchers on other ISM/R-funded projects in order to provide an interdisciplinary approach. He will be expected to contribute to the Irrigation Systems Outside the Indus Basin, the Surface Drainage and Water Table Control and the Tubewell Performance projects by assisting in their design and supplying data.

5. Work with researchers and extension specialists in "action research" programs as presented in the Integrated Watercourse Management project.

6. Identify needs for additional sociological research in water management and encourage the participation of social scientists in universities and research institutions.

7. Assist in the recruitment and supervision of short-term technical assistance team members who will participate in the Encouraging Water User Involvement projects.

8. Review and evaluate proposals in the field of social sciences submitted for funding in the competitive grants program. Assist proposers in re-drafting them as required.

9. Identify training needs for social scientists and help select participants in training programs.

10. Train and supervise the activities of a Pakistani social science research associate who will be a member of the core team.

11. Conduct and attend workshops, seminars, and conferences organized by the Project.

12. Write and present technical reports and conference papers.

13. Take the initial lead in preparing a water management newsletter which will outline project activities and other work in water management in Pakistan.

14. Review project technical reports preceding their distribution.

15. Participate in the socio-economic monitoring and evaluation of on-farm water management interventions by other projects as directed by the Chief-of-Party.

16. Perform administrative duties as required.

Location:	Lahore, with frequent visits throughout Pakistan
Time and Duration:	To begin in March, 1985 for a period of 48 months

Qualifications:

1. Ph.D. in anthropology or rural sociology.

2. Experience in designing and administering applied social science programs and conducting field research in developing nations.

4. A record of collaborative research with a technical assistance and with host-country professionals

5. Although a knowledge of Urdu is not a prerequisite, the social scientist must be willing to learn the language for field research.

SCOPE OF WORK

RESEARCH PROGRAM SPECIALIST

The Research Program Specialist will have primary responsibility for development and administration of the competitive grants program and for seminars, workshops and other activities connected with research management. The Specialist will be expected to make technical contributions to the Program in his/her field of specialization. He/she will work as a member of an interdisciplinary team under the direction of the Chief-of-Party.

Detailed Responsibilities

1. To have lead responsibility for development and administration of the competitive grants program. This will include development of program criteria, preparation of announcements, contact with the research community for purpose of informing them about the program, conduct of workshops, assistance in preparation of proposals, liaison with other team members to facilitate proposal preparation with Pakistani researchers, and review and evaluation of proposals.

2. To work with IDFCRC in administration of the grants program and toward development of the Council's ability to sustain a grants program in water management after contract termination.

3. To have lead responsibility for coordinating the information management portion of the Program including liaison with IDFCRC, newsletter preparation, and arrangements for TDY personnel for the documentation/library activity.

4. To assist the team leader in coordination of all in-country training activities, including seminars, workshops, exchanges, field days, and to assist in coordination for participant training.

5. To assist the team leader in carrying out administrative duties as required.

6. Depending upon the technical background of the Specialist, to assist in project implementation and in the development and implementation of potential research projects.

Location: Lahore or Islamabad, with frequent travel throughout Pakistan

Timing and Duration: To begin July 1985 for a period of 36 months

Qualifications:

1. Ph.D. in agriculture, engineering, the social sciences, or the equivalent.

2. A minimum of ten years experience in development of research proposals, conduct of research, and management/administration of research programs. Experience in water-related research is preferred.

3. Previous residency overseas working with research programs. Ample short-term experience may be substituted for the residency requirement.

4. An ability to work both within and outside his/her technical specialty in developing wide-ranging research projects with host-country professionals.

5. An ability to work with an interdisciplinary technical assistance team and with host-country professionals.

SCOPE OF WORK

IRRIGATION AGRONOMIST

The irrigation agronomist will have the primary responsibilities for providing technical assistance to Pakistani professionals engaged in agronomic and irrigation research, and will make contributions to training, technology transfer, and research management components of the project. Thus, the irrigation agronomist will provide technical assistance leadership to specific interdisciplinary tasks as well as supply technical assistance input in irrigation and agronomy to all project components and at all sites. He will work as a member of an interdisciplinary team under the direction of the Chief-of-Party and will also assist in performing administrative duties as required.

Detailed Responsibilities

1. To have lead technical assistance responsibilities for the Farm Water Management (FWM) series of projects. The irrigation agronomist will make periodic visits to sites such as Mona, LIM, UAF, PARC and others, to review field experimentation in progress and to interact and collaborate with Pakistani researchers having primary responsibility for the FWM projects.

2. To work with researchers and the afore-named institutions and others in the planning, design, conduct, and analysis of water management research.

3. To collaborate with other technical assistance staff and Pakistani researchers on other projects funded under ISM/R, providing agronomic and irrigation technical assistance as required on these projects. For example, this will include contributions to the Small Scale Irrigation Systems Outside of the Indus Basin project, the the Encouraging Water User Involvement project, to the Surface Drainage and Water Table Control Project, and to others.

4. To work with researchers and extensionists on Farming Systems Research and Extension (FSRE) trials and demonstrations (adaptive research), and to assist them in all other technology transfer efforts designed to bring research-generated results into use by farmers.

5. To assist in preparing irrigation agronomy technical materials for technology transfer and training components.

6. To review and evaluate proposals for technical merit that are presented to ISM/R for funding.

7. To help select Pakistani researchers for further training.

8. To help conduct and to attend seminars and workshops as required.

9. To write specific technical reports and to contribute periodic reports on project progress to the team leader.

10. To assist the team leader in carrying out administrative duties as required.

Location:	Lahore, with frequent visits throughout Pakistan
Timing and Duration:	To begin approximately January, 1985 for a period of 36 months

Qualifications:

1. Ph.D. in agronomy or agricultural engineering, or the equivalent.

2. A minimum of five years professional work experience in irrigation agronomy beyond the Ph.D.

3. A minimum of five years previous professional residency overseas.

4. Experience with both arid-zone and humid-tropical crop production and irrigation techniques, preferably in working with small-holders. The candidate should have had previous experience with rice, wheat, maize, or cotton production.

5. An ability to work with an interdisciplinary technical assistance team, and with host country professionals.

SCOPE OF WORK

HYDROLOGIST

The hydrologist will have resonsibility for in-country supervision of groundwater and surface water-related research projects conducted under the ISM/R Project. Primary responsibility will be for technical conduct of the groundwater-surface water modeling project as well as training, information dissemination, technical liaison with government research units and support for other components of the total project. He will be a member of the Groundwater Systems Analysis Advisory Group to assure timely communication of the results and the status of ISM/R hydrologic research with all research entities.

Specific Responsibilities

1. Responsibility for technical management of the project on groundwater-surface water models to include training and supervision of three research teams for data collection, data analysis and computer model development. Provide detailed guidance and supervision on field procedures for collection of groundwater and surface water parameter measurement.

2. Provide assistance to technical teams and research management personnel on data management procedures for hydrologic data storage, retrieval and analysis.

3. Provide technical assistance to other Pakistani researchers and other technical assistance staff on planned and future projects under ISM/R. Technical assistance on the projects on tubewell rehabilitation, small-scale irrigation systems outside the Indus Basin, and drainage systems will be furnished by the hydrologist.

4. Assist with preparation of materials for formal training programs, conduct of seminars and workshops, selection of Pakistani researchers for training and technology transfer efforts.

5. Review research proposals submitted under the competitive grants program.

6. Prepare technical progress reports, papers for technical journals and training material as required.

7. Assist the Chief-of-Party in administration of projects as required.

Location:	Lahore	
Timing and Duration:	Begin:	June, 1985
	Terminate:	April, 1989
	Duration:	47 months

Qualifications:

1. Ph.D. in water resources, hydrology or equivalent.

2. Extended research experience in water resources systems modeling with emphasis on groundwater flow models. The individual should have actual experience with micro, mini and mainframe computers and be competent in FORTRAN and BASIC programming.

3. Experience in hydrologic data management systems.

4. Good communication skills and ability to work with other team members of other disciplines and with host-country professionals.

2. Short-Term Consultant Requirements

Consultants on TDY will support the long-term technical assistance team which cannot itself provide all the research and training inputs required by the program to improve Pakistan"s research capacity on water management. All of the designated water management research projects and many of the proposed institution-building activities require the participation of short-term specialists. Just as the long-term team provides continuity to the implementation effort, short-term technical assistance will be provided by a core team of advisors who will be expected to make regular visits to Pakistan to take part in research projects and training activities. Continuity in staffing enhances the program's implementation by fostering close and continuing professional relationships between Pakistani and foreign researchers. The proposed level of short-term consultant input in the Program is as follows:

Component	Short Term Specialty	Man-Months
A. Research Management		
1. Farm Water Management	Irrigation Agronomy	12
2. Integrated Watercourse Management	Irrigation Agronomy	7
3. Beyond Watercourse Improvement	Agricultural Economics	20
4. Encouraging Water User Involvement	Sociology Organization Behavior Public Management	10
5. Irrigation Systems Outside the Indus	Agricultural Economics Hydrology Irrigation Agronomy Irrigation Engineering	10
6. Surface Drainage	Agricultural Engineering Agricultural Economics	10
7. Groundwater Modeling	Agricultural Economics Computer Science Water Resource Mgmt. or Hydrology	12
8. Tubewell Performance	Agricultural Engineer	8

B. Institution Building Activities

1.	Competitive Grants Prog.	as required	12
2.	Research Management	Information Management Organizational Development	6

Additional short-term technical assistance will be required during the life of the program depending upon identification of the research needs. Some potential research areas are mentioned in the report: advanced irrigation technologies, command water management, irrigation policy, reservoir operations. If implemented, these projects may be funded through the competitive grants program or become core program projects. In either case, they are likely to require technical assistance. Other short-term support may be needed for research management activities and will be determined in the course of the program's operation.

SCOPE OF WORK

Short-Term Consultants

Short-term consultants increase the diversity of the technical assistance team by providing expertise for specific interventions. Short-term assistance will be largely provided by a core team that will make repeated trips to Pakistan as a way of fostering those professional relationships with Pakistani scientists.

Detailed Responsibilities

1. Provide technical assistance to Pakistani investigators on implementing the designated research projects.

2. Collaborate with Pakistani researchers on the writing of progress reports, working papers, and technical reports.

3. Lead technical seminars in water resource issues pertinent to Pakistan.

4. Participate in in-country training programs on research methods and research management and lead appropriate sessions.

5. Where applicable, advise Pakistani graduate students funded by the program to study at their home institutions and serve on their theses and dissertation committees.

6. Participate in researcher exchange programs in which Pakistani and foreign researchers spend time at the other's research institution cooperating in its activities.

7. Present papers at international conferences and write for publication in order to disseminate the program's research results.

Qualifications

1. Appropriate degree in field of specialty.

2. Experience in their respective fields, preferably in a developing country.

3. Experience with interdisciplinary team work.

A detailed work plan will be attached to each scope of work with the specific qualifications required by the program.

ANNEX G

Linkages Between ISM/R and Other Technical Assistance Teams in Pakistan

INTRODUCTION

The Peterson Report (1) lists 19 ongoing or to-be-initiated donor-assisted projects in Pakistan's water sector having a combined funding total of almost $1.2 billion dollars. Five other projects or activities (2) related directly or indirectly to the water sector and not mentioned in the Peterson Report, but to be supported by USAID or other donors swell this figure by an additional $170 million dollars. The major portion of funding allocation and more than half the projects deal almost exclusively with construction (for example, Tarbela Dam Repair, Chashma Right Bank Irrigation, Left Bank Outfall Drain). The remaining portion of the donor-assisted project portfolio involves water development and management, or provides support to institution building activities related to irrigation management.

Both the magnitude of the current investments and the number of water sector projects can be considered rationale for coordination amongst projects with respect to research activities, perhaps a water-sector research network, that could be developed under and spearheaded by ISM/R. Many of the mechanisms conducive to a coordinated set of research activities between projects will evolve naturally during implementation of ISM/R and the other projects. ISM/R staff will informally devote a small percentage of their time to collaboration with other technical assistance teams just as members of other teams will be called upon to collaborate with and assist ISM/R. However, other mechanisms such as inter-team working groups could be structured so that better coordination is achieved. The purpose of this annex is to briefly describe other related projects and to make mention of specific linkages between these and ISM/R so that during implementation a better meshing is obtained between water-related technical assistance efforts in Pakistan.

---

1. Peterson, Dean F., "Long-Range Strategy Options for Water Resources", Report to USAID/Islamabad, April, 1984

2. Baluchistan Area Development Project (USAID) - $50 million
   On-Farm Water Management Project (USAID) - $10 million
   Managing Agricultural Research Technology (USAID) - $30 million
   NWFP Agricultural University, Peshawar (USAID) - $30 million
   International Irrigation Management Institute (Pakistan) (Multi-donor) - estimate $2 million annually

WATER SECTOR PROJECTS

1. Irrigation Systems Management
2. On-Farm Water Management
3. Command Water Management
4. Managing Agricultural Research Technology
5. Baluchistan Area Development
6. NWFP Agricultural University, Peshawar
7. Baluchistan Minor Irrigation - IBRD
8. On-Farm Water Management - ADB
9. On-Farm Water Management - IBRD
10. Mardan Salinity Control and Reclamation Project (SCARP) CIDA
11. International Irrigation Management Institute (IIMI) - Multi-donor

DESCRIPTION OF PROJECTS

1. Irrigation Systems Management Project (ISM)

Co-financed by USAID and IBRD, the seven-year ISM Project assists the PIDs to rehabilitate currently deteriorated surface irrigation and drainage systems and upgrades PID capacity to operate and maintain the systems. Principal project components include rehabilitation of an estimated 14,000 km. of canals and 3,500 km. of surface drains, purchase of maintenance and construction heavy equipment, upgrading six workshops, technical training for equipment operators, engineering and management training for professionals, assistance in re-design of main channels and drains, support for hydraulic research, and development of a management information system to generate information needed for management control and decision-making. Four technical assistance teams have been contracted under ISM:

1) engineering (ISM/E)
2) planning and management (ISM/P&M)
3) equipment management (ISM/EM)
4) research (ISM/R).

The research team, ISM/R, is the component that would be implemented by UI/WSU/DAI. Because of common funding, ISM/R is administratively linked to the other three project teams.

This administrative linkage carries over to technical cooperation and, during ISM/R design, the research definition team met frequently with staff from other ISM teams to explore research areas for cooperation. The engineering team (ISM/E) has responsibility for engineering and hydraulic research that impacts upon the rehabilitation program. Much of that work will be carried out with the PIDs, for example, modeling work with the Irrigation Research Institute in Lahore. ISM/R work will focus on water management research in the program areas specified in this report. There will be several interfacing research issues where close collaboration is required. For example, development

of designs for small scale structures needed for Baluchistan or for civil canal diversions in NWFP will be done with engineering design assistance from ISM/E. In the planning and management area (ISM/P&M) common areas are research management, management information systems, and computer technology. Workshops in those areas could be joint undertakings. The research team will continually update staff of the other ISM teams regarding the total research program. Line agency staff with whom they have contact will be made knowledgeable about the program. ISM/R and other ISM teams are headquartered in Lahore, (ISM/P&M, excepted), and it is proposed that an inter-team working group meet regularly to discuss collaboration between teams.

Although all ISM teams will be working in the irrigation sector, and therefore close collaboration is envisioned, it is well to point out key distinctions between ISM/R and the other ISM teams. ISM/R team members will be researchers working toward a goal of increasing Pakistani research capability in water management. Other ISM team members are not researchers; they are design engineers, O & M specialists, equipment specialists and managers whose assignment it is to assist in the rehabilitation of major works and to upgrade PID capacity in O & M. The examples cited in the previous paragraph indicate ways in which the teams will assist one another. It is important to realize that the prime institutional linkage for ISM/R is through WAPDA, whereas the other three ISM teams link to the PIDs. Goals, the nature of the specific assignment, the type of professional employed, and the institutional linkages established for implementation all contribute to ensuring that there will be no duplication of effort between ISM/R and other ISM teams.

2. On-Farm Water Management Project (OFWM) - USAID

USAID has reactivated its pioneering assistance to OFWM with a $10 million dollar grant to support effective use of funds now being provided by ADB and IBRD in separate OFWM projects largely, but not exclusively, directed to watercourse improvement. (See items 8 & 9, this annex) OFWM funds a long-term technical assistance team consisting of an engineer (Lahore), agricultural economist (Islamabad), agronomist (Quetta), and an extension/training specialist (Hyderabad) to undertake research and training activities, some of which closely follow those proposed under ISM/R. These include:

- Strengthening water user associations;
- Improving extension techniques;
- Introducing computer technology in watercourse design work;
- Upgrading the capacity of OFWM training centers;
- Evaluating watercourse improvement projects;

- Improving engineering design of facilities.

In preparing this report, the ISM/R definition team interacted with OFWM staff and would continue to do so during implementation. It can be noted that OFWM engineer assigned to Lahore is a UI graduate and former student of the ISM/R team leader. Such relationships obviously will facilitate cooperation on projects such as Integrated Watercourse Management, Beyond Watercourse Improvement, and Encouraging Water User Involvement in Better Water Management, all of which have a central focus on water management below the mogha.

3. Command Water Management (CWM)

A five-year USAID/IBRD co-financed project to begin late in 1985, CWM deals with management of seven (7) sub-project areas comprising about 510,000 acres. CWM deals with the effectiveness and efficiencies of managing small irrigation sub-project areas rather than the large irrigation network as is current practice in Pakistan. CWM involves water inputs (canal remodeling, drainage, OFWM, tubewells) and non-water inputs (fertilizers, storage facilities, roads), as well as upgrading the management capability of the individuals and institutions charged with management of the sub-project offices.

Although the concept of CWM can be considered researchable in the Pakistan setting, tasks to be implemented under CWM are not. CWM is an operational project with a focus on agricultural output. And individuals charged with CWM management will be totally occupied with operational issues, not research. ISM/R will offer CWM staff a research and possibly, a policy component. Several of the projects and their outputs proposed under ISM/R feed directly into CWM. For example, the series of projects in the Farm Water Management program area all deal with researchable issues of utility to CWM. The Integrated Watercourse Management (IWM) Project deals with management of a series of watercourses. If enough watercourses are so managed, they could be called a command. ISM/R projects dealing with Drainage and Water Table Control, and with Tubewell Performance also have utility to CWM. Further, it is anticipated that several of the ISM/R projects will be pilot tested in CWM sub-project areas.

4. Management of Agricultural Research and Technology (MART)

ISM/R focus on increasing the capacity of researchers and institutions in water management ties neatly to three components of MART, Research Management and Administration, Information Transfer and Training for Agricultural Research. MART, which should be operative during the second half of 1985, will be directed primarily to PARC and associated institutions, several of which will be benefited in part by ISM/R. Specific opportunities for collaboration could be:

- joint training activities where water is a primary concern;

- workshops on proposal preparation, and project management;

- joint sponsorship of seminars on research topics;

- pilot testing of technology transfer arrangements similar to those planned under MART for the Islamabad District;

- publication of a water research information newsletter;

- creation of a review board and mechanism for funding of small water management projects that would be ISM/R funded;

- utilization (sharing) of short-term expert staff.

An additional component of MART will lead to placement of five long-term researchers at AZRI in Quetta and to strengthening that center. It is likely that AZRI would be an important cooperating institution under ISM/R for the Irrigation Systems Outside of the Indus Basin project.

5. Baluchistan Area Development Project (BALAD)

The BALAD Project is expected to be operational late in 1985. Its focus is on road and water development in remote Makran Division in SW Baluchistan. This area differs from the majority of Baluchistan for it is low-lying, marine, and semi-tropical. Similar to the rest of the province, it is extremely arid, with oasis agriculture dependent on the karez. Consequently, long-term staff will include specialists in groundwater hydrology and maintenance, and also in planning and management. BALAD deals with a lowland environment that is entirely different from higher areas of Baluchistan. Both environments are outside the Indus Basin; both are water short; both would be dealt with by the Irrigation Systems Outside the Indus Basin Project that will characterize traditional farmer practice and subsistence farming. Models developed by the Groundwater-Surface Water Model Project could have utility for characterizing and monitoring confined groundwater resources in Makran.

6. NWFP Agricultural University, Peshawar (TIPAN)

Support to the Agricultural University in Peshawar is expected to be inaugurated in early 1985. The project is known as TIPAN, Transformation and Integration of the Provincial Agricultural Network and provides $51 million dollars in grant support to the University. Under TIPAN it is expected that the university will over 7 years assume a more important role in agricultural re-

search in NWFP. If that mandate becomes operative, water management research may be conducted in collaboration with university staff. A more immediate type of collaboration between projects is in the training area. TIPAN calls for training of 70 Ph.D's, 70 M.S.'s and 65 non-degree professionals over a ten-year period. Some of these individuals would go for training in water management and related fields and could conduct thesis research in Pakistan under the aegis of ISM/R.

7. Baluchistan Minor Irrigation and Agricultural Development Project (BMIADP)

An IBRD-financed project, BMIADP deals with up to 30 small scale irrigation projects in Baluchistan which will be developed at the feasibility level for the PID. BMIADP also calls for several pilot schemes to be constructed that address sailaba agriculture and groundwater recharge. ISM/R, through the Irrigation Systems Outside the Indus Basin Project will characterize and define indigenous and improved farmer practices for water management. ISM/R definition team members and the BMIADP staff have agreed to work together cooperatively on research of utility to BMIADP implementation.

8. On-Farm Water Management (OFWM) - ADB

ADB's $40 million dollar OFWM Project is in its third year of implementation. It draws on experience gained from the earlier USAID-financed OFWM Pilot Project and is designed to:

- improve existing watercourses;
- install privately-owned shallow tubewells;
- offer training programs in formation and operation of water user associations;
- provide in-service training of field personnel in watercourse rehabilitation;
- assist in the establishment of a functional water management extension force.

OFWM is being carried out in two areas in Punjab and NWFP, covering some 460,000 acres.

One interface between ISM/R and OFWM will be through the Beyond Watercourse Improvement Project under which an evaluation will be made of the impact of watercourse improvement upon agricultural production. It will be useful to determine improvement effects by area (thus by donor) to determine if different watercourse strategies (water management extension programs, incorporation of tubewells, ...) have had a bearing on agricultural productivity. A second area for interface between projects is simply to capture the experience of the long-term ADB team members insofar as training, farmer organization, technology transfer techniques,

and water management extension are concerned, and to utilize this information in shaping research to be conducted under ISM/R. Preliminary discussions between ADB-OFWM and the ISM/R definition team have been held.

9. On-Farm Water Management (OFWM) - IBRD

Begun in 1982 and running through 1985, the IBRD-sponsored OFWM Project is being carried out in all four provinces. The project cost is $110 million dollars. Main project components are:

- support for civil works, materials and construction equipment;
- renovation of 2065 watercourses;
- improvement (heavy cleaning, desiltation, weed control, straightening, minor structures) of 16,500 watercourses.

Less costly investments are being made in land leveling, demonstration plots and training. To upgrade training under this program, a long-term expatriate consultant is working at the OFWM training facility at Niazbeg. He was consulted during the ISM/R design phase.

Cooperation between IBRD-OFWM and ISM/R will follow the lines outlined above for ADB-OFWM.

10. Mardan SCARP

Canadian Government support through CIDA is being provided for an alternative type of SCARP project, with a focus on tile drainage rather than tubewells to obtain reclamation aims. A consulting team is preparing final designs for drains to cover 73,000 acres in the Mardan and Peshawar Districts. A demonstration project of about 150 acres was installed in February, 1983. The main purpose the demonstration was to show various techniques for drain installation. Some measurements of drain discharge, but none of water table depth, have been made following the installation of the drains.

Mardan SCARP and the ISM/R project dealing with Surface Drainage and Water Table Control both deal with drainage questions. There is no specific research component included in plans for the Mardan SCARP, and discussions between staff connected with each of the projects have been held with preliminary agreements suggested to use Mardan SCARP as one location for ISM/R drainage research.

11. International Irrigation Management Institute (IIMI) (Pakistan Cooperating Unit)

IMMI is a newly established international institute with focus on water management. Similar in some ways to the commodity oriented research centers of the CGIAR net, IIMI will seek to enhance independent national competence to improve irrigation system management and sector performance in several environments. Established with a headquarters in Sri Lanka, IIMI is also committed to establishing a cooperating unit in Pakistan with focus on arid and semi-arid zone water management. Startup is anticipated in mid-1985.

Although the program for IIMI (Pakistan) has not yet been finalized, linkages between IIMI and ISM/R can be through activities such as:

- joint planning and sponsorship of research programs;
- review of research results;
- conduct of joint seminars;
- IIMI facilitation of ISM/R linkages to the external irrigation community.

ANNEX H
RESEARCH MANAGEMENT

A. Report by Dr. Tom Armor
September, 1984

Beyond the several specific research projects to be carried out under the ISM/R Project, there is a need within the Pakistani research community for increased skills in the management of research programs and projects. The ISM/R can and should address this concern directly in those substantive projects it identifies and undertakes. In addition, ISM/R should support a specific effort to increase these research management skills in other irrigation-oriented research activities in Pakistan.

A. NEED FOR INCREASED RESEARCH MANAGEMENT SKILLS

The International Service for National Agricultural Research (ISNAR) reported the following list of issues they felt to be critical to successful national agricultural research based on their experience and country reviews: (1)

* Links between policy units of government and the research system need to be strengthened to establish clearly the key role of agricultural research investment in contributing to national development.

* More problems found in national agricultural research systems seems to be based on human or political issues, rather than on technical matters.

* Many systems do not have well developed plans for their research programs, especially regarding needs for manpower and other factors of research productivity.

* Staffing and leadership for agricultural research has not grown as fast as the demand.

* Even though most systems have fewer scientists than they need, lack of support services often requires that those few available scientists spend an undue amount of time on non-research activities.

* National public service regulations, under which most developing country agricultural scientists are employed, often do not provide the salary and promotion opportunities needed to retain the best scientists in government research service.

* Many researchers work in relative isolation, not in close contact with scientists seeking to solve similar problems.

* In many research systems, emphasis remains on single disciplines or commodities; problems often are not approached with the possible creativity that comes from interdisciplinary work.

* Closer contact with producers -- including expanded on-farm testing -- would lead to more usable research results, in many instances. Producers could give valuable aid in defining problems according to production systems, as well as put findings quickly into practical application.

In any context, the skills learned for scientific research are often quite different from those needed as a productive and successful manager. Unfortunately, these managerial skills are seldom developed in any systematic way within the research communities of most countries, developing or otherwise. Doctoral programs in the sciences do not address budgeting, planning, supervision, interpersonal problem solving, personnel administration, etc. It is the rare in-service training program that provides such needed skill development support for research managers.

When there is support for the management development needs of research managers it is often modeled after general management experience. This is an important and useful step, however research does have very unique characteristics that should be addressed in such support activities. For instance, the linkage between research and ultimate applications is often difficult to establish making 'results-oriented' management complex, some problems require great specialization while others can only be resolved by collaborative or interdisciplinary research efforts, often the busy manager is not able to remain current in his own or related fields that he must manage and about which he must make critical decisions. These and other special concerns of research management require special support efforts.

B. RESEARCH MANAGEMENT IN PAKISTAN

Few developing countries have as rich a body of human resources trained in research disciplines as does Pakistan. At both the Federal and Provincial levels there are many organizations and institutions devoted to various aspects of agricultural research. This is perhaps a blessing and a dilemma at the same time.

As the base of staff and institutions grows the need for effective and coordinated management of these resources grows exponentially. It is suggested here that lack of attention to the development of managerial resources within the agricultural research community of Pakistan has severely limited the impact of the research done in the past and currently underway. This is reflected as well as in the lack of supporting networks among scientists with similar interests. Such networks often contribute significantly to scientific progress, even if seldom recognized in any formal form.

USAID and the government of Pakistan have recognized this problem and moved to help overcome it. The establishment of, and support for, the Pakistan Agricultural Research Council (PARC) has been one such step. However, PARC will serve a coordinating and funding role more than one of direct support for increased managerial development. A recent USAID project design entitled Management of Agricultural Research and Technology (MART) seeks to address this problem more directly. MART will not begin to make direct interventions, however, for about a year if the usual implementation schedule for such projects prevails.

Improvements in the management of research will no doubt address the general issue of public administration in development efforts. For instance, a recent article by Kenneth Nobe placed Pakistan in about the middle of a comparative scale describing LDC's ability to overcome the constraints of "administrative organization" in favor of "management organization" (2). He defines an administrative organization as one which concerns itself almost exclusively with the 'input' side of the productivity and effectiveness equation while avoiding feedback from the 'output' side. He describes management organizations as those that adjust their behavior in accordance with feedback about their performance. This is quite similar to David Korten's analysis of many LDC organizations, where he speaks of the need for 'bureaucratic re-orientation' toward 'learning organization' functioning that values self-correcting behavior. (3)

The On-Farm Water Management extension services and associated research institutions in Pakistan should be considered part of the research management improvement effort. Although the ISM/R project was not initially designed to address extension service directly this critical link is one key to improving the management of research. If this linkage can be made more functional -- and truly two-way -- then the feedback so necessary for effective management of research will be strengthened while improving the primary utility of extension services to farmers. The work done at Mona is an example of how this process can be useful.

C. IMPROVING RESEARCH MANAGEMENT

Three specific activities are proposed for improving the management of research within the ISM/R project. These will coordinate well with the MART project when it becomes operational, however they are not dependent on that project. These activities are mutually supportive and are proposed as an integrated effort.

1. Extending Program Management Experience of the ISM/R

The ISM/R project itself is an excellent example of a major research effort involving diverse groups, disciplines, and institutions. In this context it is perhaps better referred to as a 'program' than a project. The delineation of research topics, principal and collaborating investigators, institutional

settings for the research, funding mechanisms, budget allocations, schedules of activities, inter-agency coordination, team relationships, extension involvement, etc. are all real dynamics of the ISM/R project itself.

The ISM/R has begun a process of self-learning and team management with the pre-departure planning workshop for the initial design team conducted in July, 1984 in Idaho. That process was extended when the team returned from Pakistan and within three weeks hosted a visit by several Pakistani officials to the U.S. to participate in further refinements of the design. This process should now be extended in a clear and specific manner as part of the ongoing implementation of the project.

The following activities are proposed to help transfer the experience and learnings from the management of the ISM/R program to host government staff and institutions:

a. Establish a "Research Management Task Group" composed of the ISM/R TA team members, GOP counterparts from all collaborating institutions, the principal investigators from all projects funded by ISM/R, USAID project officer. The U.S. based project management (i.e. from University of Idaho, Washington State University and Development Alternatives Inc.) would join this group when they were in-country.

b. Participation in this learning group (RMTG) would be a condition of ISM/R support for any research activities. The ISM/R would fund travel and expenses for all LG meetings and activities.

c. The RMTG would meet regularly, approximately every 8 weeks. These meetings would ideally be rotated between various institutions in Pakistan. The schedules would be adjusted to take advantage of any of the U.S.-based leadership visiting Pakistan.

d. The agenda for these LG meetings would be two-fold:

i. Management of the Program/Project

- Briefly review all current and proposed activities to assure all relevant institutions are informed. This is not a decision making function in this context, only one of information sharing.

- Review all activities for real or potential linkages and support to extension services.

- Identify opportunities for collaboration between various participating individuals or institutions. When such opportunities are identified test the support or constraints for making it actual. Assign responsibilities for action steps to make such collaboration operational, including special resources from ISM/R where necessary.

- Identify any special budgeting, funding mechanisms, or staffing opportunities that can increase the effectiveness of the research work.

ii. Learning from the ISM/R Management Experience

- Identify critical management opportunities or constraints for the program and/or separate projects and institutions. Develop action plans to address these issues.

- Discuss management development needs for each institution, provide resources to meet those needs or identify training opportunities.

- Provide feedback to the ISM/R management from the GOP institutions about conduct of the project.

- Review the entire meeting (i. and ii.) and prepare a short report of the meeting. This would be reproduced by the ISM/R staff and distributed directly to all staff involved with ISM/R activities throughout Pakistan.

The incentive for active participation by all members of the RMTG would be several fold. The agenda and conduct of the meetings is intended to establish the needed networking among research professionals that is otherwise difficult to initiate within existing institutional arrangements. By specifically reviewing opportunities for collaborative research and opportunities for direct involvement of extension services in research, such aspects should gain more regular attention. Perhaps most importantly, the ability of the ISM/R project to fund jointly-designed projects originated within this group should make participation a high priority.

The intention here is to continue the effort begun with the ISM/R design team. The formation of a 'task group' is to avoid another official co-ordinating body. Experience has shown that this often becomes a constraint to action. By emphasizing the learning nature of this group, and including staff from a cross section of management and institutional settings these regular meetings will provide a context for all to better understand how such research efforts can best be managed. A consultant skilled in such management development efforts should be used to help conduct the first few meetings of this group.

2. Management of the Research Projects Within ISM/R

The substance of the ISM/R is to be several research projects, some identified at the outset of the over-all project and some to be identified during the life of this project. Each of these will involve both TA and GOP staff working together as researchers and managers. Each will have budgets, staff time obligations, funding mechanisms, institutional co-ordination, linkages to extension services, and a host of other research

management functions to be carried out.

In most such efforts these functions just happen, for good or bad, by whatever method is needed. Attention is focused upon the substance of the research in most documentation and reporting as well as the staff's conceptualization. A major learning opportunity is lost because the management functions are not recognized, reviewed and valued as part of the purpose of the project.

It is proposed that an important and specifically recognized aspect of all the projects carried out under the ISM/R be that of research management. To support this the following actions are proposed:

a. A management plan is developed for each project (given the same priority as the research design). This would include:

- Responsibilities for making allocations of resources, by name when possible.

- Proposed schedule of activities, including regular check points to review progress and revise the schedule as needed.

- Description of nature and extent of involvement of extension service staff in the research design. Listing of their responsibilities and the resources to be made available to them in support of those responsibilities.

- Collaborating institutions, nature and timing of that collaboration, level of effort expected, resources available to support that level of effort from the collaborating institutions.

b. Regularly scheduled team meetings to review progress of the research and particularly the management of the project. These meetings would identify critical management/administrative issues, develop action plans for resolving them, assign responsibilities for these action steps, identify other sources of support for resolving such issues, raise issues to be carried forward to the Learning Group meetings when appropriate, and to discuss Learning Group issues as reported by attending members.

c. Identify topics to be addressed in research management training activities to be supported by the ISM/R. This would provide input to the design, staffing and timing of the training activities described in item C.3. below.

3. In-Country Training Activities Addressing Research Management

A series of training activities aimed at increasing the research management skills of the GOP staff of ISM/R supported activities would be carried out over the life of the ISM/R project. At this point these are best termed 'activities' because

their exact format, scope, staffing, sequencing, and topical focus will be derived from the potential participants as part of their project management reviews (see item C.2.c., above).

In some cases these would be conducted for and within a single institution. In other cases they would be conducted for several collaborating institutions and serve to strengthen that collaboration as well as increase specific skills. In still other cases they would be conducted for relevant participants from all the ISM/R supported research projects in Pakistan. (Non-ISM/R connected staff could attend as well if space and format permitted). In some cases these activities might better be described as problem solving workshops dealing with specific and real concerns of managers. In any event the conduct of these activities will be in response to expressed needs of the potential participants.

Following is a list of suggested topical issues for such training activities:

a. Interdisciplinary Research Management - Methods for supporting interdisciplinary research from the policy and planning perspective, budgeting, financial control, team selection, team building activities, operational management, role definitions, research design, and project evaluation.

Interdisciplinary research seeks a new synthesis of problem statements, methodologies, and resulting solutions than has otherwise prevailed from single disciplinary approaches. Multidisciplinary research approaches a problem from several disciplinary perspectives, but without necessarily seeking a synthesis of approach or solutions. The former is integrative while the latter is additive.

Often what is described as interdisciplinary research quickly becomes multidisciplinary research and consumes great amounts of management and administrative resources dealing with inter-institutional issues. The value of the interdisciplinary approach can be lost altogether. This is critical to an increasing number of agricultural production problems that must be solved in ways meaningful to a farmer whose life is a complex of social, historical, political, and agronomic forces. This training activity is designed to give research managers the understanding and skills for conducting effective interdisciplinary research.

b. Action Research Methods in Research Management - Action research methods can be used to identify and address institutional, organizational, and group behavior that constrains effective research activities and the implementation of research results. The behavior of the relevant organizations or groups is itself made subject to research. A model is used that treats human behavior as data that can be measured, analyzed, and made the basis for action plans to overcome dysfunctional behavior and support that which is

helpful. The action plans are then reviewed for effectiveness and modified in this iterative approach.

This is simply a way to bring the scientific method to bear on the problems of organizational behavior. When data about behavior can be separated from implied motivations and value judgements more opportunity for change presents itself. This is most effective when the 'subjects' of the research are also the 'investigators'.

c. Supervision and Motivation of Professional Staff - Methods for determining individual incentives and motivating factors for professional research staff will be presented. Methods of organizational diagnosis for determining where new opportunities for appropriate incentive mechanisms can be effected as well as identifying and overcoming existing disincentives will be presented. The process of 'research proposals' is somewhat unique to managing research institutions in the publish sector and can be the basis for innovative management.

d. Microcomputer Supported Management Information Systems - In addition to their direct use in scientific research data collection and analysis, microcomputers can greatly ease the administrative and management burden of large research efforts. Many application programs for budgeting, financial management, personnel records, simple data base management, etc. make this potential realistic for the professional scientist in a management or administrative role. Often dual use of microcomputers in both administrative and scientific support roles makes their cost more acceptable. This training activity will introduce these methods and help participants adapt such applications to their own situations.

e. Budgeting and Financial Management - This activity would address the general principles as well as the special considerations of budgeting and financial management in the GOF context. The planning process cannot be effective without a clear understanding of these mechanisms. Research managers will learn the skills necessary to construct research designs that are both scientifically sound and that can be effectively carried to fruition in a public administration context. The emphasis will be on programmatic planning to support research project development and implementation.

Bibliography:

1. International Service for National Agricultural Research, 1982 Annual Report, p. 17. The Hague, NL.

2. Nobe, Kenneth, "Organizational Constraints to Greater Extension Involvement in USAID funded Agricultural Programs in LDC's", Colorado State University, Fort Collins, CO.

3. Korten, D.C. and N.C. Uphoff, Bureaucratic Reorientation for Rural Development, Manila, Philippines and Ithaca, New York: Asian Institute of Management and Cornell University, Rural Development Committee, 1981.

A H
RESEARCH MANAGEMENT

B. Report by Dr. Clark Ballard
September, 1984, Kimberly, Idaho

The goal of improving the Pakistani's capacity to carry out quality resesarch, and at the same time, generate innovative resarch results that will improve water management and ultimately agricultural production will be the basis for the project's management style. This mandates the maximum involvement of the Pakistani personnel in a significant way throughout the life of the project. Decision making on all aspects of the project will be a joint effort as will planning, implementation and evaluation.

Efforts will constantly be made to improve management. The work of the "Management of Agricultural Research and Technology (MART)" project will be carefully observed and useful ideas will be incorporated in the management of this project. Their help will be solicited as needed and as is feasible.

Collaborative Institutions Interested in Water Management

This project is designed with a minimal amount of expatriate technical assistance, thus it is heavily dependent on satisfying working relationships with various other agencies. The accelerated water management work provided for by this project must become an integral part of the greater development of Pakistan's water management capacity. As a part of the project's early management efforts, the following will be done:

- Profiles of the various institutions will be studied; their apparent potential and interest will be assessed. It will be mutually agreed as to the nature, extent and time of involvement. Not all institutions can be included initially.

- For those institutions selected, a written agreement will be made as to personnel to be involved, scope of work, financial arrangements, etc. Each institution will include their participation as a part of their plan of work.

- Since the extension service will have a major responsibility for the transfer and adoption of generated research information, a substantial effort will be made to get their early involvement and support.

The managers of this project, recognizing the interdependence of research and extension, will support as feasible, all efforts to upgrade extension personnel and improve their capacity to understand and put in place new technology.

Upgrading Research Management

As stated, a thrust of the management of this project will be to upgrade the Pakistanis' ability to manage research. To help achieve this, a vigorous training program will be pursued:

- While keeping in mind the primary purpose of the research program, the entire research program will also become a massive in-service training effort. Where expatriates and senior local investigators can train counterparts and junior research workers in all aspects of research - from management, technical agriculture, cultural practices, pest control, drainage, water management, etc. - to note taking, data analysis, evaluation, interpretation and packaging of data, etc.

- Counterpart training will be an integral part of every expatriate advisor's tasks. The advisor and counterpart together will develop a comprehensive plan for training.

- Seminars will be held at regular intervals that involve primarily "in-house personnel - both expatriate and local." This will provide opportunity to Pakistani research workers to present their own or related research work to their peers for information and critique. Development of local library facilities will assist this program.

- Field days will be held at regular intervals to permit researchers to discuss their research work and demonstrate progress. This will facilitate better upkeep of plots, familiarize both the researcher and clientele with the work being carried out.

- Visits by the campus coordinator and all short-term consultants will be utilized to present seminars on diverse subjects related to water management. They will also hold individual conferences and establish linkages between local investigators and the university.

- Traveling seminars involving expatriates in-residence, national professionals and in some cases, special consultants as instructors will be taken to the various centers where work is underway. Subjects will be selected to fit local needs as expressed by recipients in pre-seminar surveys.

- Visits will be arranged to superior research units with Pakistan. This will involve mostly research assistants, etc.

- Provisions will be made for selected technicians, scientists, etc. (at various professional levels) to participate in study tours, seminars, etc. at pertinent sites outside of Pakistan. The international centers, in particular, will be utilized.

- Annual USDA short courses will also be utilized for training. For the top and middle management personnel, special courses in management will be used. After having attended these courses, short internships at the University of Idaho and Washington State University will be arranged for selected individuals to permit "hands-on" experience in management of research.

- Training will also include long-term degree training programs at U.S. and developing country universities. Since experience indicates that many of the returning participants ultimately become research managers, provisions will be made to give some managerial training - preferably near to or after the completion of their degree program. This could involve interning at the training institutions, taking special university courses or attending the USDA management courses, or some combination of both.

- Provisions will be made for persons who have conducted meritorious research work and have generated substantial papers to attend international meetings where they can present papers, exchange ideas and obtain materials useful in their research.

Selection and Orientation of Personnel

- Good personnel are vital to successful upgrading and training efforts. Considerable effort will be expended to assure that quality people are assigned to this project. Competition for these position will be encouraged.

- Jointly prepared position descriptions will be developed for every person so that they understand and agree to the role assigned them.

- Orientations will be held for all personnel, local and expatriate, to help create understanding of the mission and goals of the project and the individuals role in the same.

- Some funds will be reserved to be used as grants for research proposals on a competitive basis.

Project Management Strategy

The project management strategy calls for a careful consideration of start-up date with only selected activities initiated in certain areas in collaboration with a few institutions. Expansion will proceed at a rate dictated by the results of the initial experience. In all cases, the amount of research work undertaken will be maintained at a level that can be properly monitored. This increases confidence in the validity of the research results which in turn are the basis for future planning.

Prime candidates for early start-up will be activities that based on experience within the country or externally, would seem to have promise for early success.

A number of practices, etc. may only need a little more study and verification under actual farming conditions in a particular geographic area.

Trials of all kinds conducted on farmers' land present a special problem. There is always more chance of unavoidable variables than on more controlled experiment stations. At the same time, the researcher has not completed the work until results have been verified under these conditions.

Some study needs to be done on means of getting more precision in "on-farm trials" or in developing other techniques (sampling, etc.) that produce results that might be considered valid even through the data obtained aren't exact enough to permit analysis under standard statistical methods. For example, are single or duplicate plots in various locations acceptable? etc. (Replication by location).

Graduate Students

Graduate students will be used in the research program. This includes both U.S. university and Pakistani students attending U.S. universities who would be assigned to do thesis work in Pakistan to satisfy thesis requirements.

U.S. graduate students will be under the direct supervision of university faculty advisors. Their research will be on discrete problems that constrain progress.

Pakistani students doing thesis work for the Pakistan university degree will receive advice from various research officers - both Pakistani and expatriate. They will be encouraged to report their findings to the research unit to which they are assigned as well as to their sponsoring university.

All graduate students would be candidates to present the "in-service" seminars.

ANNEX I

Establishing an Information System for Research Support on the ISM Project

by
Paulette F. George, Information Specialist
University of Idaho
October, 1984

"Scientific information embodies the heritage of man's verified knowledge as well as the current records of his never-ceasing inquiries into truth. It constitutes an essential resource for the work of scientists. It is a cumulative resource: knowledge builds on knowledge as new findings are reported. It is an international resource, built painstakingly by scientists of all countries without regard to race, language, colour, religion or political persuasion. As it is built internationally, it is used internationally. It is a means through which the world's scientists discipline the practice of their professions. It is a medium for the education of future scientists and a principal reservoir of concepts & data to be drawn on for application to economic and technological development programmes."(1) So begins the UNESCO report on how to make a worldwide scientific information system functional.

The National Science Policy of the GOP acknowledges the importance of libraries in supporting scientific research. One stated objective is "to develop an effective information network for science, engineering and technology having adequate links with international information services, for providing research and development workers and other interested agencies speedy access to current knowledge in their fields."

A contribution to this system is recommended through the ISM/R program. Indeed, without adequate scientific library support for water-related research a self-sustaining water management research program cannot be created. What is clearly lacking, as shown below, is a library system which provides the full range of support to scientists engaged in water-related research: reference, referral, documentation, and dissemination.

Within Pakistan there are three libraries associated with water resources: the WAPDA Central Library, the library at the Center for Excellence for Water Resource Engineering, and the Library of the Irrigation, Drainage, and Flood Control Research Council (IDFCRC). Two other libraries are also of importance even though water resource material is not a priority part of their collections. They are the library at the Agriculture University in

---

(1) UNISIST: Study Report on the Feasibility of a World Science Information System. (Paris: UNESCO, 1971. 161 p. Document SC.70/D.75/A.)

Faisalabad and the Pakistan Agricultural Research Council National Agricultural Research Centre Library in Islamabad. (Detailed profiles on these and other libraries visited are attached.)

The library at WAPDA Central in Lahore focuses on engineering and the basic sciences and directly supports the operational role of WAPDA. The social sciences and economics receive very little attention, virtually none related to water. This library supports research work at Mona and the beginning program at LIM.

The library at the Center for Excellence in Water Resources Engineering has the best extant resource in water engineering; a large collection of journals dating back 10-40 years and sufficient budget to support the purchase of new journals and books. The narrowness of its collection is made up by the depth of materials held. It is also expanding into various non-print media.

The IDFCRC library has the broadest mandate for water-related research but has not received adequate funding to fulfill assigned functions. The library budget is inadequate for materials or equipment, and the collection is very old and incomplete with materials covering engineering, agronomy and the social sciences. A PC-1 has been prepared to expand the collection and acquire equipment for effective management of current and proposed collections. A microcomputer-based management system is envisioned that would allow the automation of current awareness lists (now done by hand), full subject cataloguing and the creation of indexes or subject bibliographies. Individual journal articles as well as documents from various governmental agencies would be included for full cataloguing.

The library at the Agricultural University of Faisalabad has the largest general collection on agriculture in Pakistan (120,000 journals and books). The library serves to support the teaching function of the university and is little used for non-academic research. (The adjacent Ayub Agricultural Research Institute has a separate library.)

The National Agriculture Research Centre Library of PARC is the official Pakistani center for AGRIS, the FAO supported international agricultural information network. Therefore, this library should be the ultimate location for all Pakistani documents related to any field of agriculture, including water management documents. The collection of PARC/NARC is very closely tied to the research being performed at the center. Since there is not any extensive water-related work currently in progress in the PARC/NARC the library does not include resources of any great significance for water research.

FINDINGS

The libraries, separately or combined, are not adequate to support a continuing water management research program. Current collections do not contain sufficient reference materials nor current publications to enable Pakistani scientists to keep abreast of work either in Pakistan or related developments in other countries. In-country work is not systematically collected, catalogued, abstracted, and disseminated. Journal subscriptions are maintained by some libraries but depending on the function of the particular library, acquisitions are focused on particular fields of water management, excluding relevant work on related disciplines and subscriptions are hampered by foreign exchange constraints.

There is no system for interlibrary lending, enabling clients of one library to access needed materials except on a personal basis. Cataloguing is normally limited to providing shelf listings and is constrained by lack of staff or equipment. Catalogues are not shared by libraries.

Library staff were found to be well trained and aware of inadequacies within their particular libraries and the potential of interchange among libraries. A strong service orientation was evident but again constrained by institutional rules and lack of equipment to improve services.

RECOMMENDATION

The water management research program requires strong information management. It is recommended that a water resource library be developed comprised of additions to existing collections and creation of an interlibrary lending program. The library would address five basic requirements:

Reference: Establish a collection capable of providing standard library functions: reference sources, leading journals, books, bibliographies, and current awareness services.

Referral: Track research in progress to enable scientists working on similar problems to collaborate.

Documentation: Design and printing of current awareness lists, catalogues, and bibliographies.

Dissemination: Production of materials for distribution to users.

International linkages: Access to foreign data bases and continuing subscriptions to leading journals.

Of the libraries currently holding water-related collections, IFDCRC has the broadest mandate to cover the fields necessary for a broad based research program and the linkages to concerned institutions, i.e., WAPDA, PID's, universities. It is recommen-

ded that the PC-1 for improvement of the information services be supported, and supplemented by additional equipment for use by other libraries to enable a network of water-related library services to be created.

If adequate budgetary support to meet recurring costs to maintain the collection of water resources material cannot be assured by IDFCRC, then the program described below should be implemented at WAPDA or the Centre for Excellence.

It is proposed that the library be organizationally part of an Information Resources division which includes three sectors: the library, documentation (printing and publications) and information dissemination. (See Figure 1.) The IDFCRC management is currently in the process of strengthening these operations by adding a total of 13 positions. Their own budget, as proposed by the Sixth Five Year Plan, is deemed by their management as being capable of supporting the all continuing costs of salaries and operations once the basic equipment and resources for this research library are in place.

Another requirement for the program is the development of a non-bibliographic information management system. This Information and Referral (I/R) function would have two parts: listing available scholarships or fellowships and tracking research in progress. This is a natural extension of the microcomputer system envisioned.

The IDFCRC program recognizes the need to disseminate information. Plans have been made to use various media to reach users. The plans to develop new materials in print and varying audio-visual formats (videotape, slides, cassette tapes, photographs, and microforms) is a recognition that information users' needs differ from those who are contributing the information. This view is moving IDFCRC from a simple library into an information analysis center where experts repackage information to meet the needs of various users. Support for the planned print and non-print media development seems to be a logical extension of the mandate to create an adequate research library.

The IDFCRC needs are primarily of a one-time nature: supplying basic equipment and resources for library and training for the new personnel Support for the purchase of journals and for linkages into international networks will require longer-term external support than the IDFCRC management has envisioned.

OBJECTIVES: Information Management Program for Water Management Research

1. To establish a functional research library on water resources.

2. To implement a system to capture and disseminate Pakistani materials related to water resources including those of the ISM/R program. Dissemination may be in varying print or audio-visual formats.

3. To establish a system for continuing receipt of foreign journals, serials, monographs and other materials.

4. To develop a functioning nationwide network of interlibrary cooperation related to water resources materials within Pakistan.

5. To establish a system linking Pakistani water resources libraries to international information networks and resources.

6. To develop a functioning nationwide information and referral system related to water resources research within Pakistan.

7. To input water resources documents developed in Pakistan into the AGRIS information system.

OUTPUTS

1. Photocopies of journal articles for water resources research.

2. Books available on loan for water resources research.

3. Current awareness bulletin related to water resources materials available nationwide.

4. Bibliographies on water resources topics.

5. Microfiche collection of Pakistani water resources documents.

6. Catalogs (book and/or computer-readable) of holdings in water resource libraries.

7. Referral service linking water resources researchers.

8. Trained information specialists capable of meeting reference, referral and information dissemination needs in water resources.

9. Individually designed audio-visual and/or print interpretations of water resources research applications.

10. AGRIS entries for Pakistani water resource documents.

IMPLEMENTATION

A member of the implementation team will be responsible for the coordination, consulting, and training functions related to the information support segment of ISM/R.

Current programs and needs will be reviewed in-depth with staff of the IDFCRC, WAPDA Central, and Center for Excellence in Water Resource Engineering libraries. A detailed time plan for implementation of the reference, referral, documentation and dissemination programs will be developed. At this time required equipment will be ordered and additional staff will be hired. Journal and book purchases will begin as soon as possible. Plans for gradually including continuing costs in the agencies' budget submissions to the GOP will be made during this planning phase.

It is expected that the primary emphasis will be on developing the reference system and its companion referral system. The documentation and dissemination activities are expected to be started in a second phase during the second year of the project. (This is in part due to the expected delay in receiving the larger equipment needed for these projects.)

Training for the staffs of the programs will be begin as soon as practical. Since all training is of a short-term nature, mostly individualized, there will be great flexibility in the scheduling. The training indicated is all short-term due to the presence of adequate library schools within Pakistan where basic skills are obtainable. The training within the USA is envisioned to include the course which the Volunteers in Technical Assistance (VITA) of Arlington, Virginia offers. This gives basic training in the use of computers in information settings: reference, cataloguing and referral. On-the-job-training at the University of Idaho are also part of the training involved in the USA. Exposure to various ways of doing the same task and some time to plan their own operations without the pressure of day-to-day demands are two of the benefits of the time outside of Pakistan.

The training in Pakistan is intended to be of a practical hands-on nature. Primary among the types of training done here will be using the microcomputers for the various functions, training in the microfilming of documents, training in the use of the press and related equipment, and training in typesetting. This will be very short-term, but may need to be repeated on a more advanced level in the second or third year of the program.

Short-term foreign consultants will be utilized to help set up programs as the trained staff and necessary equipment are available. Most of this consultation will take place within the first 18 months. Evaluations of the various programs will be held annually after starting to aid in modification and improvement. Various additional training (probably in-country) may be suggested based on the needs of the staff after this period of operation.

PROFILES OF SELECTED PAKISTANI LIBRARIES

LIBRARY PROFILE: Applied Economics Research Institute
University of Karachi
Karachi
Telephone: 434992

Staff: Ms. Matul Wadood, Head Librarian
Assistant Librarian
Clerk

Staff training: both librarians have Masters degrees in library science from Pakistani universities.

Collection:
Primary subject area: Economics
Extent of water publications: None now, just added subject class 72 books on shelf in agric. econ.
Books: 5,000 volumes
Subscriptions: 105 (75-80 foreign, 50-60 from USA). Received through Faxon via IIE.
Length: mostly 3-5 years

Abstracts/Indexes: none
Special: World Bank depository
Receiving many Pakistani economic agency publications
Age: Library has been open since 1980.
Most books less than 10 years old.
Publications: none

Budget:
Source: From Institute itself
Amount: $20,000 divided equally between journals and books
Special: Received grant for 400 volumes from British Council, from British publishers only. Institute for International Education (IIE) subsidizing some foreign journals.

Technical Services:
Classification system: Dewey to 2 decimals (3rd now being added)
Govt. documents only filed by agency/series
Subject classing: Dewey shelflist only. Books only.

Interlibrary Cooperation:
Formal: fortnightly staff goes to State Bank library in Karachi, less often go to British Council Library

Informal: will give photocopies on request, seldom asked. Have loaned books as favor taking responsibility personally for losses. (Checked materials out to self then loaned.

Charges: free unless amount is significant

International access: none

Memberships: none. Finds Pakistani Library Association too far away and not very relevant.

Computer Access:

Library: none now. Plans for a micro-based system in indefinite future.

Institution: HP9045 and AppleII microcomputers. Timeshare on IBM mainframes. Considering mini purchase to decrease timeshare costs. Library might access mini.

Other: University Arts Commission investigating possibility of all universities acquiring a single integrated system.

Problems:

Journal delivery infrequent: delays and non-delivery.

Reference materials are weak. Need encyclopedias and dictionaries for economics.

Assets: Strong organizational support. Modern facility with room to expand. Well-trained staff. Service oriented.

LIBRARY PROFILE: Irrigation, Drainage & Flood Control Research Council
House 6 Street 41, F-61
Islamabad Telephone: 823316

Staff: Mr. Syed Khurshid-ul-Hasan Jafri, Deputy Director, Documentation and Library
Miss Qamar Afroz, Assistant Director, Documentation & Library
Mr. Anjum Khaliq, Assistant Director, Public Relations
Library Assistant
Typist

Staff training: Ms. Qamar has a Masters degrees in library science from Pakistani university (Lahore). Came to IDFCRC from Assistant Librarian position at PIDE 3 months ago.

Collection:
Primary subject area: Water Resources
Extent of water publications: 10,000 volumes
Books: 1,000 volumes
Subscriptions: none paid, a dozen or so received irregularly
Length: virtually no complete volumes
Abstracts/Indexes: none
Special: Receiving some Pakistani water agency publications but irregularly. Have some WAPDA materials from 1960's.
Age: Library has been open since 1970 or so.
Most books much more than 10 years old; seldom used.
Documents, except IDFCRC's, also not current.
Publications: monthly acquisitions listing
numerous detailed subject bibliographies (most are annotated)

Budget:
Source: From Council itself
Amount: Staff salaries only to this point. All materials donated.

Technical Services:
Classification system: Dewey to 6 decimals.
Govt. documents only filed by agency/series
Subject classing: Dewey shelflist only. Books only.

Interlibrary Cooperation:
Formal: none
Informal: will give photocopies on request, seldom asked
Charges: free
International access: none
Memberships: none

Computer Access:

Library: none now. Plans for a micro-based system in indefinite future.

Institution: none now. Looking for micro-based management and word processing systems.

Problems:

Lack of resources to furnish library and to buy starter collection.

Assets:

Strong backing by organization for development of information services. Organization willing to staff and maintain vastly expanded operation if basic start-up costs are obtained from external source.

Well-trained staff with well-thought out plans for expansion and means of supporting the expanded program.

Governmental mandate to develop the information services.

LIBRARY PROFILE: PARC/National Agriculture Research Centre Library
L/13 Almarkaz, F-7/2
P. O. Box 1031
Islamabad
Telephone: 29889

Staff: Mr. Anwar Ali Chaudhry, Director, Scientific Information
Mr. M. H. Shabab, Chief Librarian
Assistant librarian.
Documentalists-2
Library Assistants-4

Staff training: Mr. Shabab has a Masters degrees in library science from Pakistani University.

Collection:

Primary subject area: support of NARC agricultural research
Extent of water publications: 100 volumes, 50 listed in AGRIS
Extent of science publications: 8,000
Books: 8,164 volumes including bound journals
Subscriptions: 410 received mostly through a jobber in UK
Length: most around 5 years, some 15-20 years.
Abstracts/Indexes: AGRIS
Access to AGRIS online, receiving 23 sdi's
Apparently receiving 3 sdi's from CALS through USAID (Harry Dewey)
100 retrospective searches of AGRIS available yearly (used 46 in 1983, 35 so far in 1984)
Special: 2000 Pakistani developed documents (input into AGRIS)
Age: Library began service in 1980, facility newer than that.
Most books less than 5 years old. Don't look well used.
Publications: Fresh Arrivals (monthly list of new serials, books)
Current Contents: (tables of contents organized in four subjects: animal sciences, crop sciences, social sciences, and natural resources; monthly) AGRIS sdi's copied and distributed

Budget:

Source: PARC
Amount: $20,000 of which $15,000 buys journals. (90% foreign)

Technical Services:

Classification system: Dewey to 5 decimals.
Govt. documents only filed by agency/series
Journals shelved by Dewey class.

Subject classing: Dewey shelflist only.

Interlibrary Cooperation:

Formal: Photocopies only. Books not loaned.

Charges: Rs 3.00 ($.20) for up to 10 pages of photocopy.

International access: AGRIS for bibliographic citations. Are borrowing for other libraries, presumably in the AGRIS network.

Memberships: Coordinating effort to join all agriculture libraries into a network. First effort is to make a one-year list of serial holdings in 23 libraries nationwide.
Long-range plans for complete serial holdings and a union catalog of monographs.

Computer Access:

Library: AIM 16 (Digital Corporation of Japan): 16/32 micro. with 40.0 and 7.5 mbyte hard disks and 1.1 mbyte floppy.
Not used for AGRIS formatting. Presumably preparation of current awareness journals and the union lists of the agriculture libraries are done on the computer. No terminal visible in library or managers' offices.

Problems:

Difficulty in getting all agencies to donate documents for AGRIS.

Lack of resources to get all the cooperating agencies to input into the union serials lists and the union catalog.

Assets:

Strong budget. Large well-trained staff. Good facility. Leader in organizing resource sharing for agricultural library community. AGRIS official agency with access granted through that into the international community.

LIBRARY PROFILE: Center for Excellence in Water Resource Engineering
P. O. Box 1163
G. P. O. Lahore Telephone: 332210

Staff: Dr. N. M. Awan, Director
Miss Ruby Yamin, Librarian

Staff training: Miss Yamin has a Masters degrees in library science from Punjab University.

Collection:
Primary subject area: water resources engineering
Books: 10,000 volumes including bound journals
Subscriptions: 34 purchased.
Length: expanding to 30 years for most, buying microfilm
Abstracts/Indexes: none
Age: Library is 10-12 years old, not staffed until 1980. Most books 5-10 years old. Well used.
Publications: none

Budget:
Source: Centre itself
Amount: $25,000 for materials plus salary support.

Technical Services:
Classification system: Dewey to 2 and sometimes 4 decimals. Govt. documents only filed by agency/series
Journals shelved by Dewey class.
Subject classing: Dewey shelflist only, but journal article are included.

Interlibrary Cooperation:
Formal: through PASTIC obligated to provide photocopies
Informal: whenever requested (seldom)
Charges: free for photocopies. Books not loaned.
International access: Uses BLLD and UNESCO coupons to get foreign journal articles for staff only.
Memberships: Pakistan Science and Technology Information Center (PASTIC) which provides library promotion assistance in return for input into their union catalog.

Computer Access:
Library: Possibility of access to a PDP 11/34 minicomputer.

Organization: IBM PC on order to use with IBM 1130 for training.
IBM 370 and time sharing on the WAPDA mainframes for scientific applications in research/teaching.

Problems:

Microforms cannot be printed. Copying all cards by hand is time consuming and makes PASTIC membership a burden. Short staffed since there is no clerical help at all. Space is at a premium (but plans to expand to new space in next year.)

Assets:

Strong collection, especially in journals. Multi-media collection growing. Anxious to form local, national and international linkages to serve clients.

LIBRARY PROFILE: NESPAK Library
Room 434
WAPDA House
Lahore

Staff: Mrs. Shabana Bilal, Librarian
Library Clerk
Typing pool when needed

Staff training: Mrs. Bilal has a Masters degrees in library science from a Pakistani university.

Collection:

Primary subject area: applied sciences and engineering

Books: 8,000 volumes including bound journals (circulates 250/mo)

Subscriptions: 45 purchased (decreased from 60 2 years ago due to rising costs.

Length: 4-6 years in most cases

Circulates each journal to internal staff on arrival. Has little use of back issues of journals (probably as a result of the routing.)

Special: Has all the NESPAK technical reports and drawings. These are in all fields of engineering consulting in all parts of the country. 2400 now, adding 800 yearly.

Abstracts/Indexes: none

Age: Library is 10-15 years old. Most books 10 years old. Well used.

Publications: none

Budget:

Source: NESPAK

Amount: $20,000 for materials plus salary support.

Technical Services:

Classification system: Books & serials arranged by a "main topic, subtopic, accession number" system. NESPAK documents are shelved by the project number assigned externally.

Subject classing: By the predetermined topics in shelf-list order

Interlibrary Cooperation:

Formal: none. Tried unsuccessfully to get librarians in Lahore to agree to loan of books with usage restricted to the libraries.

Informal: borrows as personal action from others, does not loan.

Charges: any user must pay all costs (must go outside building to commercial firm to even make photocopies)

International access: none
Memberships: none

Computer Access:
Library: none

Problems:
Lack of space. Increasing costs of journals are forcing reduction in their numbers.

Assets:
Self-sufficient mostly. Adequate staffing.

LIBRARY PROFILE: WAPDA Central Library
Room B43
WAPDA House
Lahore

Staff: Salma Begum, Librarian
Assistant Librarian
Clerk

Staff training: Salma Begum has a Masters degrees in library science from a Pakistani university.

Collection:
Primary subject area: Engineering and the basic sciences.
Extent of water publications: few hundred titles
Books: 10,125 volumes (90% technical, 10% general 310 is average monthly circulation.)
Subscriptions: 126 (15 purchased through PakBook Corp., jobber)
Length: 5 years
Abstracts/Indexes: none
Special: Most WAPDA publications
Age: Library has been open since 1980.
Most books less than 10 years old.
Publications: has a monthly or bi-monthly selected list of new publications distributed to 2000 WAPDA engineers nationwide.

Budget:
Source: WAPDA
Amount: Materials $6100 (up from $2100 previous year, $7200 next year.)
Special: Received grant for 400 volumes from British Council, from British publishers only.

Technical Services:
Classification system: Dewey to 2 decimals
Govt. documents only filed by agency/series
Subject classing: Dewey shelflist only. Books only.

Interlibrary Cooperation:
Formal: none
Informal: will give photocopies on request, seldom asked. Goes to local libraries when own collection insufficient.
Charges: free
International access: none
Memberships: none.

Computer Access:
Library: none now. Plans for a micro-based system in indefinite future.
Institution: Numerous mainframes. Probably mini's as well.

Problems:

Cannot catalog materials as desired due to lack of staff time.

Sees a microcomputer system as the answer to this and a way to generate more reports and bibliographies internally.

Needs more books especially in mechanical, civil, and electronics engineering. Need a photocopier for the library. Need microform readers (to save on expenditures on journals). Needs more space currently, but will have an adjacent room within a month.

Assets: Strong organizational support from the Chief Engineers who are the library's governing board. Part of a network within the agency which reaches every part of the country. Client-oriented. Increasing financial support from WAPDA.

LIBRARY PROFILE: University Library
University of Agriculture
Faisalabad

Staff: Mr. Najat Ali Khan, Librarian in Charge
Associate Librarian
Library Assistants
Clerks

Staff training: Mr. Najat has a Masters in Library Science from the University of Illinois, Champaign-Urbana.

Collection:

Primary subject area: All areas of agriculture
Extent of water publications: not a specialty, but supports coursework at Bachelors level
Books: 170,000 volumes including bound journals plus 15,000 textbooks.
Subscriptions: 182 (reduced from 400 due to budget cuts)
Length: most are in excess of 10 years
Abstracts/Indexes: Bibliography of Agriculture (USA), all the individual Commonwealth Agricultural Bureaux indexes,
Biological Abstracts, Chemical Abstracts, AGRIS, Government Reports Abstracts and Index (NTIS).
Special: 3,000 theses and dissertations (will be microfilmed). All Pakistani and several foreign newspapers (currently being microfilmed for preservation.)
Age: Library is approximately 15 years old.
Most books less than 10 years old.
Publications: none

Budget:

Source: University budget
Amount: unknown

Technical Services:

Classification system: Dewey to 6 decimals
Subject classing: Library of Congress subject headings with only major headings. (No analytics.)

Interlibrary Cooperation:

Formal: will loan books on request. Uses British Council and USIS libraries to obtain books. Uses PARC/NARC to obtain journal articles not held.
Charges: none
International access: through PARC/NARC to AGRIS centers.
Memberships: none.

Computer Access:

Library: none

Problems:

Knowing what resources others have in order to borrow effectively.

Rising cost of journals and abstracting/indexing services.

No staff to perform reference and library instruction.

Assets: Largest collection in agriculture in country. Anxious to share all resources. Willing to take a lead in building network cooperation.

LIBRARY PROFILE: Ayub Research Center
Jhang Road
Faisalabad

Staff: Mr. Mukhtar Bhatti, Deputy Director, Research
Librarian
Clerks-4

Staff training: unknown

Collection:
Primary subject area: areas of agriculture supporting research primarily commodity oriented
Extent of water publications: one journal, a few books
Books: 15,000 excluding bound journals
Subscriptions: 140 (collection is almost exclusively journals)
Length: most are in excess of 10 years
Abstracts/Indexes: most of the Commonwealth Agricultural Bureaux indexes available back for 15 years.
Age: Library is approximately 20 years old.
Most books more than 10 years old.
Publications: none library related. (Institute puts out numerous extension publications.)

Budget:
Source: Government of the Punjab
Amount: $20,000

Technical Services:
Classification system: Dewey to 2 decimals
Subject classing: Dewey shelflist order only.

Interlibrary Cooperation:
Formal: Uses British Council and USIS libraries to obtain books.
Informal: Will provide photocopies if ever requested. No books loaned.
Charges: none
International access: none
Memberships: none

Computer Access:
Library: none

Problems:
Lack of space. No climate control to keep reading areas comfortable. Disinterested in networking and resource sharing.

Assets: Large collection of agriculture journals. Has sufficient budget. Librarian knows the collection intimately.

LIBRARY PROFILE: United States Information Service Library
60 - Khyaban-e-Quaid-i-Azam
F-6/4 Blue Area
Islamabad Telephone: 824051
ext. 244

Staff: Mr. Manzur H. Soil, Head Librarian
Serials Librarian
Reference Librarians-2
Library Assistant-2

Staff training: Mr. Manzur has a Masters degrees in library science from Lahore University.

Collection:
Primary subject area: United States
Extent of water publications: minimal
Extent of science publications: good general reference
Books: 8,500 volumes including standard bibliographic tools (only ones seen in Pakistan)
Subscriptions: 200+ brokered through USIS central purchasing.
Length: 5 years in print, back to 25 years on microfilm
Abstracts/Indexes: several in all subject areas; Readers' Guide, Monthly Catalog of US Government Publications, and Government Reports Abstracts (NTIS) most important.
Special: Photograph and vertical file collections. irregularly. Have some WAPDA materials from 1960's.
Age: Library is new. Former collection burned 5 years ago.
Most books less than 5 years old.
Publications: none

Budget:
Source: From USIS itself
Amount: Unknown.

Technical Services:
Classification system: Dewey to 3 decimals.
Govt. documents only filed by agency/series
Subject classing: Full subject access, Library of Congress heading

Interlibrary Cooperation:
Formal: extensive including books and photocopies.
Informal: not needed
Charges: free
International access: indirect back to U.S. libraries
Memberships: Pakistani library association

Computer Access:

Library: none

Institution: word processors at the least. Other unknown.

Assets:

Strong budget. Large well-trained staff. Good facility.
Mandate to share all materials as widely as possible.
Leader in organizing local training for library community.

ITINERARY OF VISIT

9 October Karachi

Applied Economics Research Institute (AERI)
Mr. Shahid Zahid, Senior Research Economist
Mr. Akhtar Hai, Research Economist & head of Library Affairs Committee
Mrs. Matul Wadood, Librarian

10 October Islamabad

Irrigation, Drainage and Flood Control Research Council (IDFCRC)
Dr. Mashhood A. Kureishy, Chairman
Mr. Makhmoor Ahmad Goheer, Director-Secretary
Mr. Munir Bhatti, Deputy Director, Planning & Foreign Assistance
Mr. Syed Khurshid-ul-Hasan Jafri, Deputy Director, Documentation and Library
Mr. Anjum Khaliq, Assistant Director, Public Relations
Mr. Shamim Iqbal, Assistant Director, Foreign Assistance and Training
Miss Kamar Afroz, Assistant Director, Documentation and Library

United States Information Service Library (USIS)
Mr. Manzur H. Soil, Librarian

11 October Islamabad

Pakistan Agriculture Research Council (PARC)
Mr. Mushtaq Ahmad Khan

PARC/National Agriculture Research Center Library (PARC/NARC)
Mr. Anwar Ali Chaudhry, Director, Scientific Information
Mr. M. H. Shabab, Librarian

IDFCRC (returned)

13 October Lahore

Center for Excellence in Water Resources Engineering (CEWRE)
Dr. N. M. Awan, Director
Miss Ruby Yamin, Librarian

NESPAK Library
Mrs. Shabana Bilal, Librarian

14 October Lahore

WAPDA Central Library
Begum Salma, Librarian

15 October Faisalabad

University of Agriculture Library
Mr. Najat Ali Khan, Librarian In-charge

Ayub Research Centre
Mr. Mukhtar Bhatti, Deputy Director, Research
_____, Librarian

EQUIPMENT LIST
INFORMATION SYSTEMS

ITEM CLASS	UNIT COST	UNITS	TOTAL COST
COMPUTERS (PC TYPE)			
Personal Computer (512kb)	6,500	4	26,000
Volt. Regulator w/battery	700	4	2,800
Monitor	400	4	1,600
Printer (dot matrix)	650	4	2,600
Printer (impact let. qual.)	900	4	3,600
Software (DOS, W. p. etc.)	2000	4	8,000
Spare Parts	1000	4	4,000
Tool Kit	200	4	800
			49,400
OFFICE EQUIPMENT			
Photocopier	6000	3	18,000
Overhead projector	300	2	600
Projector 35mm	550	1	550
			19,150
LIBRARY EQUIPMENT			
Microfilm/microfiche reader	450	3	1,350
Portable microfiche reader	250	6	1,500
Microformat reader/printer	3000	3	9,000
Catalog card duplicators	1000	11	11,000
Air conditioners	1100	6	6,600
Vacuum cleaner	200	1	200
Microform storage cabinet	1200	1	1,200
Card catalog(60 tray)	1800	1	1,800
Journal display rack	300	1	300
Numbering machine	150	1	150
Cardex,guides,boxes	800	1	800
Microfilm camera	15000	1	15,000
Microfiche duplicator	5000	1	5,000
IBM mag card composer	5000	1	5,000
Electric typewriters	1000	2	2,000
Stencil machine	3000	1	3,000
Thermal binding machine	700	1	700
Ring binding punch	330	1	330
Punching/stapling machine	210	1	210
Mini-offset press & scanner	15000	1	15,000
Functional color darkroom	5000	1	5,000
Commercial video studio	40000	1	40,000
			125140

PROJECT TOTAL W/O VEHICLES	193690
PROCUREMENT COSTS(5%)	9685
PACKING/FREIGHT(5%)	9685
TOTAL COSTS W/O VEHICLES	213059
VEHICLE COST	0
PROJECT TOTAL W/VEHICLES	213059

ANNEX J

PERSONS INTERVIEWED

Irrigation Department, PUNJAB

Mian Masood Akhtar	Secretary
Ijaz Ahmed	C. E. Flood Control
Rana Khurshid Anwar	C. E. Provincial Coordinator, ISM Project
Rana M. Aslam Chohan	C. E. Lahore
Riaz-ur-Rahman Rao	C.E. Multan
Ch. Nazar Muhammed	C.E. Sargodha
Sikandar Hayat	S.E. Qadirabad Balloki Link Circle, Sheikhupura
Riaz Ahmad Khan	S.E. Jhelum
Mazhar Saeed Quereshi	C.E., Faisalabad
Mhd. Yaqoob Khan	S.E. Hqtrs, Faisalabad
Khawaja Saleem Uddin	S.E. Lower Chenab Canal, West, Faisalabad
Zafar Ahmad Khan	S.E. Drainage, Faisalabad
Saleem Quereshi	XEN Hqtrs Operations, Faisalabad
Abdus-Sahar Malik	XEN SCARP, Faisalabad
Mohammed Ashraf Cheema	XEN, Sheikhupura
Mohammed Aslam Quershi	XEN, SCARP I
S. Aijazul Hassan	XEN
Malik Mhd. Akram	SDO, Canal Bank, Lahore
Qazi Anwar Ali	Xen, Bhalwal Irrigation Workshop

Irrigation Department. SIND

Abdul Rashid Shaikh	Secretary
A. Rashid Memon	Deputy Secretary
Khalil Ahmad Soomro	Additional Secretary
A. L. Quadri	ISM Coordinator
Aziz Akhtar	Section Officer, Irrigation System Reclamation Project
Qadir Bux	Director of Design
Atta Mohammad Soomro	Chief Engineer, Irrigation Development

WAPDA

Dr. Bokhari	Member Water, deceased
S.M. Ayoob	Senior Officer for Research & Development
M. Badruddin	General Manager Planning
K.G. Butt	D.G. Training
Muhammad Munir Chaodhry	Project Director, Water Resources Planning and Research Dept.
Ahmed Masud Chaudry	C.E., ACOP
Amjad Hussain	C.E., Monitoring and Eval.
Hamid-Ullah Khan	Director, Water Quality & Soils Laboratory
Mian Mohd. Ashraf	C.E., Planning and Investigations
Ch. Rahmat Ali	Project Director, M & E Planning Division
R.I. Ahmad Khan	Deputy Director (Economics) Planning Division
I.A. Khaliq	C.E., Hydrology & Systems Analysis
Fazil Sabir	Director, Systems Analysis
Iqbal Ahmed	Monitoring and Evaluation

Nadir Khan	Director Project Planning, WAPDA South
Sayed Mukarram Ali	General Manager, WAPDA South
Waryam Ali Mohsin	Senior Engineer/Deputy Director, Agricultural Engineering Section, Planning Division
Ch. Mhd. Amin	Senior Engineer
..... Shamsi	D.G. Directorate of Geohydrology
Mian Saeed	Geologist
.....	Director General, Computer Center
Iqbal Chaudry	Director, Analog Model Studies
Rashid Ali	Senior Hydrologist, Directorate of Geohydrology

WAPDA Academy, Tarbela

Khalid Mohtadullah	Principal

Federal Ministry of Water and Power

Major General Agha Manzoor Rauf	Additional Secretary, Water
Ch. Altaf Hussein	Chief Engineering Advisor Chairman, Flood Control Commission
Naved Ali Nasri	Joint Secretary

Drainage & Reclamation Institute of Pakistan (DRIP)

Arz Mohammed Talpur	Director General
Maula Bux	Civil Engineer, Director Services
Talib Ali Chaudry	Director Lysimeters
G.M. Soomro	Director Research (October)
Yassin	Deputy Director, Soils
Rashid Ahmad	Director
Mal Nas Khalid	Deputy Director, Soil and Water

Haroon Chang	Deputy, Director, Soil & Water Laboratory

Lower Indus Water Management & Reclamation Research Project

Muhammad Umar Khan	Senior Research Officer, Hyderabad

Sind Agriculture University

A.Q. Ansari	Vice Chancellor
Ghulam Mustafa Soomro	P.E., Asst. Prof., Dept. of Irrigation & Drainage Engineering (August)
Kazi Abdul Muktadir	Dept. Irrig. & Drainage Engineering
Bashir Ahmed Chandio	Assoc. Prof. and Dept. Head Dept. Irrig. & Drainage Engineering
Ghulam Nabi Kalwar	P.I., Department of Agronomy
Muzaffar Kalharo	Dept. of Agricultural Engineering
Nek Mohammed Narejo	Dept. of Agricultural Engineering
I.D.M. Kundhor	Dean, Faculty of Agricultural Engineering
M. Sami Abid Khan	Professor and Chairman, Dept. of Agricultural Economics
Sharif Ahmed Saddiqi	Assistant Professor, Dept. of Agricultural Economics

Sind Regional Plan Organization

Sajjad Hussain	Director
Mutawakil Kazi	Additional Director, Human Resources
A. G. Pirzada	Additional Director, Agriculture
Noor Mohammed Memon	Additional Director, Land Use and Settlements

Applied Economics Research Institute

Ashfaq Qadri	Director
Shahid Zahid	Senior Research Economist
Akhtar Hai	Research Economist

Provincial Department of Agriculture, Sind

Mohammed Ashraf	Acting Director, OFWM Project
Aftab Ahmed Khan	Director General of Extension
K.M. Soomro	Director for Adaptive Research Extension Service

MONA

Bashir Ahmed	Superintending Research Officer
Mehr Shahadat Khan Herl	Executive Engineer
Ch. Abdul Hafeez	Senior Engineer, Hydrology and Water Management
Dr. Muhammad Ramzan	Senior Research Officer (S&R)
Ch. Barkat Ali	Senior Research Officer (Ag Econ)
Ch. Muhammad Anwar	Senior Research Officer (Extension)
Maghmoom Muhammad Iqbal	Senior Research Officer (Agronomy)

University of Agriculture, Faisalabad

Qurban Ali Awan	Principal Investigator, Agricultural Engineer, Water Management Research Project
Arshad Ali	Principal Investigator, Agricultural Engineer, Water Management Research Project
Abdul Rauf	Principal Investigator, Farm Management Unit, Water Management Research Project
Mian M. Bashir Kausar	Principal Investigator, Water Users Associations, Water Management Research Project

Abdul Rauf Chaudhry	Principal Investigator, Farm Management Unit, Water Management Research Project
Afzal Khan	Research Officer, Water User Associations, Water Management Research Project
..... Subin	Chairman, Department of Farm Machinery and Power
Khalid Pervez	Chairman, Department of Irrigation and Drainage
.....	Dean, Agricultural Engineering and Technology
Ahmad Saeed Khan	Professor Agricultural Economics Secretary Punjab Agricultural Research Coordinating Board, Head Water Management Research Project
Mhd. Hayat Khan	Soil Scientist
Ashfaq Mirza	Associate Professor, Department of Rural Sociology

<u>Provincial Department of Agriculture, Punjab</u>

Mohd. Pervez Masud	Secretary
Mohd. Afzal Malik	Director General Ag Extension
Rana Zahoor Qamar	Dep. Director Plant Protection
Mohd. Sadiq Cheema	Director General, Water Management
Mushtaq Gill	OFWMD Training Director
Mohammad Shafi	Agricultural Engineer, OFWMD Training Institute
Mumtaz Ahmad Awan	Irrigation Agronomist, OFWMD Training Institute
Muhammad Saleem	Assistant Agricultural Economist, OFWMD Training Institute
M. A. Bajwa	Director General, AARI Faisalabad
Mohd. Hayat Bhatti	Ag. Chemistry and Soils, AARI, Faisalabad (retired)

Punjab Engineering Academy, Lahore

Mian Khalil Ur-Rehman	Principal

Engineering University, Lahore

Dr. N.M. Awan	Director, Centre of Excellence in Water Resources Engineering

Punjab University, Lahore

Mohammad Anwar	Chairman, Dept. of Sociology
Yar Mohammad Khan	Dean, Faculty of Arts

Irrigation, Drainage, and Flood Control Research Council, Islamabad

Mashood A. Kureishi	Chairman
Makhmoor Ahmed Goheer	Director/Secretary
Munir Ahmed Bhatti	Deputy Director, Planning and Foreign Assistance
M. Muzaffar Iqbal	Director, Evaluation, Programming Consolidation and Research
M.I.A. Hashmi	Director

Department of Agriculture, NWFP

Mahboob Gul	OFWM, Deputy Director and Acting Director, Peshawar
Ralph E.H. Atkinson	Senior Agricultural Planning Officer

Mardan SCARP, NWFP

Colin E. Lovegrove	Agricultural Engineer, Drainage
Mohammad Zaman Khan	Project Director
Sadiq Awan	Soil Scientist

Department of Irrigation, NWFP, Peshawar

Abdul Aziz	Chief Engineer
Aslam Saleem	Assistant Director of Designs
Rab-nawaz Khan	Director of Designs and Provincial Coordinator ISM Project
A.B. Balouch	Executive Engineer, Tubewell Irrigation Division, Warsak Irrigation Division

Pakistan Agricultural Research Council (PARC), Islamabad

Amir Mohammad	Chairman
Ch. Mohammad Anwar Khan	Member, Natural Resources Division
Akhtar Bhatti	Principal Scientific Officer, Division of Natural Resources
M. Sarwar Anjum	Director of Agricultural Economics and Marketing, Div. of Social Sciences
Mushtaq Ahmed Khan	Director, Research, Land and Water Resources, Natural Resources Division

OFWM Program, Federal Cell, Ministry of Agriculture

A.M.H. Kango	Director-General
Baz Mohammad Khan	Director-Field
M. Farooq Ahmad	Agronomist
Harold Bergsma	CID, World Bank TA, OFWM Training Institute, Lahore
Akhtar Hameed Khan	Project Director, Orangi Pilot Project
Shamim Zainuddin Khan	Joint Director of Health and Education, Orangi Pilot Project

Agha Khan Rural Support Programme, Gilgit

Shoaib Sultan Khan	General Manager
Tariq Hussain	Programme Economist
Robert d'Arcy Shaw	Director, Special Programmes

National Centre for Rural Development, Islamabad

Dr. Akbar Ahmed	Director General
Salim Maqsud	Director of Planning Training and Administration
Mohammad Azim	Director of Research and Training Curriculum

Pakistan Institute of Development Economics, Islamabad

Dr. Fazd Mohammad	Research Economist

National Institute of Folk Heritage

Dr. Adam Nayyar	Research Director

Quaid-i-Azam University, Islamabad

Dr. Mohamed Abdul Rauf	Chairman, Department of Anthropology
Dr. Doris Nayyar	Department of Anthropology

Fruit Development Research Center, Quetta

M. Saeed	Project Director
Jim Cartwright	FAO Advisor

Government of Baluchistan

S.R. Poonegar	Additional Chief Secretary, Planning and Development, Quetta
Muzaffar Ali	Director, OFWM, Quetta
Atta M. Jaffar	Secretary of Finance, Quetta

Abdur Raziq Khan	Secretary of Irrigation, Quetta
Zulfiqar Ali Khan	Director General for Extension
Brig. M. Mushtaq	Project Director, Minor Irrigation & Agricultural Development Project Quetta
Akram Kahloon	Engineer, Minor Irrigation and Agricultural Development Project, Quetta
Syed Abid Hussain	Sub-engineer, Las Bela, Hub Chowki

Other USAID Consulting Teams

Walt Halset	ISM Team, Chief of Party
Max Williams	" Engineering Team Leader
Ray Tilton	"
Sam Cooper	"
Jim Ball	"
Bill Brown	" ISM Team, Quetta
Willard Rusk	" Equipment Team Leader
Tom McCarthy	" P & M Team
Bill Bell	OFWM Project, Lahore
Robert Smail	OFWM Training Project, Hyderabad
Steven Kovacks	Irrigation Agronomist, OFWM Project, Quetta

International Rice Research Institute, Los Banos, Philippines

Edwin Price	Agricultural Economist, Farming Systems
Muhammad Akbar	Research Fellow, Plant Breeding Chief Scientific Officer, PARC Islamabad
Amir U. Khan	Agricultural Engineer, Former Project Director, IRRI/PAK Agricultural Machinery Program, Islamabad

University of the Philippines, Los Banos, Philippines

Manuel M. Manuel	Director UPLB Computer Center FAO Computer Training Specialist to Ministry of Agriculture, Islamabad

USAID

Alan Hankins	Chief ARD/O
Russel Backus	ARD
John Anania	ARD
John Quay	"
Jalil Ahmed	"
Nek Buzdar	"
Hassan Mirza	"
Marian Fuchs-Carsch	PDM/O
Basharat Zaidi	LO/Karachi
Mohammad Anwar	LO/Karachi
S.A. Chughtai	LO/Lahore
Tariq Durrani	LO/Peshawar
Robert Traister	Quetta
Masood Khan	LO/Quetta
William M. Miller	Agronomist, Tribal Areas Development Project, Peshawar
Charles Herndon	Engineer, Tribal Areas Developmen Project, Peshawar
Fred Zumwalt	Quetta

World Bank

Anis Yousef	Irrigation Engineer

Outside Consultants

P.S. Lee	Team Leader, Sir M. McDonald & Partners, Hyderabad
Jim Dempster	Partner, Sir M. McDonald & Partners, Cambridge England
Peter Whiteman	Agronomist, Integrated Rural Development Project, FAO/UNDP, Gilgit
Jon M. Beeny	Irrigation Agronomist, Halcrow-Ulg Baluchistan Minor Irrigation and Agricultural Development Project, Quetta
Frank E. Dines	Representative, Asia Foundation, Islamabad
N.R. Hayles	Rural Development Planner, Halcrow-Ulg Baluchistan Minor Irrigation and Agricultural Development Project, Quetta
Tanamur A. Hyder	Director, Development Workshop (Consultants, Sattar Mansions, 17 Link McLeod Road, Lahore. Tel: 304554, 304558, 68132)
Riaz Ahmed	Director, Development Workshop
Mazhar Ali	Civil/Irrigation Engineer, Development Workshop
Abbas Hasan	Construction Engineer, Development Workshop
Reza Ali	Planner, Development Workshop
K.A. Sandeelo	NESPAK
Graham Holt Elizabeth Holt	Coordinator/Training, ADB Technical Assistance Team, OFWM Proper, Islamabad
Derek Byerlee	Regional Economist, International Maize and Wheat Improvement Center, Islamabad

NWFP University of Engineering and Technology

M. Athaullah	Professor, Civil Engineering
M. Abdullah	Dean, Engineering University
Rafiq Ahmad	Professor, Agricultural Engineering
Arshad Aziz	Professor, Agricultural Engineering

NWFP Provincial Irrigation Department

Gulzar Khan	Chief Technical Officer
Amir Haider	Section Officer, Construction
Aktar Ali Ismaeli	S.E., Central Irrigation Circle

ANNEX K

FOREIGN AGRICULTURAL RESEARCH GRANTS PROGRAMS

FOREIGN AGRICULTURAL RESEARCH GRANT PROGRAMS

[Special Foreign Currency Research (PL 480)]
(U.S. - Poland Joint Board)
(U.S. - Yugoslavia Joint Board)

January, 1982

Prepared by
International Research Division
IRD-OD-1021

CONTENTS

Standard Abbreviations

Chapter 1 - Introduction	PAGE
100 Purpose	1
101 Origin and General Policy	1
102 Organization	1
102.1 Regional Office	1
Exhibit 101 List of Excess Currency Countries	
Chapter 2 - Research Proposals	
200 Research Proposals	3
201 Areas of Research Interest	3
201.1 Utilization Research	3
201.2 Marketing Research	3
201.3 Agricultural Economics Research	3
201.4 Farm Research	4
201.5 Human Nutrition Research	4
201.6 Forestry Research	4
202 Submission of Proposals	4
203 Preparation of Research	5
203.1 Preparation of Technical Data	5
203.2 Preparation of a Budget	5
Exhibit 203.2 (Page 1) Budget, Research Proposal	10
Exhibit 203.2 (Page 2) Budget, Research Proposal (Contd.)	11
204 Appraisal of Research Proposal	12
Chapter 3 - Research Grants	
300 Grant Negotiation	13
301 Grant Payments	13
302 General Provisions	13
A. Duration	13
B. Maximum Obligation	14
C. Payments	14
D. Accounting for Funds	14
E. Unspent Grant Funds	14
F. Reporting Requirements	14
G. Access to Facilities, Records, and Accounts	14
H. Research Assistance	15
I. Travel	15

		PAGE
	J. Capital Assets	15
	K. Publication of Research Results	15
	L. Patent and License Rights	15
	M. Prior Grantee Country Requirements	16
	N. Expenses for U.S. Patent	16
	O. Prohibition Against Certain Fees	16
	P. Personal Benefits	16
	Q. Research Materials	17
	R. Amendments	17
Chapter 4 - Grant Reporting Procedures		
400	Reports - General Requirements	18
401	Semi - Annual Research Reports	18
402	Annual Research Reports	18
	A. Title Page	18
	B. Summary	19
	C. Detailed Report	19
403	Final Research Report	30
	A. Content	20
	B. Translation of Reports into English	21
	C. General Considerations	21
	D. Format	21
404	Fiscal Reports	23
405	Trip Reports	25
406	Submission of Reports	25
407	Number of Copies	25
	Exhibit 401 Research Progress Report	26
	Exhibit 404 Fiscal Report	28
Chapter 5 - Guides and Requirements for Travel		
500	Travel of Grantees	29
	500.1 Requests for Authorization to Travel	29
	500.2 Notification of Authorization for Travel	30
	500.3 Expenses Allowable for Travel Between Countries	31
	500.4 Payment of Travel Expenses	32
	500.5 Failure to Travel	32
	500.6 Report of Travel	32
	500.7 Use of Air Carriers	32

ABBREVIATIONS

FAISECTC	- Federal Administration for International Scientific, Education, Cultural, and Technical Cooperation (Yugoslavia)
FERRO	- Far Eastern Regional Research Office
ICAR	- Indian Council of Agricultural Research
IRD	- International Research Division
OICD	- Office of International Cooperation and Development
PARC	- Pakistan Agricultural Research Council
SFC	- Special Foreign Currency
SFCRP	- Special Foreign Currency Research Program
USDA	- United States Department of Agriculture

Chapter 1 - INTRODUCTION

100 PURPOSE

The objective of the Special Foreign Currency Research Program (SFCRP) is to develop new information in the fields of research pertinent to the mission of the United States Department of Agriculture (USDA), with the aim of improving uses and markets of farm and forest products and increasing the efficiency of farm and forest production.

101 ORIGIN AND GENERAL POLICY

The SFCRP originated in 1958 under the authority of subsections 104(a) and 104(k) of U.S. Public Law 480 (The Agricultural Trade Development and Assistance Act of 1954). By amendments to this Public Law, these subsections are now known as Sections 104(b)(1) and 104(b)(3). At the present time, Special Foreign Currency (SFC) funds are made available for new grants only in countries (Exhibit 101) designated as excess currency by the Treasury Department and as appropriated by the U.S. Congress.

In addition to research grant programs in the excess currency countries, similar programs are conducted in Poland under terms of the 1974 Marie Sklodowska-Curie Joint Fund to finance scientific and technological activities, and in Yugoslavia under terms of the U.S.-Yugoslav Joint Board on Scientific and Technological Cooperation established in 1973. The joint programs in Poland and Yugoslavia are funded by deposits from the Polish and Yugoslav Governments and equal contributions as appropriated by the U.S. Congress.

Grants are made to colleges, universities, research institutes, and other agencies organized to conduct research. The institutions normally have the personnel, general equipment, and facilities necessary to conduct research. Grants are financed with local currencies, are issued to an institution, not an individual, and must be accepted by an authorized representative of the grantee institution and the foreign government.

102 ORGANIZATION

The International Research Division (IRD) of the Office of International Cooperation and Development (OICD) is responsible for administration of the foreign research grant activities for the USDA.

102.1 REGIONAL OFFICES. To assist in administration of the program, the International Research Division, OICD, maintains a regional office in New Delhi, India. This Far Eastern Regional Research Office (FERRO) in New Delhi is responsible for OICD activities in the Far East Asia area. The Regional Office is organizationally attached to the Office of the Agricultural Counselor, U.S. Embassy.

Exhibit 101

List* of Excess Currency Countries

Burma	India
Guinea	Pakistan

*Subject to changes or limiting conditions at any time.

January 1982

200 RESEARCH PROPOSALS

Institutions interested in submitting research proposals should be guided by the following information and instructions.

201 AREAS OF RESEARCH INTEREST

Proposals may be submitted in any of the following broad fields of agricultural research : utilization, marketing, economics, plant and animal sciences, forestry, and human nutrition. They must be mutually beneficial to the agricultural interests of both the United States and the country concerned. The following paragraphs describe in more detail the types of research projects which may be financed under the Special Foreign Currency Research Program. While the descriptive material is illustrative only, it does cover the major areas in which research may be financed.

201.1 UTILIZATION RESEARCH. Proposals for utilization research are concerned with chemical and physical studies of a fundamental or applied nature that will contribute to the development of new or improved uses for the major agricultural crops particularly cereal grains (wheat and corn), cotton, animal and vegetable fats and oils (tallow and soyabean, cottonseed, and linseed oils), dairy products, hides and leather, meat, sugar crops (cane and beet), wool, fruits and vegetables, and tobacco.

201.2 MARKETING RESEARCH. Projects in marketing research provide basic information on the maintenance, improvement, and evaluation of the quality of agricultural crops in marketing channels ; or provide improved facilities, equipment, and work methods for handling agricultural products :

a. Quality Maintenance and Improvement
b. Quality Evaluation
c. Packaging
d. Quality of U.S. Agricultural Products in Foreign Markets
e. Conditioning, Handling, and Storing of Grain

201.3 AGRICULTURAL ECONOMICS RESEARCH. Projects in agricultural economics research provide basic information on the economics of farming, analysis of public food distribution, market structures, and practice and components of marketing margins.

a. Farm Economics
b. Analysis of Public Food Distribution Programs
c. Market Structures
d. Components of Marketing Margins for Foods

201.4 FARM RESEARCH. Projects in the field of farm research provide basic information that will lead to improved plant and animal production :

a. Soil and Water Conservation
b. Crop Production and Protection
c. Animal Production
d. Animal Diseases and Parasites
e. Plant Production and Protection
f. Agricultural Engineering
g. Energy Resource Development and Conservation

201.5 HUMAN NUTRITION RESEARCH. Projects in human nutrition research provide basic information that will lead to a better understanding of functions of and interrelations among nutrients and of human nutritional requirements, the physiological utilization of nutrients from different classes of foods, and quantitative methods of determining nutrients in cooked as well as raw foods and food mixtures.

201.6 FORESTRY RESEARCH. Projects in forestry research provide basic information leading to improved forest resources management :

a. Forest Management (including silviculture and tree breeding)
b. Watershed Management
c. Range and Wildlife Habitat Management
d. Forest Products Utilization Research
e. Forest Economics
f. Forest Fires
g. Forest Insects
h. Forest Diseases

202 SUBMISSION OF PROPOSALS

Research proposals may be submitted at any time. Because of nature of the programs and the review and approval process, several months usually elapse before an appropriate response may be made to a proposal.

All proposals originating with institutions located in India, Pakistan, or Burma should be addressed to the Director, FERRO, IRD:OICD:USDA, American Embassy, New Delhi, India. Proposals and correspondence orginating in other countries should be addressed to the Program Leader, Special Foreign Currency Programs, IRD:OICD:USDA, Federal Building, 6505 Belcrest Road, Hyattsville, Maryland 20782 USA, through the Agricultural Attache or Counselor, American Embassy, in the country in which the institution is located.

Proposals and correspondence orginating in Yugoslavia should be transmitted through FAISECTC, Kosancicev Venac 29, Belgrade. Proposals and correspondence originating in Poland should be transmitted through the Chief, P.L. 480 Coordinating Unit, Ministry of Agriculture, Warsaw. The proposals and correspondence then will be forwarded to IRD:OICD:USDA through the Agricultural or Science Counselor in the American Embassy, Warsaw or Belgrade.

203 PREPARATION OF RESEARCH PROPOSAL

Proposals should be written in English, using the following outline. Ten copies of each proposal are required. (Forty copies of proposals originating in India are needed by ICAR; thirty copies by PARC in Pakistan). All instructions must be followed carefully.

203.1 PREPARATION OF TECHNICAL DATA

a. Title. Give a brief but clear title of the proposed research investigation.

b. Name. Name and address of institution and name of director. Give brief history of the institution, its organization, available research personnel, facilities, physical plant, library, etc., which could contribute to the proposed research. Attach available general information bulletins and other publications.

c. Department or Laboratory. Name the head of the department and a brief history of his experience. Also, list the number and type of employees and any special equipment, facilities or experience which particularly qualify the laboratory or department to carry on the proposed research. Equipment of special use to the project should be listed.

d. Principal Investigator. Name of the proposed principal investigator for the project, his educational background and experience, publications relating to the proposed research, and any additional qualifications for this particular research.

e. Objective. Give a summary statement of the objective(s) of the investigation.

f. Importance of the Investigation. Describe importance in terms of knowledge or solution(s) to practical problem, including, if known, relation of the proposed research to previous studies in the field and other current studies now going forward at the proposing institution or elsewhere.

g. Plan of Work. State clearly how the study would be conducted. A detailed and well-prepared plan of work is essential to the appraisal of research proposal. Where possible, state the plan of work year-by-year.

h. Duration. Give the duration of the proposed project. The maximum time is 5 years.

i. Scientific Personnel Assigned. Estimate the total scientist years of professional and technical assistance required to accomplish the research. For example, if the principal investigator planned to spend one quarter of his time on the project and he had two full-time Research Officers and one half-time Senior

Research Officer, the total would be 13.75 scientist years over a 5-year period. For purposes of this scientist years computation, include personnel in possession of at least a bachelor's degree with experience in science (or equivalent).

j. Total Scientist years and Description of Duties. In addition to the scientific or professional scientist years described above, list all other personnel years of supporting effort. If functional titles are not adequately descriptive, describe briefly duties to be performed by each employee listed in the Salaries and Benefits section of the Budget described below.

203.2 PREPARATION OF A BUDGET (Exhibit 203.2)

a. Cost Estimates. Estimate costs for the total period of the grant in the currency of the country where the research is to be conducted. Break these costs down into the following categories in accordance with these instructions. In some instances, one or more of these categories may not be involved in a particular proposal. The fact that no cost is involved should be mentioned, however.

(1) Salaries and Benefits. Show position titles, names of professional staff, if known, percentage of time to be devoted to the project by each person, and salaries and benefits to be paid. The salaries should include all fringe benefits, such as cost of living allowances, honoraria, employee contributions to pension plans, insurance, etc. Policies of the institution or government with which the project principal investigator is connected will determine whether he/she or other professional assistants drawing a regular salary from that institution will receive an honorarium or any other additional payments from grant funds. Annual salary estimates should be based on the wage scales generally used by the institution and should include all applicable fringe benefits and allowances.

Show salary figures for only those periods the employee actually is expected to work on the project. For instance, if during the beginning or the final months of the project no plant propagator (as an example) is needed, do not indicate his salary costs for that time

If several months will elapse before a position can be filled, this should be reflected in the estimates also.

(2) Travel Within the Country. Under this heading, include per diem (daily allowance) and other travel costs, the number and purpose of trips proposed, and mode of travel. Show per diem and transportation costs separately. The per diem rates should be the same as generally authorized for other employees of the institution.

In a supporting statement, describe within-country travel as to number of trips, purpose, places to be visited. An example is :

"The principal investigator and other research personnel will make approximately ( ) trips each year and will visit forests in different parts of_____to study and collect forest plants and to transport equipment, needed supplies, and materials. Some of the locations to be visited are the areas of_____, _____, and_____. Transportation will be by motor vehicle and train."

(3) Transportation of Things. In supporting statements, describe items involved. Include estimated cost for shipping such things as samples of raw material, plants, fruits, animals, non-expendable equipment, etc. Include postage for parcel post mailings but not for correspondence.

For example :

"A total of _____ is considered necessary to cover the cost of transporting plant samples, soils, etc., from forest areas of _____ to the institution. The yearly distribution follows (or is indicated in the Budget)."

(4) Rents. Estimates under this cost category should be developed only when it is necessary to rent lands and buildings from other individuals or companies. If there are no costs expected for this item, a typical note of explanation would be :

"Buildings and lands owned by the institution are available and adequate for the conduct of this investigation.

Rental of buildings is unnecessary for this project, and there will be no charge to grant funds for this purpose."

(5) Contractual Services. Illustrative types of services are equipment repairs, storage and maintenance of vehicles, printing and reproduction, translation, or any other services performed under contractual arrangements with individuals or organizations for which direct payments are made. In addition to the single line entry contained in the budget and the distribution of estimated funding requirements by year, exemplary supporting statements might include the following :

"An estimated total of_____ will be needed for translation services and for making photographs and reprints.

Also, _____ will be required for printing and publishing reports; _____ for repairs to _____."

Repairs and alterations of rooms and structures should not be included in this category as they are not recurring costs and, therefore, should appear as cost under Capital Assets.

(6) Supplies and Materials. Some of the items which may be included under this category are glassware, chemicals, fuels, small-cost (less than $200 equivalent per item) laboratory equipment, experimental animals, forage, and office or laboratory supplies. Generally commodities in this expense category are consumed or converted after they are put into use. Be sure to explain any unusual items for which costs are included in the budget.

In countries where foreign exchange is not available, care must be taken to exclude supply items for which foreign exchange would be required.

(7) Indirect Costs. Some costs normally in this category would be those for general administration and support, postage, typing and secretarial services, costs not specifically identified with the research program or research area; e.g.. telephone and telegraph, share of library costs, share of copier costs, general heat, cleaning, and light. Such costs should be listed and distributed by year of estimated expenditure in support of the totals appearing in the budget.

(8) Travel Outside the Country. When travel outside the country is believed necessary to aid the effective completion of the project, a formal travel request must be submitted for approval by U.S. authorizing officers at least 5 months in advance of travel. To support costs indicated in the budget, tell reasons for travel and give estimates for per diem, transportation and other costs, mode of transportation to be used, duration of travel, and countries (and locations within the countries) to be visited.

Travel is normally limited to 21 days. Travelers are expected to use less than first class air transportation and to subsist on a per diem authorized in accordance with the practices of the grantee institution but not to exceed the equivalent of per diem allowed U.S. Government employees traveling in the United States, and that prescribed by Standardized Government Travel Regulations for travel in other foreign countries.

This item is not to be budgeted in countries where foreign exhange is not available or foreign travel under the grant program is prohibited by the grantee country.

(9) Capital Assets. Include under this category property of a more or less durable nature and costing more than the foreign exchange equivalent of of $200 for each item (excluding duties, tax, transportation, or installa-

tion costs) such as laboratory furniture, machinery, instruments and apparatus, and special type structures (such as greenhouses) or remodeling and alterations of existing structures to meet the needs of the research. These items must be needed specifically for the successful operation of the project and not principally for the purpose of upgrading the facilities of the institution.

The need for each Capital Asset item should be explained. For such items having a relatively long life, a policy of cost-sharing with the institution will be followed. Special-type structures, such as greenhouses, must be cost-shared. In countries where foreign exchange is not available, care must be taken to exclude supply items for which foreign exchange would be required.

BUDGET, RESEARCH PROPOSAL
(Cost Estimates in Local Currency)

Project Number _____

RECURRING COSTS

Salaries and Benefits :

Working Title	% of Time	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	TOTAL
	%						
	%						
	%						
	%						
TOTAL Salaries and Benefits :							
Travel Within Country :							
Per diem							
Transportation							
TOTAL Travel Within Country :							
Transportation of Things							
Rents							
Contractual Services							
Supplies and Materials							
Indirect Costs							
TOTAL Recurring Costs (Carry Forward)							

Exhibit 203.2 (Page 1)

BUDGET, RESEARCH PROPOSAL (Contd.)

	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	TOTAL
TOTAL Recurring Costs (Brought Forward)						
NON-RECURRING COSTS						
Travel Outside Country :						
Per Diem						
Transportation						
TOTAL Travel Outside Country :						
Capital Assets : 1/	Gross Cost		%Cost Shared		Cost to Grant Fund	
			%			
			%			
			%			
TOTAL Cost of Capital Assets to Grant :						
TOTAL Non-Recurring Costs						
TOTAL ESTIMATED COST OF GRANT						

1/ Indicate in footnotes proposed year of research in which expenditures are anticipated for capital assets. Reflect such information clearly so that it will be understood in which years specific items of capital assets are to be purchased. Generally, most capital assets will be purchased in the early years of the research period.

204 APPRAISAL OF RESEARCH PROPOSAL

Careful consideration is given by the USDA to every proposal received from a foreign institution through their government's clearance procedures to conduct research under the Special Foreign Currency Research Program. It is first reviewed within the Department of Agriculture and forwarded to appropriate technical specialists familiar with the type of research being proposed.

Such a review ascertains that the proposal has scientific merit and benefits for the United States, assures that the work proposed does not duplicate other research that has been performed or is now in progress, and coordinates the proposal with other research being done in the United States or elsewhere.

The review may result in acceptance of the proposal as it is submitted by the foreign institution. It also may result (1) in suggested modifications in the proposal to make the results more broadly applicable, (2) in suggestions for the use of new or different techniques to produce more valid or rapid results, or (3) in a recommendation that the proposal not be accepted. In some cases additional information will be needed before a decision to approve or disapprove can be made.

All proposals modified in the appraisal process are returned to the originating institution for further consideration. If the originating institution concurs in the modifications, the proposal is approved. The approved proposal is then usedto negotiate a grant when prior approval of the concerned government has been received and when funds are available.

Chapter 3 - RESEARCH GRANTS

300 GRANT NEGOTIATION

Representatives of the USDA will meet with representatives of the institution, preferably and whenever possible, at the institution where the research is to be conducted. The representatives of the USDA will be capable of discussing the technical aspects of the work and administrative and fiscal matters.

The purpose of this visit is (1) to discuss procedures to be followed in carrying out the research; (2) to ascertain more definitely the personnel, equipment, and facilities the institution proposes to use in conducting the research; (3) to familiarize the institution with the general provisions of the program; and (4) to establish the amount of funds needed to finance the project. Such visits by representatives of the USDA present an opportunity for the representatives of the institution to ask any questions they have regarding the program to secure information useful in conducting the project.

301 GRANT PAYMENTS

Grants are authorized for fixed total amounts to meet the estimated costs for the life of the project. Payments are made semi-annually to the institution for the period of the grant. An initial advance payment is made at the beginning of the grant to cover estimated costs for the first period. Semi-annual reports of expenditures and reports of research progress, including estimates of financial needs for the ensuing 6 months, are required from the institution. On the basis of these reports, further payments are authorized. Payments are always in the currency of the country where the grantee institution is located.

302 GENERAL PROVISIONS

General provisions have been developed which are applicable to all grants under this program. These General Provisions are usually discussed when a grant is negotiated. It is important that they be fully understood since an institution must agree to them when accepting a grant. A descriptive sample version of the General Provisions follows :

A. Duration. The grant starts on the day the grant letter is signed and dated by the authorized representative of the grantee organization. It shall remain in force and effect until completion of the agreed research, but shall not exceed the number of years stated in the grant letter or any amendment thereto. However, the grant may be terminated at any time by mutual agreement of the grantee and the Deputy Administrator for International Research, Office of International Cooperation and Development, U.S. Department of Agriculture (hereinafter referred to as the Deputy Administrator), or by the Deputy Administrator alone for good cause.

B. Maximum Obligation. The maximum obligation of the United States Government shall not exceed the total amount of the grant or any amendments thereto.

C. Payments. An advance payment in the currency of the country of the grantee will be made as soon as possible after receipt by the Deputy Administrator or his regional office reprepresentative of the signed and dated original grant letter. Payments other than the first advance payment will be made upon receipt from the grantee of satisfactory research progress reports and fiscal reports as required elsewhere under these General Provisions.

D. Accounting for Funds. Payments made by the Government and the expenses charged against such payments for the purpose of the proposal identified in the grant letter must be recorded separately in the accounts of the grantee organization. Such funds may be used only for the purposes outlined in the proposal identified in the grant letter. Expenditures will be supported by receipts or other appropriate documentation. It would be useful for the grantee to keep a separate set of account books of expenses charged to the grant. The grantee will also keep a separate record of any interest earned on grant funds. Such interest must be returned to the Treasury.

At the completion of the grant, a statement of financial condition will be prepared by the Deputy Administrator for concurrence by the grantee organization. It is recommended that records and accounts be established and maintained so as to accommodate the requirements of the fiscal report.

E. Unspent Grant Funds. At the end of the grant period any grant funds in the possession of the grantee organization not spent or firmly obligated (committed) for payment of expenses are to be returned on request.

F. Reporting Requirements. For each year of the grant, two fiscal reports showing the amount of grant funds spent and two technical reports showing the progress of the research are to be submitted by the grantee. Detailed information and instructions concerning the preparation and submission of these reports, including reporting dates, will be provided to the grantee promptly after the original grant letter is signed and returned from the grantee institution. At the completion of the grant, a final (rather than an annual) report will be required covering the technical aspects of the research performed during the entire period of the grant. In addition, the grantee will furnish such other reports relating to the grant funds and to the grant research as may be required by the Deputy Administrator. All reports must be prepared in English.

G. Access to Facilities, Records, and Accounts. Accredited representatives of the United States Government shall have access at any reasonable time to laboratories, offices, or other facilities relating to the project. Such data, information, records, reports, and accounts will be retained and made available for further reviews a minimum of 2 years beyond the completion date of the grant. Officers and employees of the grantee organization, or other personnel assigned to or engaged in the conduct of the project, shall be available for consultation with such representatives at any reasonable time.

H. Research Assistance. The grantee organization is responsible for performing the proposed research in an effective and efficient manner. No contract, grant, or other arrangement shall be made by the grantee with any other party for performing all or any portion of the research except as may be authorized by the Deputy Administrator.

I. Travel. Grant funds may be used to finance travel of grantee representatives necessary for the effective conduct of the research. Such travel within the country where the research is being performed should be in accordance with the regulations or regular procedures of the grantee organization. Travel outside such country must be previously authorized in writing by the Deputy Administrator.

J. Capital Assets. The use of grant funds is authorized for the purchase of capital assets identified in the negotiation documents. No additional capital asset items may be purchased from grant funds, and the total amount indicated for capital assets may not be exceeded except as may be approved by the Deputy Administrator. At the completion of the grant, the United States Government reserves the right to appraise all capital assets purchased entirely with grant funds and to determine their disposition. In case the grant is terminated prior to its normal expiration date, the disposition of capital assets purchased in part with grant funds will be determined mutually.

K. Publication of Research Results. Results determined as not supporting a U.S. patent application may be published either by the grantee or the U.S. Government in such manner and wherever considered most feasible. Manuscripts prepared by the grantee shall be furnished the USDA in triplicate, with at least one copy in English, when the article is submitted for publication. The grantee will also give the name of the journal to which the paper has been submitted. The preparation, content, editing, approval, and publication of such manuscripts are the responsibility of the grantee. Review of these manuscripts prior to submission for publication will not be made by the USDA unless specific request is made for review and comments. All manuscripts prepared by the grantee and related reprints are required to contain a footnote such as "This research has been financed in part by a grant made by the United States Department of Agriculture, Office of International Cooperation and Development, authorized by Public Law 480," (or under joint Board agreement as applicable). Upon publication, copies of reprints shall be furnished to the Deputy Administrator or his regional representive in the number requested by the USDA.

L. Patent and License Rights. Any patentable results which develop from research under the grant must be made available to the public in the United States. The Deputy Administrator will determine how this will be done. In countries other than the United States, the grantee institution may secure patents on the results from this research; but the U.S. Government must be granted worldwide, nonexclusive, irrevocable, royalty-free license to use the patent for U.S. Government purposes.

To enable the Government to file a patent application in the United States, the grantee organization agrees:

(1) to advise the Deputy Administrator promptly as soon as results which may be patentable have been obtained under the grant.

(2) to cooperate, when requested, in the preparation and processing of a U.S. patent application.

(3) to prepare and/or sign any necessary papers relating to the U.S. Government application.

(4) to secure the cooperation of any employee of the grantee institution necessary to make a U.S. patent application. Any such cooperating employee may not receive additional pay from the United States for services furnished while assisting in development of a U.S. patent application.

M. Prior Grantee Country Requirements. If the laws of the country of the grantee require that patent applications on inventions made in that country be first filed there before any such applications are filed abroad, the grantee shall promptly take appropriate steps to preserve the right of the U.S. Government to obtain a patent in the United States and to receive the benefit of the earlier filing date under the Lisbon 1958 Revision of the International Convention for the Protection of Industrial Property. This shall include promptly filing a patent application in the country of the grantee and, as soon as possible thereafter, furnishing the Deputy Administrator a certified copy of the application and a certified translation, when the original application is not in the English language.

N. Expenses for U.S. Patent. Expenses required to secure a U.S. patent are a responsibility of the United States. These include the cost of prior art searches, the formal preparation and filing of applications, the determination of questions of novelty, patentability, and inventorship as well as other functions of a U.S. patent attorney.

O. Prohibition Against Certain Fees. The grantee organization warrants that no person or selling agency has been employed or retained to solicit or secure the grant upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the organization for the purpose of securing business. For breach or violation of this warranty, the Deputy Administrators shall have the right to annul the grant without liability, or in his discretion, to deduct from the agreed amount or consideration, the full amount of such commission, percentage, brokerage, or contingent fee.

P. Personal Benefits. No member of or delegate to the U.S. Congress, or resident Commissioner, shall be admitted to any share or part of the grant or any benefit that may arise therefrom, unless it be made with a corportation for its general benefit. United States law requires this provision.

Q. Research Materials. Upon request the grantee will provide the U.S. Department of Agriculture with seeds, plants, vaccines, or any other such research materials discovered or developed during the life of the grant.

R. Amendments. The grant may be amended by mutual consent between the grantee organization and its government and the Deputy Administrator whenever considered necessary or desirable.

Chapter 4 - GRANT REPORTING PROCEDURES

400 REPORTS - GENERAL REQUIREMENTS

All grantees are required to furnish research, fiscal, and trip reports. Reports should be written in English and submitted promptly in accordance with the following instructions.

401 SEMI-ANNUAL RESEARCH REPORTS

Semi-annual progress reports are submitted after the first six months of research conducted under the grant. They serve as interim measures of progress being achieved and more fully described in annual reports. Subsequently, they are submitted six months after each annual report unless otherwise agreed to at the time of the negotiation. Semi-annual reports are required in original and four (4) copies on a prescribed Form OICD-29 (Exhibit 401).

402 ANNUAL RESEARCH REPORTS

The annual research report is submitted one year after the start of the project and annually thereafter except at the end of the final year of the grant, when a final report is prepared. Suggestions for content and arrangement of the annual report are given here to serve as a guide. It is well understood that with certain types of projects the suggested form of reporting may be difficult to employ or may be entirely unsuitable. For example, when there are several somewhat unrelated pieces of work to be included in one report, the experimental procedure, results, and discussions might be consolidated for each piece or segment of work, and the different segments reported consecutively. An entirely different form may be more suitable for reporting projects on plant or insect collections. Nevertheless, a uniform method of reporting provides advantages, and cooperating institutions are urged to use this reporting procedure whenever another method is not more practical.

The report should be prepared in single-space typing with at least two copies signed by the principal investigator and the official authorized to sign for the grantee institution. A total of ten (10) copies are required, including photographs, charts, tables, and other attachments. The format recommended and suggestions for preparing the annual report follow :

A. Title Page. The following information should be tabulated on the title page :

1. Name and Address of Reporting Institution :
2. Name of Principal Investigator :
3. Project Title :
4. Project and Grant Numbers :
5. Project Starting Date :
6. Scheduled Life of Project :

7. Dates of Research Period Covered by Report :

8. Cooperating Scientist :

   (a) Name :
   (b) Location :

9. Project Objectives (very brief) :

B. Summary. This section (approximately 500 words on a separate page) of the report is to be a clear and concise statement, in non-technical language, of research accomplishments since the start of the investigation and not just for the period covered by the annual report. The summary should include an explanation of the problem, results of research to-date, and a discussion outlining significance of research results and benefits to be derived from such results. Particular emphasis should be given to significance of research results rather than merely reporting number of measurements, analyses, or experiments conducted or describing routine operations.

C. Detailed Report. It is suggested that this section of the report be prepared in a style similar to scienitfic papers for publication, except that it should contain more substantiating data and other details than would normally be used in such publication. There is no need to report every individual experiment or to describe routine operations, techniques, or calculations where identification by name or reference would be sufficient. Where new procedures have been developed, old procedures modified, or unusual measurements or calculations made, these should be described with sufficient detail to enable other trained scientists to conduct similar operations. Where possible, experimental results should be presented in either tabular or graphic form. If new or modified equipment should be developed, a detailed description, preferable with drawings, should be included. It is suggested this part of the report consist of the following sections :

(1) Introduction. A concise statement of the problem, a brief summary of previous knowledge in the field of research, and any other pertinent information.

(2) Experimental Procedures. Description or identification of procedures in accordance with suggestions given above.

(3) Discussion. An incisive discussion of significance of data obtained, a theoretical interpretation of the data, a presentation of derived information obtained from the original data, and a discussion of and reasons for difficulties encountered. Patentable material and patent applications should be discussed in some detail. This section should not be a summary of results presented in 4) [redacted].

(4) Results. Presentation of pertinent data clearly and concisely in accord with the suggestions given above.

(5) Relevance to other work in the grantee's country.

(6) Conclusions. A brief statement of one or two paragraphs describing the present status of the project in the light of presented data.

(7) Plan of Future Work. A brief outline of the research to be undertaken and the approach to be used during the coming year.

(8) List of Scientists. List scientists and technicians who actively participated in the research and the percentage of their time devoted to the project during the annual report period.

(9) Publication. List the total papers submitted for publication during reporting period. Indicate name of author(s); title of journal or publication, volume, page, and year; and state whether the manuscripts and reprints have been submitted to the Regional Research Office in your area.

403 FINAL RESEARCH REPORT

A good final report is essential to the successful completion of a project. It is important that sufficient time be allowed by the grantee for preparation of a complete, clear, and well-organized report before the completion of the grant. The final report should be suitable for publication and include all pertinent data, and should summarize the work done, results accomplished, and conclusions reached. Final reports are considered public information, and a copy is deposited in the National Agricultural Library of the USDA.

Suggestions and recommendations for preparation of a final technical report follow :

A. Content. Careful attention should be given to the material included in the report. Essential data should not be omitted. Generally, graphs, tables, and photographs should be included or inserted into an appendix even though they may have been included in an earlier report. The report should provide a complete and logical story of the work done and its significance. It should be written in a manner that will allow the reviewer to follow the presentation of the research data without the necessity of frequent reference to numerous publications and earlier reports.

In most cases, one year will have elapsed between preparation of the last annual report and the final report. Any new data obtained during this intervening period should be reported in the same detail as in the annual reports. It is suggested that these new data be included as an appendix to the final report. However, they may be placed in the body of the report if this seems to be a more desirable procedure.

Data obtained during the early years of the project should be re-evaluated in the light of later experiments to be sure that no important points have been overlooked or given improper emphasis in earlier reports.

B. Translation of Reports into English. When it is necessary to prepare the report in one language for translation into English, extreme care should be used to avoid any changes in meaning or emphasis during the translation. Technically trained translators should be employed and ample provision made for discussions between the translator and research worker. A copy of the report prepared for translation should be submitted along with the number of English copies required in grant correspondence.

C. General Considerations. It is preferred that the final report be prepared in single space typing. Two copies must be signed by the principal investigator and by the official authorized to sign for the grantee. A total of twenty (20) copies, including charts, tables, and other similar attachments, are usually required. At least five (5) of these copies must have a complete set of all photographs that are used for illustrative purposes.

D. Format. The following format should be used in those cases where the information lends itself to this type of presentation. In cases where this is not suitable or appropriate, it may be modified to the extent necessary to provide a clear record of research activities and accomplishments during the period of the grant.

(1) Title Page.

Designation as final technical report
Project Title
Name of principal investigator
Name and address of reporting institution
Project number
Grant number
Dates of research period covered by report

(2) Summary. Beginning on a separate page, this section should consist of a short, clear statement in non-technical language of research accomplishments during the entire life of the investigation. The summary should include an explanation of the problem, statement of research accomplishments without supporting data, and brief discussion of significance of research findings.

(3) Detailed Report. This section of the report is intended for scientists well acquainted with the field of research. This section may be divided as follows :

a. Introduction. A short statement of the problem, a brief summary of previous knowledge in the field, and other such pertinent information.

b. Results. Presentation of data in a clear, orderly manner. Detailed data covering research accomplished since submission of last annual report may be included here or, preferably, in an appendix to the report.

c. Discussion. In this section, the author should describe significance of the results, effect these results may have on related fields of research, problems encountered, and reasons for these problems. Patentable ideas and patent applications should be discussed in some detail.

d. Conclusions. The author should state briefly the conclusions he has drawn from his data.

e. Need for Additional Research. List any phase of the research on which additional work is desirable, including observations which could not be pursued.

f. List of Scientists. List scientists and technicians who actively participated in the research and the percentage of their time devoted to the project.

g. List of Publications, Patents, and Patent Applications. Itemize all publications resulting from this research, giving exact title, authors, journal, volume, page number, and date. State whether the manuscripts and reprints have been submitted to the Regional Research Office for your area. List pertinent data about all manuscripts, both complete and incomplete, that are being considered for publication. Patents and patent applications should be included in this section.

h. Graduate Students. Give the number of graduate students who assisted in the conduct of the research and a list of graduate degrees received during the life of the grant.

404 FISCAL REPORTS

This report is submitted in original and three (3) copies on the prescribed Form OICD-31 (Exhibit 404). It should accompany the semi-annual research report or the annual research report, as appropriate. Fiscal report should be submitted promptly at the conclusion of each reporting period since additional grant funds to continue the research project cannot be made available until such reports have been received.

All charges against grant funds are to be reported in local currencies. Instructions for completing the prescribed form (Exhibit 2) follow:

Block 1 - Name of the grantee institution, the department performing the research investigation, and the complete address, including a postal (zip code) or zone number, if one is assigned to the given address.

Block 2 - Grant number as it appears in the upper right corner of the letter offering the grant and as accepted on behalf of the institution.

Block 3 - Amount specified in the grant letter for financing the research project.

Block 4 - Number of the fiscal report. This should be No. 1,2,3, etc., to show that the report covers the first, second, third, etc., reporting period under the grant.

Block 5 - Inclusive dates of period covered by the fiscal report, month, day, and year.

Block 6 - Title of the research investigation as stated in grant letter. If lengthy, abbreviate, showing essential identification.

Block 7 - Total amount of all grant funds received from beginning of grant to the last date shown in Block 5.

Block 8 - Total of all charges, less any adjustments or disallowances, made against the grant funds from beginning of grant to last date shown in Block 5.

Block 9 - Actual balance of grant funds on hand at the end of the report period.

Block 10 - Estimated amount needed from the grant to finance the research costs for the period from the last date shown in Block 5 to the end of the next reporting period. Any unusual expenses or requests for funds in larger amounts than would be indicated as necessary by the fiscal report should be explained in a separate statement attached to the fiscal report.

The following instructions, concerned mostly with Part I of the fiscal report form, cover costs of a recurring nature and include all costs discussed during negotiations except

travel outside of country in which research is being conducted and capital assets as identified in the grant or as subsequently approved.

Block 11 - Actual salary and benefit costs charged against Research Agreement funds for all persons working on the research project, identified by name and title. Included are all charges for payments, salaries, wages, fees, allowances, benefits, insurance to all persons engaged on the research project. Only personnel cost for time worked on the project should be included. Part-time services should be indicated as a percentage of full-time work. Honorarium for principal investigator and co-principal investigator, if approved, should be in this block.

Block 12 - Include under this item amounts paid by the institution for travel and transportation expenses within the country for persons working on the research project.

Block 13 - Include in this item costs for all services performed by other individuals or organizations under formal or informal contractual arrangement. This includes analytical services; facility renovation; printing, reproduction, and translations; repairs to equipment, vehicles, etc. Itemize by category.

Block 14 - Total cost charged to Research Agreement funds for supplies and materials, such as glassware, chemicals, fuel, small-cost laboratory equipment, experimental animals, forage, and other supplies needed for the project.

Block 15 - Include miscellaneous direct cost items not identified above, such as rents and transportation of things. If several classifications are included in this total, attach an explanatory sheet.

Block 16 - Total of recurring costs as reported in Blocks 11 through 15.

Block 17 - This allowance is to provide for costs that cannot reasonably be allocated to direct cost, such as expenses for utilities, general administrative and personnel support, maintenance, typing and secretarial services not otherwise estimated, postage for correspondence, and any other costs of a general nature. These amounts cannot exceed the agreed allowance or percentage indicated in cost estimates.

Block 18 - Actual purchase cost of approved non-expendable capital assets described in list attached to the Research Agreement. Any proposed use of grant funds for purchase of capital assets not listed in the grant document requires prior authorization from the Program Leader, Special Foreign Currency Programs, IRD:OICD.

Block 19 - Amount expended for authorized travel outside the country of the grantee institution. Such expenses may be allowed only when necessary for the effective conduct of the research project.

Block 20 - Total of all charges against the grant funds for the reporting period shown in Block 5.

Block 21 - Interest, premiums, or commissions earned on bank deposits of grant funds from start of grant.

Blocks 22 to 27 - Self-explanatory: signature, titles, and dates.

405 TRIP REPORT

Every person using grant funds to visit another country or countries is required to prepare a report on his travel. Included in the report are names of persons and institutions visited, a statement of accomplishments, decisions or conclusions reached, and any other information of value to the research project. Within 1 month after the end of the trip, five copies of this report should be submitted. The actual cost of the completed travel should be included in the report.

406 SUBMISSION OF REPORTS

Reports described above should be addressed in the same manner as initial research proposals.

407 NUMBER OF COPIES

Report should be written in English and submitted promptly in accordance with instructions.

A. Semi-annual progress. The original and four (4) copies.
B. Annual research. Ten (10) copies.
C. Final research. Variable number — up to twenty (20) copies as required by grant correspondence.
D. Fiscal. Original and three (3) copies.
E. Trip. Five (5) copies.

U.S. DEPARTMENT OF AGRICULTURE OFC. OF INT'L COOPERATION & DEVELOPMENT INTERNATIONAL RESEARCH DIVISION RESEARCH PROGRESS REPORT—P-L. 480	1. TOTAL AMOUNT OF GRANT	2. PREVIOUS AMOUNT PAID	3. PROJECT NO.
	4. AMOUNT OF CURRENT PAYMENT REQUESTED		6. GRANT OR CONTROL NO.

6. NAME OF INSTITUTION	7. REPORT PERIOD		3. REPORT NO.
	A. FROM	B. TO	

9. PROJECT TITLE

10. SUMMARY OF PROGRES (*Give concise summary of progress for this report period - include significant findings.) If additional space is required, use OICD-29A.)*

11. PRINCIPAL INVESTIGATOR IN CHARGE (*Signature*)	12. DIRECTOR OF RESEARCH INSTITUTION (*Signature*)

OICD-29 (3-80
Replaces IPD Form 1, Sept. 1977

U.S. DEPARTMENT OF AGRICULTURE
OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

FISCAL REPORT OF GRANTEE UNDER AGRICULTURAL RESEARCH PROGRAM, PUBLIC LAW 480 AS AMENDED

1. FROM *(Name and address of grantee)*	2. GRANT NO.	3. AMOUNT OF GRANT	
	4. REPORT NO.	5. REPORT PERIOD	
		FROM	TO

6. PROJECT TITLE

SUMMARY STATUS OF FUNDS	AMOUNT
7. Total Grant Funds *RECEIVED*	
8. Total Grant Funds *SPENT* including This Report Period	
9. Balance Grant Funds on Hand End of This Report Period *(Item 8 from Item 7)*	
10. Estimated Expenses for Next Period *(EXPLAIN ANY UNUSUAL EXPECTED COSTS BY ATTACHING STATEMENT)*	
PART I - GRANT FUNDS SPENT DURING THIS PERIOD - RECURRING COSTS	
11. Salaries and Benefits of Project Personnel *(Names and Titles)*	
12. Travel of Personnel Within Country	
13. Contractual Services *(ITEMIZE)*	
14. Supplies and Materials *(EXPLAIN UNUSUAL COST ITEMS BY ATTACHING STATEMENT)*	
15. Other Recurring Costs *(Include Items Not Identified Above)*	
16. TOTAL *(Add Items 11 thru 15)*	
17. Indirect Costs *(Agreed Allowance or Percentage of Item 16)*	
PART II - GRANT FUNDS SPENT DURING THIS PERIOD - NON-RECURRING COSTS	
18. Capital Assets Provided Under Grant *(Identify Each Item and Attach Copy of Paid invoice)*	
19. Approved Travel Outside Country *(Identify Travelers and Attach Breakdown of Expenses)*	
20. TOTAL GRANT FUNDS SPENT FOR REPORT PERIOD *(Add Items 16 thru 19)*	
21. Total Interest Earned on Grant Fund Deposits, if any, from Start of Grant	

We certify that the amounts reported spent from grant funds are in accordance with provisions applicable to the above identified grant.

22. Signature of Principal Investigator	23. Title	24. Date
25. Signature of Official Authorised to Sign for Grantee	26. Title	27. Date

OICD-31 (3-80)
Replaces IPD Form 7, Nov 1970

500 TRAVEL OF GRANTEES

Any travel requested by the grantee must be necessary for the effective conduct of the research project. Although purposes and cost estimates for such travel may have been included in the initial research proposal and subsequently ratified by the negotiations, steps must be taken during the course of the research to request approval for travel to be performed outside of the grantee country. Travel within the country where the research is being conducted is applied for/or performed in accordance with the regulations of the grantee institution.

The travel of a grantee scientist to the United States is authorized for the primary purpose of consultation with USDA and other scientists who are qualified in the field of research specified in the grant. Applications for such travel or travel to third country institutions will be considered and permitted if the benefit to the grant is clearly recognized.

500.1 Requests for Authorization to Travel. Requests for authorization to travel outside the grantee's own country must be received by IRD:OICD, Hyattsville, Maryland, at least five (5) months in advance of the proposed trip. Requests should be addressed and mailed to the same offices as are stipulated for submission of the initial research proposal (Section 202). Failure to make a timely request may result in disapproval of the travel.

All requests for travel authorization should be submitted in an original and three (3) copies and contain the following information :

a. Project and grant numbers and title

b. Name and address of institution

c. Name, date of birth, place of birth, citizenship, title of proposed traveler, and his responsibilities to the project.

d. Approximate dates proposed trip is to begin and end. The length of stay in the United States will vary depending upon the number of institutions whose scientists are qualified to advise on the research conducted by the grantee. A trip of up to 21 days is usually considered adequate to meet the needs of a project.

e. Estimated costs of travel, itemized as to fares, subsistence, accident and sickness insurance, etc. Indicate class of proposed transportation and type of transport; i.e., air, land, or sea. Use of less-than-first-class air accommodations is required in most cases.

f. Any necessary approval by the Government of the grantee for conversion of local currency to dollars or to other foreign currency for travel expenses is the responsibility of the grantee. It should be stated whether approval has been obtained.

g. Statement by appropriate institution authority that traveler is, or will be, covered by adequate accident and sickness insurance while in a travel status. Note: Insurance must be valid in country or countries of travel.

h. Statement naming accompanying traveler(s). Although grant funds may not be used to finance travel for members of the family of an authorized traveler, the request should state whether the traveler will be accompained by members of his family or by professional colleagues traveling on other funds.

i. Justification for the proposed travel, indicating in detail why the trip is expected to be of benefit to the research project.

j. An itinerary showing person (s), laboratory (ies) and office (s) of the USDA to be visited. If it is considered necessary to visit other research institutions, include also the names and addresses of these organizations. The itinerary submitted by the grantee may be revised by the appropriate regional office or the International Research Division, OICD, Hyattsville, Maryland.

k. For all foreign Grantee travel:

Traveler submits as soon as it is available a travel schedule to IRD:OICD, Hyattsville, Maryland for each location to be visited, showing:

1. Proposed flight numbers (or pertinent information if by other mode of travel).
2. Dates and times of arrival.
3. Dates and times of departure.

l. Statement of approval of the proposed travel, signed by appropriate authority of the grantee institution.

500.2 Notification of Authorization for Travel. Notification that travel has been authorized should include specific persons or places to be visited. The traveler is obligated to include such visits in the final itinerary for the trip. Several actions by the traveler are necessary after he has received notification that his proposed trip is approved:

a. Taking into consideration suggestions and requirements for certain visits specified in the authorization for travel, the traveler should prepare a final itinerary, indicating firm dates and the amount of time to be spent at each place.

b. For Grantee travel outside the country but not including U.S.

1. The traveler should communicate well in advance of actual departure date directly with the various individuals to be visited. Traveler should give approximate dates of proposed visits and subject matter to be discussed. Two copies of such correspondence should be sent to the Regional Research Office administering the grant.

2. A confirmed itinerary should be forwarded at least four (4) to six (6) weeks in advance of actual departure to the same office from which travel authorization was received.

3. Traveler arranges all travel and hotel reservations.

500.3 Expenses Allowable for Travel Between Countries. Since grantee institutions have different regulations governing travel, it is not practicable to establish a single set of rules to cover allowable expenses between countries. Therefore, it is the general policy to authorize expenses of such travel on the basis of the rules and regulations applicable at the institution and in the country of the grant.

a. Class of Accommodation. An exception to this general policy relates to the use of air travel. For most air travel, U.S. Government regulations require use of less-than-first-class accommodations. Therefore, less-than-first-class accommodations will be used by all grantee travelers when available unless there are extenuating reasons to the contray. Any requests for an exception to this requirement must be supported by a strong justification. Traveler should take this into consideration in developing information required above.

b. Per Diem. As a further exception to the general policy on travel expenses, travelers will be expected to subsist on a per diem authorized in accordance with accepted practices of the grantee institution, but not at a rate exceeding that prescribed in the United States by Standardized Government Travel Regulations for travel in other foreign countries.

c. Benefit to Research Project. Grant funds may not be used to pay the expenses of any travel which has little or no direct relationship to the research being carried out. While it is recognized that experience and education secured during sabbatical leave or study tours may have value to an investigator conducting research on a grant project, authorization to use grant funds for travel associated with such leaves orstudy tours will not be granted. Authorization to use grant funds will not be issued when the proposed travel is solely to attend an international congress or conference, except under unusual and special conditions.

500.4 Payment of Travel Expenses. Grant funds may be used for all necessary travel costs directly connected with authorized travel and as approved by the appropriate

official of the grantee institution in accordance with its rules and regulations. A statement showing totals for transportation, per diem, or actual subsistence costs, accident and sickness insurance premiums, and incidental travel expenses, such as taxis and airport fees, should be attached to the original copy of the fiscal report for the period in which such expenses are paid.

When some of the costs of the authorized travel are borne by other sources (sponsors of national or international conferences, the grantee research institution itself, or foundations), report such costs and sources in the fiscal statement.

500.5 Failure to Travel. Occasionally, a traveler is unable to perform authorized and approved travel to the United States because of illness or for other reasons. Failure to make an authorized trip within 45 days of the final scheduled time serves to cancel the athorization granted. If the traveler wishes to make the trip at a later date, a new request for authorization must be submitted.

500.6 Report of Travel. Instructions for content, number of copies, and expected date of submission are set fourth under Section 405 (Trip Reports).

500.7 Use of Air Carriers. U.S. Law now requires that all travelers under our research grant program use U.S. flag carriers, wherever these operate, outside their own country. The traveler will have to pay from his own pocket for any unauthorized use of non-American flag carriers. If, for personal reasons, the traveler plans to deviate from the approved route, then that portion of the transportation cost must be paid by the traveler personally.

ANNEX L

Proposed Training at the Snake River Conservation Research Center at Kimberly, Idaho on Biotic Reclamation of Sodic Soils

I. Justification

Over 25 percent of the irrigated land in Pakistan's Indus Basin has sufficient sodium in the soil to make water and soil management difficult and reduce crop production.

II. Objectives

To provide two persons with knowledge of the basic concepts, equipment and experience needed to:

(a) identify crop species which are able to give good yields on sodic soil and produce high CO_2 levels in the soil;

(b) develop water and soil management practices which will optimize these high CO_2 levels, use them to solubilize Ca^{++} from the lime in the soils and displace Na^{+} from the soil;

(c) adapt these practices to the needs and resources of farmers so that the practices can be extended by extension personnel.

III. Types of Studies to be Conducted

A. Results of studies utilizing fodder crops (such as Diplechne fusca in Pakistan and Sordan in the U.S.) on improvement of sodic soils will be collected and reviewed by the trainees, their supervisors, and Dr. C.W. Robbins.*

B. Lysimeter Studies at the Snake River Conservation Research Center (SRCRC): Diplechne fusca (Koller grass), a sorghum-sudan grass hybrid (Sordan), and other crops which grow vigorously in sodic soils will be grown in sodic, calcareous soils in lysimeters, irrigated at 1.2 and 1.5 times ET. Growth rates, CO_2 levels in the soils, Na^{+} and Ca^{++} in the soil, water and leachate, and infiltration rates will be determined as a function of time. The data will be used to further refine a computer model which Dr. Robbins has developed for this system and to provide the second trainee with experience in using computers for modeling purposes.

---

*Soil Scientist, USDA-ARS, Snake River Conservation Research Center, Kimberly, Idaho.

C. Field Studies at SRCRC (during the following spring and summer) - Grain sorghums, grasses, and other crops for which there is evidence for vigorous growth capabilities in saline soil will be grown both at the Center and at the sodic Rock Creek site to determine and compare their capabilities for developing high CO_2 levels in the soil, achieving good yields, and increasing water intake rates of sodic soils.

D. Field Studies in Pakistan: Sordan, Kaller grass and other crops which indicate good potential will be used to reclaim sodic soils, comparing them with recommended gypsum treatments. Irrigation rates providing different leaching fractions will be evaluated. First approximation recommendations including crop species and variety, and water management will be developed for effective reclamation of sodic soils.

IV. Schedules

As soon as possible, one trainee would be selected from Mona and one from LIM. They will survey studies on biotic and gypsum reclamation of sodic soils in Pakistan. They will then come to the U.S. One will go directly to the SRCRC and begin working with Dr. Robbins on biotic soil reclamation studies in lysimeter and field studies (6 to 9 months). He will stay there through one growing season and will then return to Pakistan using experience gained and results of his SRCRC studies to design and conduct similar studies.

The other trainee will be selected by his agency for degree training in Soil Science that will begin at the University of Idaho during the 1985-86 academic year. He will go to the SRCRC during the following summer and study with Dr. Robbins for the cropping season. He will then return to Pakistan in October of 1986 and conduct studies there. The studies at the SRCRC and in Pakistan will form the basis for his M.S. thesis in Soil Science from the University of Idaho, which should be written before September, 1987.