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COMMAND WATER MANAGEMENT PROJECT

FINAL REPORT

CWM-ARDINC/USAID/PAKISTAN

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TABLE OF CONTENTS

Abbreviations and Acronyms		i
Preface		iii
I.	**Introduction/Background**	1
II.	**Project Description**	5
III.	**Technical Assistance**	9
IV.	**Work Plan**	13
V.	**Project Implementation**	15
	Waterlogging, Salinity, and Drainage--Lasbela, Balochistan	16
	Irrigation Scheduling	17
	Full Watercourse Trials--Kandiaro and Lasbela Subproject Areas	18
	TAT Activities in Punjab CWM Program	20
	Kandiaro and Lasbela Extension Outreach Program	24
	Training	27
	Dissemination of Agricultural Information	28
	Balochistan Demonstration	28
	Conclusions	28
	Implementation Problems	29
VI.	**Conclusions and Recommendations**	37

Annexes

Annex A:	Description of Subproject Areas
Annex B:	Detailed Project Amendment Description: The CWM Project Component
Annex C:	Team Scopes of Work
Annex D:	Supervision Mission Report
Annex E:	Water Logging and Soil Salinization of the Lasbela Subproject Area
Annex F:	Irrigation Scheduling Practices Review and Development of Recommended Improved Irrigation Management Programs--Executive Summary
Annex G:	Full Watercourse Trial Lasbela and Kandiaro Subproject Areas
Annex H:	Improved Irrigation Techniques for Cotton in Punjab
Annex I:	Farmers Seed Multiplication Program of Cotton in Punjab
Annex J:	Extension Outreach Programme Background, Accomplishments and Future Strategies--Kandiaro Subproject, Sindh
Annex K:	Report of Extension Outreach Program
Annex L:	Organization of Private Tubewell Groups
Annex M:	WUA Federation at Pacca Dalla Minor
Annex N:	End of Project Report
Annex O:	Extension Specialist's End-of-Tour Report

ABBREVIATIONS AND ACRONYMS

ac. ft.	acre feet
AOs	Agricultural Officers
ARDINC	Associates in Rural Development, Inc.
CWM	Command Water Management Project
EAC	Expatriate Administrative Coordinator
EOPS	End of Project Status indicators
ES	Extension Services
FAs	Field Assistants
ISM	Irrigation Systems Management Project
kg	kilogram(s)
md/ac	maunds/acre
mt/ac	metric tons/acre
M&E	monitoring and evaluation
OFWM	On-Farm Water Management
O&M	operations and maintenance
PID	Provincial Irrigation Departments
PPC	Provincial Policy Committee
SAR	Staff Appraisal Report
SCC	Subproject Coordinating Committee
SMO	Subproject Management Office
TAC	Technical Assistance Contract

TAT	Technical Assistance Team
T&V	Training and Visitation
USAID	U.S. Agency for International Development
WMS II	Water Management Synthesis II Project
WUA	Water Users Association
WUADS	Water Users Association Development Specialist

PREFACE

The document that follows is submitted by Associates in Rural Development, Inc. (ARDINC) as the final report of their Technical Assistance Contract (USAID Contract No. 391-0467-C-00-5076-07) which supported the USAID-funded Command Water Management (CWM) project in Pakistan.

Conditions imposed on the Technical Assistance Team (TAT) by USAID in the last months of the contract made the writing of this report almost impossible. On January 14, 1991, all expatriate members of the TAT and their families were unexpectedly ordered to evacuate post and return to the United States. Some members, including the Chief of Party, received less than 24 hours notice. Time constraints precluded the packing of files, work records, and reports, which was believed unnecessary as team members were issued return tickets and told they would be able to return as soon as security conditions allowed. Consequently, arrangements were made to keep all offices open and for Pakistani members to maintain all field trials and collect the resulting data.

The team members reported to the ARDINC home office in Burlington, Vermont. From there, they tried to direct the ongoing program in Pakistan by fax, telephone, and mail.

On February 18, 1991, ARDINC was notified by the USAID/Islamabad Contract Office that the contract was being terminated "for the convenience of the government" and to "stop all work on this Contract." The termination order was complied with immediately. Orders were issued immediately to make an inventory of all project-owned equipment, termination dates were issued to Pakistani team members, and preparations were made to close offices and pack office records. These actions virtually denied the team access to records in Pakistan or contact with Pakistani team members.

In early April, permission was granted to three team members to return to Pakistan to dispose of project equipment, close out all offices, and pack and ship personal effects of all team members. The remaining three expatriate positions were terminated. Thus, the team was split before the final report was started. Additionally, the heavy workload in Pakistan precluded significant progress on final reports.

The remaining team members departed for the United States on May 2, 1991; all were terminated and returned to their individual homes rather than the ARDINC home office in Burlington, Vermont. Thus, this final report was written by individual team members on their own time, without salary, and without access to team or project records. These constraints, plus the fact that current trials were terminated early, have resulted in some deficiencies and gaps in this submitted report.

The premature termination of ongoing trials was unfortunate since they were the most significant of the entire project; they had integrated, on a full watercourse scale, all the recommendations from previous trials and demonstrations. Their completion would have made a very significant contribution to future command water management programs. The inability to report the results of these trials has denied USAID and the Government of Pakistan much of the benefit that could have come from the Command Water Management Project.

I. INTRODUCTION/BACKGROUND

In Pakistan, 90 percent of the crops are grown on approximately 35 million acres of irrigated land. Water is primarily provided through the Indus River Irrigation System which includes the Indus River and its tributaries, three major storage reservoirs, 19 barrages/headworks, 12 link canals, and 43 canal commands delivering water to approximately 90,000 watercourses. Approximately 100 million acre feet (ac. ft.) are annually diverted into this system. An additional 35 million ac. ft. are made available from 12,500 public and 100,000 private tubewells.

Despite the system's size and sophistication, the high quality of water provided, the generally excellent soils, and the favorable climate, irrigated crop yields in Pakistan are far below their yield potential. For example, in 1981/1982, wheat production averaged only 0.66 metric tons/acre (mt/ac) compared to an estimated potential of 1.38 mt/ac. Rice has an estimated potential yield of 1.5 mt/ac, yet it averaged only 0.65 mt/ac. Table 1 below compares the yield of Pakistan's major crops to those of various other countries.

Table 1. Yield Per Hectare of Major Crops in Main Growing Countries (in kilograms)

Country	Wheat	Rice	Maize	Seed Cotton	Sugarcane
USA	2,519	5,520	6,692	1,833	84,238
India	1,873	2,126	1,292	469	55,904
Canada	1,746	---	5,894	---	---
Turkey	1,892	---	2,727	2,032	---
Pakistan	1,612	2,488	1,271	1,350	35,568
France	6,008	---	---	---	---
Mexico	4,209	---	1,585	2,302	---
Japan	---	6,414	---	---	---
Egypt	---	5,310	---	2,500	75,893

Source: FAO quoted by Agricultural Statistics of Pakistan, 1985.

The World Bank Staff Appraisal Report (SAR) suggests that in addition to the need for timely and assured irrigation water supplies, crop production can be increased by: improving the delivery and availability of certified seeds, fertilizer, insecticides, extension services, agricultural credit, and machinery; expanding farmers knowledge; and improving the rural infrastructure--particularly farm-to-market roads, rural electrification, and communications. The CWM program addresses all these issues except rural infrastructure.

The primary organizations involved in the conveyance, distribution, use, and management of irrigation water and in irrigated crop production include the Provincial Irrigation Departments and, from the Agriculture Departments, the On-Farm Water Management Directorates, and the Provincial Extension Services. Other participating organizations include public and private suppliers of fertilizer, seed, pesticide, and credit institutions.

Provincial Irrigation Departments presently have the major responsibility for the operation and maintenance of the system above the *moghas*. While the areas of responsibility and interest of these technical engineering agencies do not include the details of agricultural and crop production, they do control the distribution and conveyance of water throughout the system including delivery to the watercourse *moghas*. Additionally, they develop the fixed, rotational schedule of water delivery (*warabandi*) among the farmers on a watercourse, but are not directly involved with watercourse maintenance.

A Federal On-Farm Water Management (OFWM) division was established within the Ministry of Food, Agriculture, and Cooperatives, and OFWM Directorates were organized in each province. These Provincial Directorates were assigned the following responsibilities:

- assist farmers in the rehabilitation of their watercourses;
- help individual farmers with precision land leveling; and
- provide water management extension services.

At the Tehsil level, the OFWM Directorates consist of six-to-seven-member field teams consisting of Agricultural Officers (AOs), Field Assistants (FAs), and Water Management Officers.

The Provincial Extension Services also support the various crop production activities through demonstrations and other agronomic advisory services. Since there is no Federal Extension Cell, the Provincial Extension Directorates operate essentially as four different systems. Extension field-level work is implemented by both Agricultural Officers (AOs) and Field Assistants (FAs).

The Indus system constraints related to water inputs are numerous and include problems of design, operations, and maintenance. The system was designed to support an annual cropping intensity of 0.75. However, with increasing populations, and a subsequent demand for increased crop production, attempts were made to increase the cropping intensities and cultivate additional acreage; this led to water conveyance in excess of design capacity, which stressed the system. This situation, coupled with deferred maintenance, resulted in frequent canal bank breaches and interruptions in services. Additionally, studies by the Water and Power Development Authority (WAPDA) indicate that 25 percent of the diverted surface supplies are lost through deep percolation and evaporation before water is delivered to the watercourses. Consequently, water deliveries to the watercourse *moghas* are unreliable, inadequate, and without equity.

Due to unofficial *mogha* alterations, watercourses at the head of minors tend to receive more than their sanctioned discharge, which results in tail-end watercourses receiving less than their authorized amount. The altering of *moghas*, a primary cause of inequity in water distribution, is usually performed by lower-level PID employees on receipt of payment from the concerned farmers. Although illegal, this practice is widespread and common.

Within the watercourses, there are conditions, both physical and organizational, which contribute to water loss and constrain crop production. Mean conveyance losses over an entire watercourse generally range from 35 percent to 50 percent. Such loss is generally due to deep percolation, porous leaky banks, failure to close bank cuts, and overtopping; these losses reflect a lack of periodic maintenance. Since conveyance loss, at any point, is a function of distance from the *mogha*, the water supplied to many farmers is inadequate. As on the minors, tail-enders receive the least water.

Another constraint to increased production is that farmers are unaware of recommended water management practices and their benefits. Pakistan's fixed, rotational, continuous-flow delivery system precludes irrigation in response to plant needs. Farmers' are also unaware of how, when, and how much water to apply. Other constraints to efficient use of water for crop production include non-leveled land and the resulting low application efficiency, non-uniform emergence, and poor crop stand.

Crop production is also constrained by the improper use of non-water inputs (fertilizers, pesticides, seed). Farmers are generally unaware of the importance of timely, appropriate applications of balanced fertilizers as well as what types of pesticide to use, and certified improved seed is not readily available. The non-availability of these inputs, which prevents timely application, has been a continuing problem throughout Pakistan. Additionally, these inputs are frequently adulterated.

Increased crop production in Pakistan requires the integrated, coordinated effort and participation of the farmers, private sector dealers and suppliers, and concerned government agencies. Farmers are entitled to timely, adequate, reliable, and equitable water delivery. Similarly, non-water inputs should be available to farmers on a timely basis along with

meaningful advisory assistance on how to achieve maximum benefit from their investment. Essentially, the intent of the CWM project is to develop, through institutional development programs and activities, replicable models which minimize these constraints and promote increased crop production and farmer incomes.

II. PROJECT DESCRIPTION

To stimulate and support increased crop production in Pakistan, USAID approved and funded the Irrigation Systems Management (ISM) Project. A primary intent was to promote improved water delivery by providing efficient and effective operation, management, and maintenance of the entire irrigation system.

This parent ISM project was to address the various water and crop production constraints through three projects which were concerned with rehabilitation works, research, and institutional improvements, respectively. The CWM program was to address the institutional development aspects and thus provide an institutional basis for all concerned agencies, including the water users, to integrate their activities into the timely provision of water and non-water inputs and advisory assistance required to increase crop production.

To strengthen institutional management and remove the major production constraints, the Project Paper assigned the CWM project specific objectives as follows:

1. Substantially increase agricultural production in selected pilot areas through improved water management (i.e., by delivering water in response to crop water requirements to the maximum extent possible), and to integrate into this program the necessary agricultural support services and non-water inputs.

2. Develop water management techniques replicable over a wide range of agro-climatic zones and land and water environments for subsequent application in other parts of the country.

3. Reduce inequities in actual water deliveries in the tail reach (compared to the head reach) of canals at all levels (branches, distributaries, minors, and watercourses) through improved conveyance efficiencies.

4. Build within the provincial agencies a continuing capability for planning, implementing, and operating integrated programs for irrigated agriculture.

Although not designated as a specific objective, No. 5 below is a primary concern in both the Project Paper and the CWM Work Plan.

5. Strengthen farmer participation in formal Water User Associations (WUAs), to improve their overall management of water and non-water inputs, and to provide to farmers an enhanced decision-making role.

The CWM program concept is an interdisciplinary and integrated approach to project implementation which requires newly organized CWM offices, policy and coordinating committees, the cooperation of various GOP line agencies, a technical assistance team, water user associations, and various public and private input suppliers. It was intended that, through

the cooperation and coordination of these organizations and agencies, planned institutional and civil works activities supporting the project goal, "to increase agricultural and farmer income...," could be implemented in each of seven subproject areas.

Following are brief descriptions of the various organizations involved in the CWM project and their responsibilities:

(a) ***Subproject Management Office (SMO)***: This field-level management office, established on-site in the subproject areas, is dedicated to activities promoting increased agricultural production. It provides an institutional focus for integrating provincial line agencies (Irrigation, OFWM, Extension) and input suppliers into activities supporting farmer productivity. This office consists of a manager and staff who are organized into an Administrative Unit, Water Management Unit, and a Planning/Monitoring and Evaluation Unit. The SMO is technically supported by the Technical Assistance Team (TAT).

(b) ***Provincial Policy Committee (PPC)***: This committee is chaired by the additional Chief Secretary of Planning and Development; other members consist of the Secretaries of Irrigation, Agriculture, and Finance. PPC responsibilities include formulating implementation policies, resolving differences between line departments, coordinating line department inputs, reviewing and sanctioning SMO annual work plans, and reviewing CWM activities identifying constraints and taking remedial actions.

(c) ***Subproject Coordinating Committee (SCC)***: This committee, chaired by the Subproject Manager, serves as the direct link between the SMOs, line departments, WUAs, input suppliers, the TAT, and other related groups. Membership includes representatives from WUAs, PID engineers, the Deputy Director of Extension, the OFWM Coordinator, credit institutions, and agricultural input suppliers. The SCC is responsible for the timely and coordinated delivery of water and non-water agricultural inputs into the subproject area.

(d) ***Line Agencies***

(1) *Provincial Irrigation Departments (PID)*: Their main responsibility is to assure equitable, reliable, and adequate delivery of water to the *mogha* through timely, responsive operation, management, and maintenance of the system above the *mogha*.

(2) *On-Farm Water Management Directorates (OFWM)*: These organizations assist in WUA organization, rehabilitation of watercourses, and precision land leveling, as well as provide water management extension services.

(3) *Extension Services (ES)*: Each provincial service advises on the various aspects of crop production techniques such as fertilizer amounts, planting dates, seeding rates, and varieties. They also assist farmers in securing non-water inputs such as fertilizers, seed, and insecticides.

(e) ***Non-Water Input Suppliers***: Fertilizer, pesticide, and seed inputs are supplied by both public and private institutions. Through their representation on the SCC and contacts with the SMO and the TAT, they provide unadulterated inputs in response to farmer and crop requirements.

(f) ***Water User Associations***: WUAs act as full participants in all activities on the watercourses. They are expected to provide all unskilled and semi-skilled labor for construction and repay a modest percentage of the material costs for watercourse improvement. They are consulted in design and construction decisions. In addition to being responsible for watercourse maintenance, the farmers, through their WUAs, participate in the management of all non-water and water inputs and other watercourse activities such as demonstrations, field days, machinery pools, and training.

(g) ***Credit Institutions***: Through the help of the SMOs, SCCs, and others, attempts are made to obtain credit for needy farmers from the Agricultural Development Bank of Pakistan (ADBP), the Federal and Provincial Bank for cooperatives, and commercial banks. However, past experience shows that the distribution of credit is heavily skewed toward large landowners, whereas small and landless farmers have difficulty receiving institutional credits.

The ISM Project's purpose, and hence the purpose of the Command Water Management Project, is "to increase the capabilities of institutions involved in irrigation system planning, design, research operations and maintenance; to carry out physical improvements to the system; and to bring about policy changes needed for proper irrigation water management. The CWM program will help achieve this purpose by strengthening the management of existing institutions, the infrastructure, and the agricultural inputs and services in an integrated and collaborative manner in order to remove the major constraints to increased irrigated agricultural production in selected subproject areas" (CWM Project Paper).

The activities assigned to the CWM were enumerated in the above five objectives. Explicitly and implicitly, the activities envisioned were institutional development with some civil works support as an incentive. Primarily, those activities which involved the Technical Assistance Team (TAT) included: development of farmer organizations (Water User Associations and Federations); training of SMO staff, fieldworkers (FAs, AOs), farmers, and line agency personnel; water management improvements (water scheduling, modification of cropping patterns, conjunctive water use, application methods, water conservation, water measurement); physical improvements (field drainage systems, watercourse rehabilitation and

introduction, fertilizer recommendations, seed multiplication, sowing techniques); and monitoring and evaluation.

The above activities were implemented in seven subproject areas listed and described in Annex A. The total cultivable command areas in these subprojects is approximately 510,000 acres with 719,000 people living in 391 villages and a total of 50,000 farms in the project areas. These project areas were selected to represent the different agro-climatic conditions existing in Pakistan's irrigated regions.

From the implementation of the above programs and activities, 10 end-of-project status indicators (EOPS), as listed in Annex B, were to be achieved and in place at the project's termination. Additionally, in establishing these status indicators, various targeted outputs would be achieved as a result of the project's institutional development, training, water management, physical improvement, and monitoring and evaluation efforts and activities. These targets are listed in Annex B.

III. TECHNICAL ASSISTANCE

The Project Paper specified that five technical assistance categories would be required for the CWM program. These categories included the following:

- an expatriate team from the USAID-funded Water Management Synthesis II Project (WMS II) for diagnostic analysis of a specified subproject area;
- local supervisory consultants;
- local university and/or private sector researchers;
- a CWM Technical Assistance Team composed of both expatriate and Pakistani professional staff; and
- short-term assistance.

This final report primarily addresses the activities of the TAT and supporting short-term assistance.

A primary objective of the Technical Assistance Contract and hence, the TAT, was to assist the GOP and USAID/Pakistan in implementing the Command Water Management (CWM) component of the Irrigation Systems Management Project on a pilot basis in the seven subproject areas. Contract responsibilities were to technically advise and assist them in implementing, monitoring, and evaluating project activities; and to formulate and revise the operational plans based on the evaluation results. The team's technical assistance and guidance focused primarily on strengthening the provincial governments' capability to improve water management practices, integrating the provision of agricultural inputs and services, and increasing farmer participation in the management of the irrigation crop production system.

To fulfill these contractual obligations, a multidisciplinary team of both expatriates and Pakistanis was recruited. Initially, the professional team members consisted of the following:

- one Team Leader (Systems Management Specialist);
- two Farm Management Specialists (Monitoring and Evaluation Specialists);
- two Water Management Specialists (Irrigation Engineers);
- two Extension Specialists (Farmer Organization Specialist/Anthropologists);
- two Pakistani Agronomists; and

- one Training Systems Management Advisor.

Later in the program, the two expatriate Irrigation Engineers, the Team Leader, and the Farmer Organizational Specialist terminated their employment. Due to mission limitation on numbers of expatriate employees, these engineers were replaced with three Pakistani engineers. Later, a new Farmer Organization Specialist was recruited and an additional professional-level Social Scientist (Sociologist) was added to the team to strengthen the WUA organizational effort in the Punjab.

During the first two contract years, the TAT was split between two offices: one in Lahore and one in Karachi. The Lahore team was responsible for activities in Punjab and the NWFP provinces. The Team Leader's office was in Lahore. The Karachi team was responsible for team activities in Balochistan and Sindh. The Farm Management Specialist was responsible for the Karachi office administration.

Following the arrival of the new Team Leader in June 1989, a new head office was established in Islamabad. The belief was that this would promote closer and more frequent contact with USAID and the GOP Federal Coordinator's office, and would better support the project implementation process. The Team Leader and the Training Systems Management Advisor were transferred to Islamabad along with supporting staff.

Shortly after establishment of the Islamabad office, a new CWM/ARDINC office was opened in Peshawar to be more responsive to the NWFP SMO's needs. Previously, the technical needs of the NWFP were served from the Lahore office (Lahore TAT members spent about one-quarter of their working time in Peshawar). The Farmer Organization Specialist was transferred from Lahore to Peshawar where he was joined by a Pakistani Water Management Specialist (Irrigation Engineer) and an Assistant Farm Management Specialist who worked in Monitoring and Evaluation. Technical assistance in agronomy was still provided, on a part-time basis, from Lahore. Overall, the opening of an office in Peshawar and the resulting constant contact with the SMO improved their working relationship.

Under the first Team Leader, with only two CWM/ARDINC offices, all decisions including contract and office administration and project implementation were made by the Team Leader in Lahore. Starting in June 1989, CWM/ARDINC offices were increased to four and total contract personnel increased to 43. Simultaneously, USAID made the Contractor responsible for all personnel actions. With the increase in the number of CWM/ARDINC offices, local employees, and personnel responsibilities, it was apparent that the scale of the contract had become too large for one person to effectively control all day-to-day technical assistance details.

Accordingly, authority was delegated to one expatriate in each office to act as the office Expatriate Administrative Coordinator (EAC) and to handle the daily program details in their respective subproject areas. In effect, they were the TA counterparts of the Subproject Managers. They also were authorized to propose and develop their own work plans within the context of the Master Work Plan and subject to the concurrence of the SPM and the Team Leader. This arrangement improved project implementation as problems could be addressed more rapidly and as team members gained greater knowledge of their area's problems, they now had the latitude to develop and implement their concepts and approaches.

Each team member, in implementing his work assignments, interacted with various GOP counterparts. These counterpart relations were not specifically defined; usually, the counterparts with whom they interacted depended on the nature of their particular activity. Generally, however, the following counterpart interactions and working relations were operative:

1.	Team Leader	-	USAID Project Manager, USAID Contracting Officer, Federal Coordinator, Provincial SPM.
2.	Expatriate Admin. Coordinators	-	Provincial SPM.
3.	Farm Management Specialist	-	Monitoring and Evaluation Unit.
4.	Water Management Specialist	-	Water Management Unit, OFWM and PID.
5.	Agronomist	-	Extension Department.
6.	Extension Specialist	-	SPM.
7.	Training System Advisor	-	Provincial OFWM Training Institutes Directors, Federal OFWM Coordinators, etc.

Each of the professional team members had a contract-defined scope of work; a summary of each is listed in Annex C.

In addition to the TAT, professional support for the CWM project and its various technical activities was provided by TDY personnel who provided the following support: home-office support for the team, training, and technical support for the program through the SMOs. This assistance, while helpful to the program, brought with it problems in its implementation. Technical assistance for the project required the concurrence of all four

SPMs, which was difficult to secure. TDY home-office support for the TAT did not require SPM concurrence; this, however, was not understood by SPMs and led to some disagreements, particularly with the SPM of the Punjab subproject areas.

The project-funded, short-term support received included assistance in drainage, irrigation scheduling, water loss measurements, crop production techniques, and farmer organizations. Notable among this TDY support was assistance with irrigation scheduling, which led to the development of a scheduling method that allows timely irrigation in response to crop water requirements when applied through Pakistan's fixed, rotational, continuous-flow system.

The team enjoyed excellent support in terms of facilities and equipment. As noted above, team offices were established in Islamabad, Karachi, Lahore, and Peshawar. At each location, every professional had his individual room. In addition to space, every office was provided with a photocopier, typewriters, microcomputers for secretarial use, all necessary office furnishings, office supplies, and generators. Each professional had his own personal microcomputer. Additionally, Lahore and Islamabad offices had fax machines to facilitate communications with the home office.

The TAT also had 14 vehicles: four at Karachi, one at Kandiaro, five at Lahore, and two each at Islamabad and Peshawar. Although the team was well-provided in terms of office and office equipment, and transportation, there were deficiencies in the availability and quality of field equipment. Such equipment was controlled by the SMOs and participating line agencies, and was not always readily available or in operable condition.

IV. WORK PLAN

The Technical Assistance Contract specified that within 90 days following the Team Leader's arrival in Pakistan, a Master Work Plan would be developed; this plan was completed in May 1987.

Essentially, this "CWM Technical Assistance Master Work Plan" detailed the overall process by which the TAT supported the SMO in achieving the program's assigned objectives. Specifically, it detailed how this multidisciplinary team was to advise and assist through the implementation of a series of overlapping interventions which included the following:

- Institutional Development;
- Training;
- Water Management Improvements;
- Civil Works (Physical Improvements); and
- Monitoring and Evaluation.

These five interventions were implemented through program plans (listed below). Each plan addressed various components and aspects of the assigned objectives. The program plans included the following:

- Water User's Association Development;
- Monitoring and Evaluation;
- Agricultural Extension Activities;
- Operational Water Management System;
- Training; and
- Support to SMO.

These program plans were a simple description of the approach and the major activities to which these interventions were to be applied within these major program areas. Work plans were developed for each province in these various program areas.

It was intended that the Master Work Plan be revised periodically to account for necessary and evolving changes in direction. The first *revision* was completed in November 1989. A second *revision* was completed in June 1990, with the additions of work plans for the integrated "Full Watercourse Trial."

In March 1988, a Mid-Term Evaluation of the CWM project was conducted. The criticisms concerning technical assistance led to changes both in work plans and activities. Greater emphasis was placed on integrated trials and activities where all concerned line agencies would be more directly involved in planning and implementation. Specifically, these integrated efforts were focused on drainage, water management, farmer organizations, seed multiplication, and improved crop production practices; these topics were all addressed in the evaluation.

For example, in drainage, an additional professional training course was organized and a 10-acre pilot drainage project was constructed and completed. In water management, an irrigation scheduling procedure was developed which provided most of the benefits of "on-demand" irrigation and yet, was applicable to Pakistan's fixed, rotational, continuous-flow system. In "farmer organization," renewed and enhanced efforts were made to involve the WUAs and their memberships in all watercourse activities; Federations as well as tubewell user organizations were formed; and methods were developed for funding watercourse maintenance. Where possible, efforts were made to address the technical assistance issues raised in the evaluation.

In the development of work plans, efforts were made to involve the SMO and all concerned line agencies. This was not always successful; following the distribution of the revised Master Work Plan, no one from the four SMO offices, the line agencies, the Federal Coordinator's Office, or USAID responded to requests for comments. However, in meetings held to discuss the implementation of specific planned activities, comments from certain SMO offices were forthcoming. SMOs and concerned organizations varied in their ability, motivation, and interest in planning.

V. PROJECT IMPLEMENTATION

The Technical Assistance Team's assignment primarily included advisory, planning, training, extension, and demonstration services. In short, they were involved in applications in development rather than research.

The programs proposed were implemented through a "phased-in" approach. Initially, each TAT member concentrated on individual model component within his discipline such as new varieties, appropriate fertilizer application, water application practices, modification of cropping patterns, and procedures for organizing WUAs. These component models would later be combined into more extensive models. Normally, such trials were implemented with the assistance of concerned and involved farmers and WUAs, and were generally located on farmers' land.

The next phase involved the combination of several related components into integrated demonstration models. A typical demonstration might integrate certified seed of a recommended variety, appropriate balanced fertilizer applications, and improved irrigation procedures. Again, such demonstrations were implemented on farmers' fields with assistance and support of the local WUA. Such demonstrations were also used for training local farmers in improved production practices.

The intent of the TAT was that those improved practices tested and recommended at the demonstration plot level would be replicated at the full watercourse level, then to the minor and federation level, and ultimately to the subproject level. This approach was fully endorsed by the World Bank's Supervisory Mission during their CWM project evaluation (November 5 to December 6, 1990). It was further intended that trials implemented at successively higher organization would be broader in scope; that more previously tested and recommended components would be integrated into each successive trial.

Components used in trials and demonstrations were based on the Master Work Plan and its various revisions, from direct requests from the various SMOs, and from peer review and evaluation as enunciated in the project's Mid-Term Evaluation. A primary planning consideration was that all practices demonstrated and tested must be within the financial and technical capabilities of the subproject farmers.

Implementation of the various trials and activities was frequently difficult. Assistance, both professional and labor, was often not available from SMOs. At all locations, the TAT did not have sufficient personnel and equipment resources to physically install all trials and collect the required data. The situation was particularly difficult in Punjab Province where four widely dispersed subproject areas strained team resources and required excessive amounts of team time. Additionally, the SPM in the Punjab frequently tried to dictate all the planning and activity details for the team which often resulted in a contentious relationship.

Listed below are brief descriptions of the more important trials, demonstrations, and other work activities implemented in the various subproject areas. More detailed information is available in the designated attached Annexes and previously distributed quarterly reports. The sequence of presentation is unrelated to the order of implementation.

Waterlogging, Salinity, and Drainage--Lasbela, Balochistan

Due to waterlogging and salinity problems in some of the subproject areas, particularly Lasbela, both the Project Paper and the Mid-Term Evaluation stressed the need for drainage studies and activities.

Based on project needs, a waterlogging, salinity, and drainage training and demonstration program evolved. With assistance from the Academy for Educational Development, a four-week national training course on waterlogging and salinity was presented in Lahore in 1989, by Utah State University. Engineers from both the OFWM Directorates and the CWM project were trained in this course.

In 1990, an advanced drainage training course was presented in Karachi with fieldwork in the Lasbela Subproject Area. Again, engineers from both the OFWM Directorates and the CWM project participated in this training. The primary purpose of the training was to select a demonstration site for drainage in the Lasbela Subproject Area and to design and install a small drainage system. Included in the selection process was the development of a site description of pre-drainage site conditions and data.

A 10-acre orchard site was selected and described. Installation of the course-designed system was just barely started when the course ended due to insufficient funds and completion of the drainage system was temporarily halted.

After a period of several months, money was provided to complete this system. By this time, those GOP engineers from the Lasbela Subproject Area who were trained in the drainage courses had been transferred out of the CWM project and were not available for construction of this system. Despite the loss of the engineers, the TAT engineer in Karachi, with help from engineers untrained in drainage, completed the construction of this drainage system which is now functioning.

The Lasbela Subproject Area has developed a very serious waterlogging and salinity problem. Within a few years, much of this command area will be out of production unless drainage is established. Consequently, this drainage site is very important as a demonstration and, more importantly, for the data it could provide concerning the need for a drainage program in this area. Unfortunately, shortly after completion of this drainage system, technical assistance to the CWM project was prematurely terminated. Reportedly, the collection and analysis of drainage data has also terminated.

More detailed information concerning the Lasbela pilot drainage program is given in Annex E and in the previously distributed training report.

Irrigation Scheduling

The first specific objective assigned to the CWM project by its Project Paper included the need to deliver water in response to crop water requirements, to the maximum extent possible. The Mid-Term Evaluation also stressed the need for water management planning of which irrigation scheduling to avoid crop water stress is a major component. Unfortunately, the present system's constant flow, fixed, rotational schedule constrains the delivery of water in response to crop water requirements. Due to the costs involved, it is not an objective of this project to physically alter the system to provide "on-demand" delivery.

The local engineers employed on the TAT did not have sufficient microcomputer and scheduling experience to address this irrigation scheduling problem. Thus, TDY technical assistance was provided to develop an irrigation scheduling program which could avoid water stress and the associated yield reductions without physically altering the delivery system. The program is based on several equations (Jensen-Hays, Modified Penman, Hargreaves) which predict crop evapotranspiration from weather data; use locally developed crop coefficients; and compare results to a crop phenology clock. The weather data used was historical data recorded at sites near the subproject areas in each province.

While the computer procedure developed for analyzing the weather data and estimating evapotranspiration was highly sophisticated, the irrigation scheduling calendars produced were very simple and can be implemented by any farmer.

Examples of irrigation scheduling calendars developed for early and late wheat sowing dates in the Punjab are shown in Robert Hill's report, *Irrigation Scheduling Practices Review and Development of Recommended Improved Irrigation Management Programs* (see Annex F for Executive Summary; full report is available from USAID/Islamabad). The calendar is based on the date of sowing; it assumes the sowing takes place three to four days after a pre-irrigation. The calendar specifies the days after sowing that each irrigation should be applied. These selected days coincide with the farmers' scheduled irrigation turn according to the existing *warabandi*; note the existing seven-day or multiple of seven days between irrigations. The calendar implicitly states that if a farmer irrigates his wheat on these designated turn days, there is a high probability that wheat yield will not be depressed due to water stress. These calendars can be produced for various soil types, crops, and rain or no rain conditions. They should be particularly effective in the Sindh and Balochistan during the wheat season when little rainfall is expected.

The TAT considers the calendar irrigation scheduling approach an important breakthrough for water management on the irrigation system presently in use in Pakistan. During the 1990/1991 wheat season, this system was implemented on full watercourses in

Kandiaro and the Warsak Lift Canal. In the Lasbela and Shahkot Subproject Areas, it was implemented on a smaller scale. Unfortunately, technical assistance was terminated before these important trials were completed. Based on prior project experience, it is doubtful that the various SMOs will collect any additional data. Thus, the opportunity for advancing irrigation scheduling in Pakistan has again been delayed. Complete details of the irrigation scheduling calendar procedure are listed in Annex F.

Full Watercourse Trials--Kandiaro and Lasbela Subproject Area

The purpose of these full watercourse trials was to introduce a fully integrated range of technical and organizational improvements to farmer members of an entire water user association and to evaluate the impact on crop production and farmer incomes.

In the Kandiaro Subproject Area, watercourse 2L on Abji Minor was selected; at Lasbela, the watercourse selected was WC-24 on Minor 24. These "Full Watercourse Trials" implemented on each of these subproject areas were patterned after the General Outline listed in the Master Work Plan, Volume II, Full Watercourse Trials.

The components implemented in these integrated full watercourse trials were as follows:

a. *Watercourse Selection*: Selection was based on the following criteria which had been previously tested in the program. These criteria included: demonstration of farmer interests; identification of farmer benefits; a large number of shareholders; respected local leaders; a history of cooperation; and a majority of the farmers belonging to the same *bradari.*

b. *WUA Organization Procedures*: Procedures used in organizing water user associations included: presenting program concepts, objectives, and benefits; selecting a membership committee and enrolling members; electing WUA officers; opening a bank account; and registering the WUA with the SMO.

c. *Watercourse Rehabilitation*: The organized WUAs contacted the responsible OFWM team and submitted the required documents. The WUAs appointed survey committees to advise the OFWM team on elevation problems and the location of *naccas.* The WUA also formed labor committees to organize farmers and hire labor for rehabilitation, and appointed a quality and control committee to inspect the quality of materials used in construction. The WUAs and their memberships participated in every phase of the watercourse rehabilitation.

d. *Watercourse Maintenance*: Although both watercourses were recently rehabilitated and required no immediate maintenance, 2L Abji WUA in Kandiaro adopted a plan to meet weekly and discuss maintenance activities.

e. *Procurement of Non-Water Inputs*: Members of the WUA at Lasbela (WC-24) felt a priority need for greater access to non-water inputs and consequently opened an inputs store on the watercourse. Provision of these inputs was partially arranged by the Extension Department. In Kandiaro, the only input not readily available to farmers was certified seed. The project arranged for the purchase of certified wheat seed from the Sind Seed Corporation. Farmers ordered their seed through the WUA.

f. *Farmer Training*: At both watercourses, farmer training was required to successfully implement this trial. All training was coordinated through the WUAs. Trainers were from the TAT, the SMO, and cooperating line agencies. Where special skills were required, trainers were secured from the universities, seed corporations, and commercial seed companies. Topics selected for farmer training included: watercourse maintenance, conveyance efficiency, irrigation scheduling, irrigation application practices, improved seed, soil and seedbed preparations, sowing methods, and fertilizer applications. Training sessions were usually one-half a day or less.

g. *Credit*: The ADBP was approached concerning loans to the WUAs as corporate entities; such loans were not possible due to legal constraints.

h. *Water Management*: Water management plans were established for each trial. The plans implemented contained elements as follows: 1) a watercourse inspection and maintenance program to maintain water control, minimize conveyance losses, and ensure equitable delivery to each farm; 2) a cropping pattern which was matched to the available water; 3) improved land leveling to facilitate the even distribution of water on the fields and uniform crop stands; 4) irrigation scheduling calendars (as described above) to avoid plant stress; and 5) improved surface application practices where each acre is divided into quarters which are sequentially irrigated.

i. *Improved Production Packages*: In conjunction with the water management program, improved production packages were included in both trials. These packages included the use of improved varieties compatible with the area agro-climatic conditions and local market demand. Also included were improved soil seedbed preparations, sowing date recommendations, application of appropriate balanced fertilizer dosages, weeding recommendations, seed production and exchange options, and the necessary training required for implementation.

All the elements included in this trial, except for irrigation scheduling, had been previously tested. Additionally, all practices recommended were within the average farmer's financial and technical capability.

These trials were initiated in late October and early November 1990. In Kandiaro, wheat was the main crop during this trial; at Lasbela, the main crops were forages, wheat, and vegetables. Unfortunately, the results of these trials, while described earlier as having outstanding potential, are not known. The TAT was evacuated from Pakistan and later, the

TA contract was prematurely terminated. This resulted in the complete loss of information from the most extensive trial initiated during the project. A more detailed description of these trials is found in Annex G.

TAT Activities in Punjab CWM Program

In light of the project objectives and the mandates of the TAT, the program for Punjab can be categorized under the following headings:

- Irrigation Scheduling and Improved Irrigation Techniques;
- Agronomic Practices;
- Institutional Development; and
- Monitoring and Evaluation.

These programs were designed and pilot-tested in collaboration with the SMO, OFWM Directorate, and the Agricultural Extension Department. A summary of the above-mentioned programs and results of the pilot trials are presented in the following sections.

Irrigation Scheduling and Improved Irrigation Techniques

Under this program, an effort was made to extend water management in Pakistan from watercourses to farmers' fields. Irrigation scheduling was pilot-tested using gypsum blocks and a computer program was developed. Additionally, field trials were carried out for planting cotton on furrow-ridges and furrow-beds to improve application efficiency (see Annex H).

Irrigation scheduling with the use of gypsum blocks were tried in all four subproject areas of Punjab. Use of gypsum block received the greatest attention at the Shahkot subproject. This program was tested with the assistance of the Agricultural Officer (AO) of the Extension Department on five farms in Shahkot for wheat crop. Detailed explanations were provided to the farmers on the use of gypsum blocks and they were made full participants in the program. The gypsum block readings were made on a weekly basis by the AO and the farmers, and dates were selected for the next irrigation. Farmers followed the recommendations of the TAT Agronomist and the AO within the limitations imposed by the *warabandi* schedule.

Based on the interviews conducted, the farmers found this program highly educational in terms of the soil-water-plant relationship. However, the number of trials were limited for analysis of the relationship between the timing of irrigation and yield under this program. Problems in terms of replicating this program included the calibration of gypsum blocks and teaching farmers how to install and use related equipment.

Given the limitations of gypsum block, a modeling method was chosen to provide an effective irrigation scheduling program. Refinements in the model were made to fit the conditions of the project area.

In view of the low literacy level of the farmers, it was essential that the scheduling program be simple and usable by the farmers. Therefore, a calendar approach was used to inform the farmers of the appropriate times and amount of irrigations. Farmers' practices, irrigation turn system (*warabandi*), soil type, sowing time, crop varieties, crop growth stages, rooting depths, and other possible limitations were taken into consideration in developing these calendars.

Shahkot subproject area was selected for pilot-testing the irrigation scheduling model under direct supervision of the TAT. In collaboration with the OFWM staff, field trials were also scheduled for Niazbeg and Pakpattan subprojects. A total of 13 farms were selected in Shahkot for field trials and irrigation schedule for each farm prepared. A systematic method for collection and analysis of monitoring and evaluation data was also developed.

The field-testing of the irrigation scheduling program began in November 1990 and continued through January 1991. Due to evacuation of the TAT and subsequent termination of the project, this program could not be completed.

Improved irrigation techniques for cotton were field-tested at six different sites in Kharif 1990 in the 6R and Pakpattan subprojects. The improved irrigation techniques consisted of furrow-ridge and furrow-bed methods to demonstrate a more efficient use of irrigation water as compared to the traditional practices of basin or border irrigation. The criteria for comparison was based on the time taken to accomplish individual irrigations, as well as total time taken to complete all irrigations under each techniques. In addition, analysis of soil after sowing and before crop harvest was carried out to determine the salt movement as affected by the irrigation treatment. Yield data was also collected.

The beds were constructed using a bed shaper. Sowing cotton on ridges was accomplished with the help of a ridger. The time and amount of irrigation applied under each technique was based on farmer's judgment. Farmers were advised to avoid over-irrigation, or irrigating to the point where the water would overtop the beds or ridges.

The estimated water saving based on individual irrigation time showed that the furrow-bed irrigation saved from 27 percent to 54 percent, whereas furrow-ridge saved about 24 percent to 35 percent of water. Cotton yield from the fields prepared as furrow-beds in 6R was 6 percent to 52 percent higher and yield from field with furrow-ridges was 6 percent higher in the first trial field and 6 percent lower in the second trial field compared with flat basin.

The farmers showed interest in replicating furrow-bed irrigation technology subject to improvements in the design and operational aspects of the bed shaper. However, they

appeared reluctant to sow on ridge tops, particularly in salt-affected areas due to the movement of salt to the ridge tops and, hence, germination problems.

Agronomic Practices

Based on detailed studies of farming practices in the coordinated watercourses in Punjab, it was concluded that yield and farm income can be drastically increased by use of better quality seed and a more balanced mix of fertilizers. To determine the magnitude of improvement from seed and fertilizer programs, demonstration trials were carried out in Shahkot and 6R subproject areas for the cotton crop in Kharif of 1990. Limited trials were also carried out in rice and wheat crops in 1988 and 1989.

Data indicated that 92 percent of farmers in the 6R subproject used the seed that was kept from their last harvest. Farmers were generally not satisfied with the performance of the seed available in the market and believed that the private traders were mixing quality seed with regular seed. They also found it difficult to obtain sufficient quality seed from the Punjab Seed Corporation, particularly in the remote areas such as 6R.

Under the field trials conducted on 17 farms in the 6R area, quality basic seed produced an average yield of 21 maunds (mds), compared to 17.4 mds production from ordinary seed used by the farmers. This is equivalent to an increase in yield of about 21 percent from a minor increase of Rs. 15 in seed cost. In order to improve the availability of seed in the 6R subproject area, farmers were organized into seed multiplication groups and technical advice obtained from Punjab Seed Corporation. This is a program that can be readily replicated. In the World Bank's proposed Fordwah Eastern Sadiqia Project, which includes the 6R area, the potential for improving production through provision of improved seed has been recognized. A program for improving the availability of seed will be an integral part of this major irrigation and drainage project. Further information on the seed multiplication program is provided in the section on institutional building (see Annex I).

Fertilizer use in Pakistan has increased at an average rate of 10 percent over the past 10 years in spite of major price increases, and is projected to increase further. The problem with fertilizer use is not one of overall volume, but balance between nitrogenous and other (phosphatic and potassic) types of fertilizer. In light of the significantly higher cost of the phosphatic and potassic fertilizers, the return on investments in these fertilizers needed to be examined and an effective demonstration program for farmers established.

Field trials on 7 plots of rice and 20 plots of cotton in 1989 and 1990 kharif seasons showed that rice yield can be drastically increased by using a balanced mix of N, P, and K fertilizers. On the average, rice yield increased by 184 kg, respectively. As a result, gross income less fertilizer cost increased by Rs. 3618 per acre for rice and Rs. 1606 per acre for cotton. Programs in the areas of farmers' education and credit are needed to help farmers apply a more balanced mix of fertilizers.

Institution Building

The TAT was involved in bringing about collaboration between the SMO and the project-implementing departments of Irrigation, OFWM, and Agricultural Extension. A number of meetings and seminars were arranged in Lahore and at the project sites. In addition, continuous support was provided to the water management and monitoring and evaluation units of the SMO. The major area of institutional development in which the TAT devoted considerable time and effort was in organizing water user associations and federations.

Water User Associations (WUAs) were organized with the assistance of Water User Association Development Specialists (WUADS), hired by USAID to work with the TAT and the SMO. The WUA development activities included organizing and motivating farmers to participate in watercourse improvement and maintenance, group procurement of inputs, obtaining cooperative credit, joint tubewells, and seed multiplication. The participatory approach that was introduced in Pakistan was pilot-tested in Punjab with the assistance of a WUAD in Pakpattan subproject.

The program for organizing farmers into groups for purchase of tubewell water in Shahkot subproject was highly successful (see Annex L). The commitment made by the tubewell owners to provide water as requested and collect the payment after harvest, and create an environment of trust and cooperation among the farmers, were the two most important elements of its success. As a result of membership in the tubewell group, the first tubewell organization managed to increase the cropping intensity from 44 percent in Kharif 1989 to 95 percent in Kharif 1990. For the second tubewell organization, cropping intensity for Karif season increased from 74 percent in 1989 to 87 percent in 1990. The certainty of irrigation water also resulted in an increase in acreage under high-income vegetable crops.

Multiplication of cotton seed was facilitated by organizing 20 farmers in the coordinated watercourse of Shahkot into six groups. Each group was provided with cotton seed of Niab 78 variety to plant for multiplication. A total of 35 acres were planted for multiplication. Assistance was obtained from Punjab Seed Corporation for examination of the cotton fields and in certification of seed.

The cotton planted for multiplication was harvested and ginned separately using a small local ginning machine. A germination test was performed and the seed bagged for sale to the neighboring watercourses.

The lint produced by the seed multiplication groups was sold for between 640 to 800 rupees per mound and seed for 10 rupees per kg. Participating farmers were able to increase their gross income by 40 percent and learned to integrate into the product processing and marketing chain. This is a program with considerable potential in Pakistan and should be considered for replication by other projects.

Setting up a Federation of water users was another area where the TAT made an effort to develop a replicable institution-building model. The objectives of the Federation were identified as assistance to the Irrigation Department in the equitable distribution of water among watercourses, participation of farmers in maintenance of minors and small distributaries, and assistance in resolving irrigation water-related conflicts.

A detailed process for organizing a Federation was developed and a series of meetings with the Federation (two to three representatives of five watercourses) in the Pacca Dalla Minor at Shahkot was held (see Annex M). As the Federation's first activity, the Irrigation Department was requested to measure the water diverted into the minor and the five watercourses, and make the necessary adjustments to restore the designed allocation of water into the minor and watercourses. Unfortunately, due to early termination of the project, this program could not be completed.

Monitoring and Evaluation

The TAT assisted the SMO Planning, Monitoring, and Evaluation (PME) Unit in the preparation of the overall M&E program for Punjab, data collection, and data analysis and report preparation. The TAT irrigation engineers assisted in measuring water in selected sections of the distributaries, minors, and in watercourses. Automatic stage recorders were installed on the distributaries to facilitate data collection (see Annex N).

SMO staff were trained in the analysis of agro-economics, as well as irrigation water-related data, and assistance was provided in the preparation of reports. A comprehensive evaluation report titled *A Review of Key Performance Indicators* was prepared in 1989.

Kandiaro and Lasbela Extension Outreach Program

The Extension Outreach Program in both the Kandiaro and Lasbela programs had the following main components:

- demonstration plot program,
- seed multiplication program,
- dissemination of agricultural information, and
- training of farmers and field staff.

Demonstration Plot Program

The main objective of the program was to increase the yield of crops in the project area by efficient use of the available resources (both water and non-water) of the farmers. As the majority of the farmers in the project area were illiterate and had limited resources, it was

decided that in order to motivate/educate the farmers, the first step would be to demonstrate to them that yields could be increased by adopting simple, non-expensive, cost-effective, improved agricultural practices. Wheat and cotton, the most important crops in the project area, were selected for demonstrations. The salient features of these demonstration plot programs are listed below:

- use of certified/improved seed of recommended varieties of wheat and cotton;
- preparations of weed-free and leveled seedbeds;
- timely planting of the crop;
- cross-wise broadcasting of wheat seed to ensure gap-free germination;
- line sowing and seed placement at proper depth to ensure the required number of plants/acre;
- timely and effective weed control; and
- judicious, timely, and uniform application of irrigation water and fertilizer.

The above general practices are all within a farmer's financial resources and technical abilities. Due to limitation of funds and staff time, the demonstrations were limited to a selected number of watercourses. Farmer days were held regularly on these plots before the planting of a crop and during its different growth stages. Farmers were invited from neighboring watercourses. Water User Associations were closely associated and involved in these demonstration plots and field days. These field days provided an opportunity for WUA members to learn and educate themselves and see the benefits of using the improved agricultural practices. These practices increased the wheat demonstration yields from a base of 22 mds/acre to 40 mds/acre; cotton increased from 11.2 mds/acre to 20 mds/acre. The average wheat yield throughout the entire subproject area increased from 20 mds/acre in 1986/1987 to 32 mds/acre in 1989/1990 (see Annexes J and K).

In addition to wheat and cotton, many other crops that are more efficient in water use and have a high-yield potential were introduced and integrated into the cropping pattern.

- **Sada Bahar**

This is a hybrid multi-cut fodder (a cross between sorghum and sudan grass). It can be sown from March to June. If sown in February, it can give eight cuttings. It was first introduced in spring 1990 and became so popular with the farmers that in spring 1991, 7,000 kg of this crop had been planted in the project area and it was expected that another 7,000 kg would be planted by June. The entire seed was procured by SMO through Cargill Pak, Ltd. and sold to the farmers on cash payment.

- **Sorghum Grain**

  Sorghum grain (hybrid) was also introduced by SMO in Kharif 1990 as a demonstration. This is a very high-yielding variety which yields from 40 to 60 maunds of grain. This seed is also in high demand by the farmers and approximately 12,000 kg of this seed is expected to be planted in the project area in Kharif 1991. Hybrid maize, sunflower, lucern (imported), and barseem (imported) have also been introduced in the project area through demonstrations.

- **Kalar Grass**

  Kalar grass is known to survive in saline areas and help in reclaiming saline lands. The SMO brought two truckloads of Kalar grass from Bio Saline Research Institute, Lahore, and had planted it at unproductive saline patches at 2L-Abji. The Kalar grass is growing well and will be transplanted to other saline areas in the project.

- **Farmers' Seed Multiplication Program**

  During a demonstration plot program, good-quality seed was identified as one of the major limiting factors in increasing the per-acre yield of wheat crop. Sind Seed Corporation is the only source of supply of this seed. There is a large gap between the demand and supply. Sind Seed Corporation is only able to supply 4 percent of the total demand. Encouraged by the results of the demonstration plots and the demand for certified and pure seed, it was decided to produce certified seed through WUAs during the 1990/1991 season. The Department of Federal Seed Certification and the Sind Seed Corporation were contacted by the SMO to assist in this program. Four hundred acres were earmarked for this purpose. Certified seed of varieties T-J.83 and Sarbaz were obtained from Sind Seed Corporation. Members of WUA, 2L-Abji, and the Federation of WUAs at Kotri Kabir and Dehta Minor were contacted. A number of meetings were arranged with the farmers by the TAT's Sociologist and Agronomist to motivate them to undertake the program. Farmers were asked to prepare their lands according to the instructions of the TAT Agronomist, keep their crop weed-free, and rouge out the off-type plants. All other instructions regarding various operations were to be strictly followed according to the input management package developed by the TAT Agronomist. Three hundred acres of certified wheat seed were planted on 2L-Abji and 100 acres at Kotri Kabir, Dehta Minor, and some other watercourses. Farmers' cooperation was exemplary and beyond expectations. The crops at all locations looked distinctly better and more vagarious than the adjacent fields. A USAID representative visited the crops in its early stages, and was impressed by the enthusiasm of the farmers and even more by the crop itself.

An extensive farmers' field day was organized at watercourse 2L-Abji on March 13, 1991. Invitation was extended to representatives of different line agencies, USAID, the World Bank Mission, and farmers. The Deputy Director (Agronomy) of Sind Seed Corporation also attended the field day with his teammates, as did approximately 200 farmers from different locations in the project area. All the participants visited the entire length of the watercourse and were impressed with the uniform stand, growth, and expected yield. It was estimated that 15,000 kg of seed would be obtained from 2L-Abji, and another 4,500 kg from other locations. The Deputy Director of Sind Seed Corporation inspected the entire crop with his team members and declared that the crop met the certified and pure seed requirement, and that SSC would be willing to lift the entire crop and pay a premium of seven rupees/maunds to the farmers. The Deputy Director also informed the farmers that he would be willing to list the WUAs as their registered growers for the purpose of producing certified seed.

Training

Training of SMO/Agricultural Extension staff and farmers remained an integral part of the extension outreach program. Both formal (structured) and informal (on-the-job) training was provided by the TAT and other line agency experts.

Staff Training

The SMO/Extension staff training was linked with the Training and Visitation (T&V) program of the Agricultural Extension Department. Thirty training sessions were held, which included workshops, seminars, and refresher courses. Although a variety of topics were covered in these training sessions, the main emphasis was on the following:

- on-farm water management;
- land leveling and good seedbed preparation;
- the importance of time lines in the various recommended operations (i.e., sowing; application of irrigation water, fertilizer, and pesticides; and weeding and harvesting);
- methods of plant protection; and
- judicious and efficient use of inputs (i.e., seed, fertilizer, irrigation, and pesticides).

Farmer Training

Farmer training was organized through WUAs on various watercourses. Farmers were trained to make the best use of their resources by adopting improved agricultural practices. Most of this training was arranged in the vicinity of the demonstration plots where farmers could see the benefits of adopting the improved practices. These gatherings helped farmers to educate themselves and provided a forum where they exchanged their views with fellow farmers and discussed their problems with representatives of various line and cooperating agencies (i.e., Agricultural Extension, OFWM, research institutes, credit institutes, and input suppliers). Fifty field days were organized and 1,500 farmers received training. The training was given by the Subject Matter Specialist, TAT Agronomist, WMS, Sociologist, and extension agents. The field training was supplemented with lectures, charts, and audio-visual aids.

Dissemination of Agricultural Information

Improved management practices were developed by the TAT Agronomist for wheat, cotton, maize, sorghum, and lucern. Instructions were printed in the local language and distributed on a large scale to WUA members. Additionally, agricultural information brochures, bulletins, pamphlets, and booklets, developed by both the private and public sectors, were collected and placed at farmers' meeting places (*ottaqs*) on the watercourse to serve as reference material. Video and audio cassettes containing agronomic information on various crops, water management techniques, pest control, tractor operations and maintenance, and other related topics were collected and made available for training in the project area.

Balochistan Demonstration

Demonstration plots of fodder crops and vegetables were established similar to those in the Sindh project in vegetables and fodder crops. Watercourse 24 on Minor 4 was selected as a full watercourse trial. Most of the activities on this watercourse were confined by a lack of funds for demonstration and a limited support staff.

Conclusions

Both crop yields and farmers' income can be substantially increased by motivating/educating farmers to adopt improved agricultural practices that are cost-effective and within the financial resources and technical abilities of the farmers. Among the outputs of the extension outreach program, the following are worth mentioning:

- an increase in crop yields and farmers' income;
- improvement in farmers' knowledge;
- improved interagency cooperation and coordination;

- improved skills of the field personnel;
- improved communication between the members of WUAs, Agricultural Extension, and the Irrigation Department;
- institutional development of the SMO; and
- development of a replicable model (full watercourse trial) for increasing the agricultural productivity on a much larger scale.

More detail is provided in the Extension Specialist's End-of-Tour Report, presented in Annex O.

Implementation Problems

Major problems in implementation were numerous, including problems with design, organization, and personnel. Most striking was the complexity of the design. Command Water Management programs were initiated in all provinces. These programs were linked through a Federal Coordinator, but in reality, were provincial programs, each with its own budgeting process, PPC committees, and SMOs. In effect, the TAT was dealing with four separate integrated projects. Each was considerably different, not only due to varying agro-climatic conditions, but also because of the SPM leadership characteristics and provincial support policies. The project was too large, complex, and dispersed for the team to adequately support.

Provisions were made to support the project in areas of critical need with TDY assistance from the states. Unfortunately, such TDY assistance required the concurrence of all four SPMs. One SPM could, and frequently did, block the use of TDYs for help with critical needs and thus prevent other provinces from benefitting from this assistance.

The TAT was charged with supporting the SMOs technically. Implicit in this charge was that the SMOs were to identify the problems while the TAT were to technically seek solutions to the SMO concerns. In one province, the SMO would typically identify the problems and then establish his own program to determine appropriate solutions. He frequently would assign TAT members to work nearby as data collectors rather than as technical experts. This led to resentment with team members and conflict with the Chief of Party. Fortunately, this practice ceased in the last months of the contract.

In all provinces, the CWM program was organized for the purpose of institutional development. To motivate the implementation of these institutional aspects, considerable civil work was authorized (i.e., rehabilitation of watercourses). Unfortunately, the civil work programs were started first, even before the arrival of the TAT. From that point on, project implementation primarily emphasized civil works. As a result, institutional development was

considered of secondary importance in the project. This process was the primary constraint to progress in institutional development.

The transfer of personnel out of the project after having been trained for a particular position was common in every province. In one particular province, three different SPMs served within a three-month period. In this same province, engineers trained in drainage by the project were transferred out of the program just before the implementation of a drainage construction program. Repeatedly, in some provinces, new people had to be trained for a position which had been vacated by provincial transfers. Thus, the lack of trained personnel continually constrained implementation.

In Punjab and Sindh Provinces, the distance to the subproject area from the TAT offices also constrained implementation. In both provinces, travel to the subproject areas, except for Niazbeg, required six to eight hours each way and severely limited the TAT time available for fieldwork.

In one province, the SPM personnel relations with the supporting line agencies, particularly the Irrigation Department, were continuously strained to the point that their cooperation was limited and implementation delayed.

One of the greatest constraints to implementation was the loss of the TAT's two expatriate agricultural engineers. Both of these engineers, at the end of their two-year contract, elected to seek employment elsewhere. The Mission denied permission for ARDINC to recruit additional expatriate engineers. This action was presumably related to Mission ceilings on expatriate personnel.

The loss of expatriate engineers effectively delayed the development of a water management and drainage program for at least 10 months. Although the Mission allowed the recruitment of three Pakistani engineers as replacements, local engineers with the training and skills required were almost impossible to find. The recruitment of these engineers was held up many months due to prolonged delays in the Mission approving the amendment to the contract (Amendment No.6) that allowed hiring to proceed. The last of the expatriate engineers departed Pakistan in June 1989; local replacements could not be recruited until March 1990.

A similar situation concerned a replacement for the first Chief of Party who was relieved of his appointment in October 1988. His replacement was identified almost immediately, but could not assume his duties until June 15, 1989. During this period, there was no effective leadership of the team which led to a reduction in team effectiveness.

Despite the above constraints, there were major accomplishments from the project which directly supported the project goals, purpose, and objectives. Major progress was made in establishing the End-of-Project Status indicators (EOPS) assigned by the Project Papers. The present status of these EOPSs is briefly described as follows:

EOPS #1--Increased Agricultural Production: In the Sindh, the average wheat yield for the entire Kandiaro subproject area increased from 20 mds/acre to 32 mds/acre. Elsewhere, area-wide increase could not be documented but yield increase on demonstration plots was substantial (10 percent to 30 percent) for most crops. Given more time, the production packages recommended could result in area-wide increases in production.

EOPS #2--Improved Water Management Techniques and Programs: Various water management techniques were developed and tested as individual techniques. Most important was the microcomputer irrigation scheduling calendar approach which allowed the delivery of water in response to crop water requirements as described above. Other components tested included land leveling, improved application techniques, watercourse maintenance, and cropping pattern modification. These components were all integrated into a single water management plan and implemented on full watercourses in each province during the 1990/1991 wheat season. Unfortunately, the premature termination of the Technical Assistance contract prevented the collection and analysis of data. However, reports on these water management trials up to the time of the team's departure indicated a very favorable crop response. It is unfortunate that these trials could not be completed as the team considered these activities among the most important implemented during the project.

EOPS #3--Reduced Inequities in Water Delivery: Lining and rehabilitation of distributaries/minors and remodeling of outlets in most project areas had an impact on equity and reliability, and resulted in water savings due to reduced conveyance losses. Progress made in the Punjab has been documented in the water management and M&E reports. Primarily this was a responsibility of the cooperating OFWM teams.

EOPS #4--Capability for Planning, Implementing, and Operating Integrated Programs Institutionalized: Staff from various departments involved in the CWM project have been sensitized to the need for planning and implementing integrated programs. Punjab, NWFP, and Sindh have made major strides toward improving their internal planning, M&E, and implementation capabilities.

EOPS #5--Farmer-Initiated Water User Associations (WUA)-Reorganized Programs Established to Meet O&M Needs of Rehabilitated Watercourses: Participatory watercourse programs have been established in all project areas to test various strategies in institutionalizing the O&M function by WUAs. The participatory approach is being adopted as the normal WUA organizing procedure in all subproject areas.

EOPS #6--Meaningful Participation by WUAs in PID Planning and Decision Making Concerning Surface Water Delivery Systems: Considerable progress has been achieved through establishment of WUA Federations in Punjab and Sindh. The main system water supply was addressed and technical problems in outlet redesign have been solved through PID/WUA federation joint efforts.

EOPS #7--Increased Private Sector Sales and Appropriate Use by Farmers of Fertilizers, Pesticides, and Increased Use of Certified Seed: Farmers in provinces have been sensitized to the benefits of certified seed and its use has increased throughout the project. Farmer improved wheat seed and cotton seed production programs have been initiated in Sindh and Punjab. Farmers have also been sensitized to the need for balanced fertilizer applications and the use of phosphorous fertilizers has increased in many subproject areas.

EOPS #8--Improved Crop Management and Cultivation Practices by Farmers in Subproject Areas: In Punjab, farmers are now sowing cotton in rows rather than broadcasting. Particularly in the Pakpattan area, farmers are planting cotton in rows on raised beds and surface irrigating in furrows between these beds. The result has been an increase in yield and a saving in water and irrigation times. In the Sindh, farmers are surface irrigating smaller plots (1/4 acre) in order to achieve better water control and more uniform distribution.

EOPS #9--Provincial and Federal Government Policy Measures Implemented to Reduce Irrigation and Input Subsidies: Both provincial and federal governments have implemented policy measures to reduce irrigation and various non-water input subsidies. Subsidies on insecticides/weedicides have been completely withdrawn and fertilizer subsidies have also been reduced.

EOPS #10--Provincial Evidence of Farmer Willingness to Pay Increased Water Charges: There is no documentary evidence that farmers will pay increased water charges. However, it is noted that farmers frequently purchase water from private tubewells.

In addition to the EOPSs listed above, the Project Paper assigned a number of targeted outputs which were to be achieved during the project. The outputs, targets, and accomplishments are listed below.

- Institutional Outputs

  -- *Establish over 1,000 formally organized and registered WUAs*: In all seven subproject areas, more than 1,000 WUAs were organized. Many were organized as participatory watercourses where all subsequent activities involved the WUAs and their farmer members.

  -- *Integrate WUAs into a network of Federations and Councils*: One functioning Federation was organized in the Sindh, which interacted with the Irrigation Department and organized certain demonstration

activities in which all member WUAs participated. One WUA also was organized in the Punjab. Organization of WUAs were in process in Balochistan (Lasbela) and NWFP at the time of termination.

-- *Establish four SMOs, seven supporting Subproject Coordinating Committees, and four Provincial Policy Committees*: All specified organizations were established.

- Training Outputs

  -- *Train 25 staff members of the SMOs and Federal/Provincial Government Officials in rural organization, water management and planning, and monitoring and evaluation techniques*: This target was exceeded through six national training courses, two overseas technology transfer training tours, on-the-job training within the SMOs, and project statistical training courses.

  -- *Train approximately 20 members of the OFWM Directorate's Field Teams and 100 fieldworkers from the provincial extension directorates in multidisciplinary problem-solving techniques related to water management, WUA development, and community participation*: Here also, the target was exceeded through the six national training courses presented by the Academy for Educational Development and the TAT, and through a series of provincial training courses arranged and developed by various TAT members.

  -- *Train approximately 5,000 WUA members in planning, watercourse improvement and maintenance, and improved water management and agricultural practices*: This target was also exceeded through training courses presented to WUA members and through training organized in conjunction with the field days and demonstration plots. These various training sessions were organized through the WUAs with assistance from the SMOs.

- Water Management Planning Outputs

  -- Develop an irrigation system operational management plan for one of the CWM subproject areas.

  -- Develop a detailed methodology that can be applied to other irrigation command areas for deriving an irrigation system operational management plan.

-- Based on the above, develop irrigation system operational management plans for the remaining six subproject areas.

None of the above three targets were achieved as the TAT was terminated before the program could evolve to that stage of development. The Chief of Party had already approached the Punjab SPM about developing such operational management plans, but the request was ignored.

The TAT had developed water management and operational plans for the watercourse; the next stage of development would have been for the minors, then the distributary, etc.

The watercourse plans centered around the irrigation scheduling calendar approach, which allowed delivery in response to crop requirements without physically altering the existing, in-place systems or changing the *warabandis* in use. This system could easily be applied to higher levels of the systems.

It is interesting to note that during the development of the calendar approach, the Punjab SPM did not choose to field study the irrigation system in his subproject area.

- Physical Outputs

  -- *Complete approximately 1,000 farmer-implemented on-farm improvement programs*: Throughout the whole project, more than 1,000 watercourses were physically rehabilitated. This included lining, placement of *naccas* and culverts, and rebuilding earthen sections.

  -- *Establish approximately 1,000 agricultural demonstration plots:* These include demonstrations of varieties, fertilizer, irrigation application, and sowing methods. Many of these demonstrations consisted of a combination of components. All demonstration practices were within the technical and financial capabilities of the average area farmer.

  -- *Complete precision land leveling on about 20,000 acres*: Precision land-leveling was primarily a responsibility of the cooperating OFWM field teams. Their records show that in excess of 20,000 acres total were leveled; most were in the Punjab.

  -- *Complete and evaluate field-testing in several subproject areas of such irrigation methods as pipelines, sprinklers, drip systems*: The equipment was ordered through the OFWM Federal Coordinator's office. Delays in delivery prevented the testing of these various options. However, the

Technical Assistance contract provided the TDY assistance necessary to assemble and set up this equipment.

- Monitoring and Evaluation Outputs

  -- *Develop, field test, and adopt methodology for the systematic and sustained monitoring of CWM activities*: Although the M&E units in each SMO had developed their own approach to monitoring, evaluating, and reporting on the activities in their subproject area, there was no single methodology developed for use in all project areas. Generally, the output from these various M&E units was weak and inconsistent. In part, this was due to a large turnover in M&E personnel in some provinces. Personnel who were trained in the M&E function would transfer and new personnel had to be trained. Thus, many people never reached a high level of proficiency or productivity.

  -- *Produce reports and studies (CWM staff) that record and evaluate actual progress in the subproject areas*: M&E activities were reported in quarterly reports produced by the TAT; these reports were primarily produced by the TA Advisor. However, the M&E Unit and Balochistan (Lasbela) produced a quarterly report on the program status and progress.

  -- *Produce reports and working documents (CWM staff) that analyze the results and impact of CWM, including recommendations for replications on a wider scale of those activities that proved successful*: As per above, reports from the M&E units, outside of the TAT quarterly reports, were few. However, several were nearing completion at the time of the termination of technical assistance. Included were reports on the water losses from the Warsak Lift Canal and modification of the cropping patterns in the Punjab.

Most of the EOPSs were in place and most targets were achieved at the time the Technical Assistance contract was terminated. (It should be recognized that not all EOPSs and targets were the sole responsibility of the TAT.) In addition to these activities, the TAT was the primary force behind several important achievements as follows:

- The local development and testing of a participatory approach to organizing WUAs. Here, farmers participated in the decision-making process of every aspect of watercourse rehabilitation, organization of a maintenance program, demonstration plots, water management, and training. The process was tested in every province.

- The organization of WUA Federations which, in Punjab and Kandiaro, were holding discussion with the PIDs concerning water delivery problems.

- The development of an irrigation scheduling calendar approach which could schedule irrigations in response to crop water requirements without physically altering the irrigation system or changing the in-place *warabandis*.

- The modified cropping patterns to the crop needs with the available water.

- The introduction of new crops such as grain sorghum and barley to conserve water.

- The sensitization of farmers to the benefits of improved and certified seed and the establishment of additional sources of improved wheat and cotton seed through the organization of farmer seed production units.

- The sensitization of farmers to the benefits of balanced fertilizer applications consisting of both nitrogen and phosphorous fertilizers.

- A 60 percent increase in wheat yields in the Kandiaro subproject area through the introduction of improved variety and improved simple practices such as timely sowing, timely applications of balanced fertilizers, and timely weeding.

- The development of full watercourse integrated trials which combined irrigation scheduling with timely and improved sowing, fertilizer, leveling, weeding, and pest control activities.

- The establishment of a weather station in all provinces and the installation of recording flow measurement devices in most provinces.

- The determination, through measuring and analyzing flow, that losses in the Warsak Lift Canal and some adjacent watercourses were minimal.

- The organization of functioning tubewell associations where subscribers purchased water from the owner and where subscribers jointly owned the tubewell.

- The planning and construction of a functioning, 10-acre drainage system which was to demonstrate the benefits of good drainage in the Lasbela area (the TA contract was terminated before drainage data could be collected).

VI. CONCLUSIONS AND RECOMMENDATIONS

As of the writing of this report, it is not known what has happened to the CWM project and, in particular, what has happened to technical assistance. It is generally thought that agreement to close the project resulted from a lack of understanding on the part of certain decision makers of the importance of team recommendations and activities. The decision makers did not fully understand the significance of certified seed, timely sowing, or timely weeding to crop production. Thus, it is highly recommended that project managers be more knowledgeable in agronomics, soils, seed production, and irrigation so that such future decisions can be based on knowledge and an understanding of Pakistani agriculture. It is apparent that decision makers did not give credence to Section 4.06 of the World Bank's Supervision Mission (November 5 - December 6, 1990) Report as found in Annex D which praised the TAT's efforts and warned that "complete withdrawal of the TAT from the scene at this stage could prove to be a major setback..."

As noted above, the organization of the CWM project according to provinces, in effect, required the TAT to support four different projects. The requirement of working with four different SPMs, each with different perceptions, and different personalities, complicated the role of the TAT. The requirement of concurrence from all SPMs made the use of TDYs almost impossible. Additionally, the travel involved to serve all seven subproject areas denied team members adequate time in the field. Thus, if CWM is continued, it is recommended that, initially, the project be limited to one province only. The TAT should be stationed in or near the subproject area to allow more time on the project and avoid unnecessary travel and travel delays. This is particularly important in Sindh where security problems in Hyderabad frequently prevented travel to Kandiaro, which is north of Hyderabad.

Next to the unmanageable size of the project, civil works proved to be the biggest problem in the project. Since civil works were allowed to proceed before the institutional development components were in place, the whole character and direction of the project was changed. The main driving force of the program became construction, and institutional development was given minimal support by the provinces.

This was partially justified on the basis of the Project Paper's established target of 1,000 watercourses. The provincial emphasis on construction appeared to diminish their support for institutional development. In future institutional development projects, civil works should be restricted until the institutional development components are well-organized and in place.

At the time of project closeout, full watercourse trials were in place. These trials integrated all previously approved trial components over a full watercourse and, as such, represented a considerable donor investment. The trials, which were directed by the TAT, came to an end midway through the wheat season with the project closeout. In another three to four months, all of the data would have been collected and analyzed and would have served as a basis for expansion of trials to the next irrigation system level, the minor.

A number of benefits have resulted from this CWM project. Two of the most outstanding are the development of the irrigation scheduling calendar approach, which requires more testing, and the emphasis on the benefits in using certified and improved seed. As a single component intervention, certified seed alone will generally increase yield 10 percent to 15 percent. Unfortunately, the private sector generally does not produce certified wheat and rice seed due to the low profitability in these commodities. Thus, wheat and rice are generally provided by the public sector. In Pakistan, the public sector seed corporations only produce a fraction of the seed required. Thus, it is recommended that the CWM project continue to emphasize the need for certified and improved seed, and help farmers develop seed production units to meet the shortfall in public sector production. This would require that farmer units be trained to provide a cleaned and treated product and develop adequate storage facilities. This one activity could provide the largest contribution to increased production of any of the project-tested and -recommended practices.

ANNEXES

Annex A

Description of Subproject Areas

ANNEX A

Description of Subproject Areas

The seven subproject areas for the CWM Program, selected by the Provincial Governments, are shown in Figure 1. In a typical command area, which is the focus of the CWM Program, river water is diverted into a canal system at a headworks, flows through a network of main canals, branches, distributaries, and minors. The are served by the respective irrigation system is called its command area. Along these networks are *moghas* or outlets, each diverting surface flow to a public watercourse, whose length typically varies from 1.5 to 3 miles. From the public watercourses, water is diverted, through *nakkas* or turnouts, to farmers' private ditches or watercourses that irrigate the fields. An average public watercourse will provide water to about 400 acres of land.

There are about 50,000 farms in the seven CWM subproject areas. Table 1 shows the percentage of different sized farms in terms of the total land area and the cultivable command area.

Table 1

Farm Size in CWM Subproject Areas

Size of Farm	Percentage of Gross Area	Percentage of Potential Irrigable Land
Less than 12.5 ac	66	40
12.5 - 25 ac	25	33
More than 25 ac	9	27

Of the 50,000 farms, about 57 percent are owner-operated, or farmed by "owners-cum-tenants." The remaining 43 percent of farms are operated by tenants or sharecroppers. Farm size and the ratio of tenants to owners vary considerably in the various project sites. Table 2 shows population data for the approximately 700,000 people who live in the subproject areas.

FIGURE 1

COMMAND WATER MANAGEMENT - LOCATION OF SUB-PROJECT AREAS

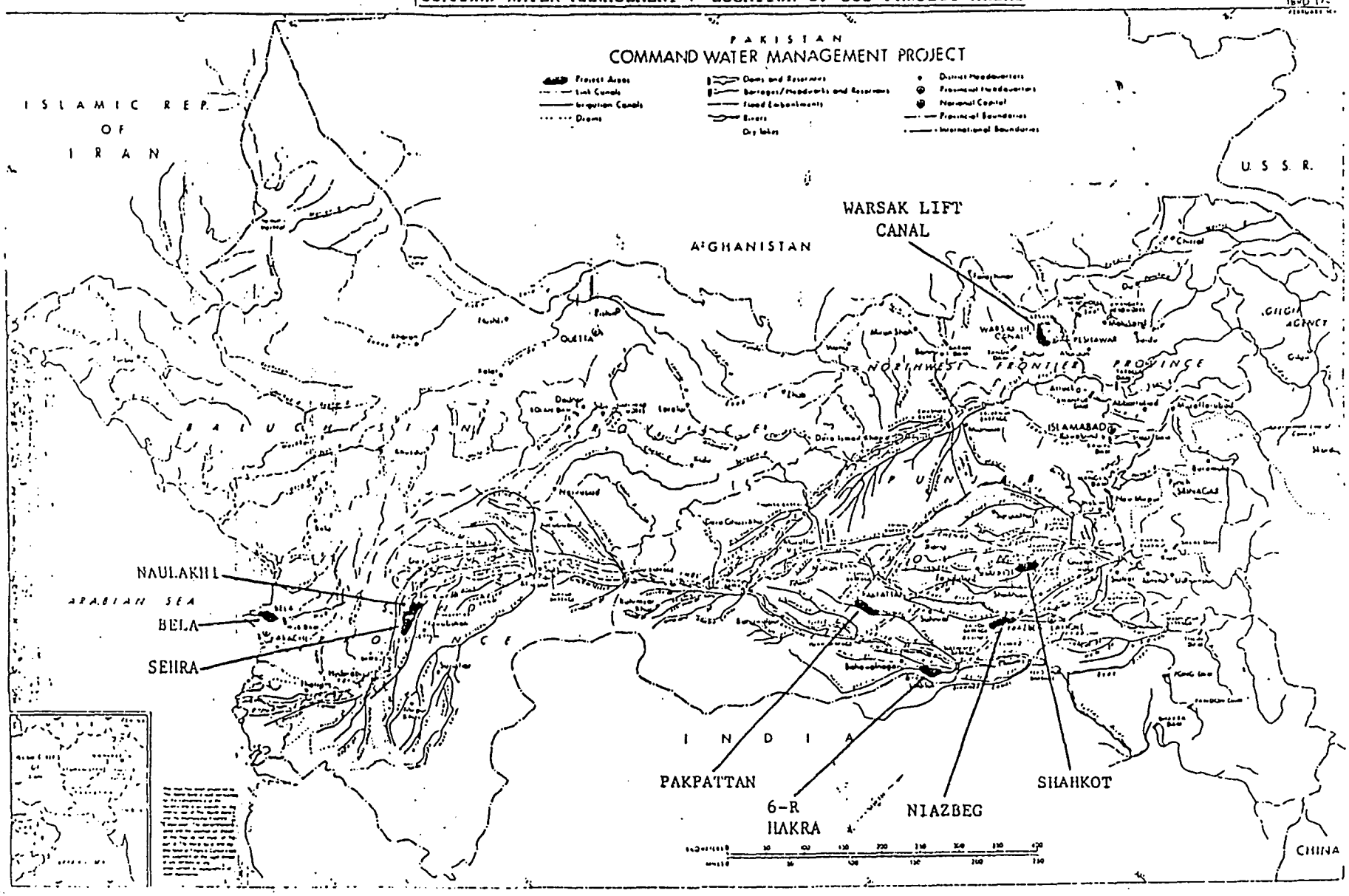

Table 2

Population in CWM Subproject Areas

Subproject	Total Population (000s)	Number of Villages
Punjab		
Pakpattan	144	80
Shahkot	96	36
6-R	136	90
Niazbeg	63	34
Subtotal	439	240
Sind		
Sehra-Naulakhi	208	95
NWFP		
Warsak Lift	69	50
Balochistan		
Las Bela	3	6
Total	719	391

Location and Size of Subproject Areas

Subproject/ Command Area	Gross Command Area (000s)	Cultivable Command Area (000s)
Punjab		
Pakpattan Canal	119	97
Shahkot Distributary	63	49
6-R Distributary	133	104
Niazbeg Distributary	45	41
Subtotal	360	291
Sindh		
Sehra-Naulakhi Branches	165	164
NWFP		
Warsak Lift Canal	55	43
Balochistan		
Las Bela Branch	34	12*
Total	614	510

*Limited to upper five minors.

1. Balochistan: Las Bela

Water from the Hub Dam, located on the Hub River which forms part of the Sindh-Balochistan border, about 30-35 miles west of Karachi, supplies the Bela Canal in the Las Bela subproject area. There are four distinct farmer groups or tribes in this area. The three main groups speak Baluchi, but are from different areas of Balochistan. Theses groups are Baluch, Brohi, and Vohora. The fourth group, which represents about 3 percent of the farmer population and is referred to as "outsiders" by the other groups, consists of private businessmen or retired military officers from Karachi. This group has either taken up farming as a hobby or functions as land speculators. Although not numerically very significant, the average size of farms of this group is relatively large compared to that of other farmers.

The Brohi-speaking tribe represents about 60 percent of all farmers in the subproject area. Formerly nomadic herders from the Khuzdar Mountains, they settled in this region during the reign of the Jam of Las Bela. The Baluch community also consists of settled nomadic herdsmen, who originate from many parts of Balochistan. The Vohora community is a Sindhi tribe who also speak Baluchi. They are the oldest settled community in the subproject area, but they are economically less well off and most often are tenant farmers.

Prior to 1947, Las Bela was a princely state governed by the Jam of Las Bela. After Independence, some of the land in the subproject area was granted to the Ham Sahib by the GOP as compensation for the takeover of the princely state. Subsequently, the majority of this land was sold at a nominal rate to those farmers who had occupied it. However, only those farmers who registered the land with the Government were recognized as legal owners. Some farmers never registered their land and, as a result, they were considered to be squatters. The Jam Sahib later sold the squatter-occupied land to "outsiders" from Karachi, but many squatters refused to vacate their holdings, claiming that they should be considered legal owners on the basis of their long occupancy and active cultivation of this land. Most litigation surrounding these conflicting claims has been settled, though a few cases still remain unresolved.

Landholdings in the subproject area range in size from less than 5 acres to as large as 540 acres. The majority of farmers own 50 acres or less, but many landowners have holdings in the 100 to 150 acre range. There does not appear to have been any enforcement of a legal limit on farm size. Less than 50 percent of the cultivable command area in Las bela (about 8,000 acres of the 18,282 acres) is now being cultivated because of inadequate water supplies, insufficient resources to fully develop the land, and land speculation activities.

The Las Bela subproject area is characterized by a mix of agro-economic activities ranging from field crop agriculture, to fruit and vegetable production, to nomadic pastoralism. The socio-cultural context of agricultural production is equally varied. Small to medium size farmers are typically subsistence-focused, producing relatively little marketable surplus. Many of these farm families obtain supplementary income to meet family needs from work as agricultural laborers or from industrial employment in factories in the industrial estate at Hub Chawki or in Karachi. Large farmers have put a very large proportion of their cultivated area into fruit tree production, seeking to maximize their returns over the long run in developing their farms. They do not depend upon their farms primarily to meet subsistence needs.

The majority of farmers--an estimated 80 percent in the subproject area--however, are tenants. In these cases, the landowner determines the crops to be grown, as well as what land improvements, if any, are necessary. Tenants only make decisions that affect day-to-day farming operations. The landowner provides funds for land improvement (e.g., land leveling, watercourse improvement), and the tenant provides labor for land preparation, sowing and harvesting of crops. General costs of production--seed, fertilizers, insecticides--are shared on a 50-50 basis, with the tenant paying his share of these costs from his portion of the harvest. The harvest also is usually divided on a 50-50 basis. Within the tenant farmer group, women as well as men typically are actively engaged in farming operations.

Although Union and District Councils have been established in Las Bela, the traditional clan leader and community elders remain the principal decision makers among the three major groups within the subproject area. Landowners on each canal minor have established informal committees to settle disputes which typically emerge over water allocation or individual farmers altering the flow of water within the channel. If the dispute cannot be settled by the committee, the local leader will request the Assistant Commissioner (AC) to convene an informal meeting of the parties involved to further discuss the dispute. The AC can, and often does, call upon a number of technical people to assist in reaching a satisfactory solution to conflicts between disputing parties. Here the role of the AC is often that of a facilitator or coordinator, but it also can be that of final arbiter.

2. NWFP: Warsak Lift Canal

The farmers of the Warsak Lift Canal subproject area reflect the diversity of tribes that inhabit the NWFP. The subproject area, substantially influenced by its proximity to Peshawar, reflects a considerable variety of economic and agronomic activities. Agricultural activities in the Warsak Lift Canal include both food and fodder production and animal husbandry that is more transhumance in character, specializing in raising sheep

and goats. Livestock producers depend upon fodder crops raised on irrigated fields to carry their animals through the dry season.

The ability of farmers in the Warsak Lift Canal command to fully develop their farming enterprise is directly affected by farm size and existing conditions of land tenure. Small farmers predominate in agricultural enterprises here, with more than 90 percent of the farms less than 12.5 acres and averaging 3.5 acres in size. They are primarily owners or owners-cum-tenants. Most small farm production is subsistence, and little if any surplus is generated for sale in the open market.

Large farms, though less than 2 percent of all farms, comprise 13 percent of the cultivated area. Although there is a legal ceiling on individual farm size, registration of land under the names of other family members has allowed large landlords, the Khans or Nawabs, to continue to control much larger acreage. Large landowners often make annual arrangements with nomadic tribes, who descend to the plains around Peshawar in the winter, to harvest their crops in exchange for fodder and feed for their livestock. Some large landowners also lease their lands to tenants through various sharecropping arrangements. The advantage that larger farmers have in their ability to mobilize resources to adopt new or improved cultural practices is reflected in the increased mechanization of many large farms. This process is displacing some tenants whose only option is to work as seasonal agricultural laborers if they wish to remain in the area. Some obtain work as unskilled labor in Peshawar as well.

By and large, farmers in the subproject area follow traditional cultivation practices in land preparation, planting, crop tillage and harvesting, and have little knowledge or understanding of modern irrigated agriculture. Some traditional agricultural implements still in use (e.g., the bar point plow) are only effective within a narrow range of soil moisture conditions, and traditional cropping patterns do not make the most efficient use of irrigation water. Watercourses within the subproject area are often meandering, reflecting perhaps the inability of the agricultural community through its decision-making process to negotiate rights of way with intransigent individual farmers. Maintenance of watercourses is relatively poor, and the head reaches of many watercourses are so deep below the surrounding land surface as to preclude easy access for periodic maintenance. Many farm field reflect a genuine need for access to effective land leveling resources. Non-water agricultural inputs--seed, fertilizer, insecticides--are normally not available either int he required quantities or on a timely basis, although the advantages of these inputs seem to be understood and appreciated. Adequate credit facilities are similarly lacking.

In spite of the advent of formal local governing bodies--union and district councils--to which representatives were elected in 1979 and 1981, the traditional village-level *jirga*

(meeting of the clan or tribal elders) remains the primary forum for decisions that affect the community. The community or clan leader (Khan) commonly mediates a variety of disputes, and, in most instances, he is instrumental in decisions regarding the distribution and use of irrigation water within the community.

3. Punjab: Niazbeg, Pakpattan, Shahkot, and 6-R

The farmers ind the four subproject areas are characterized by their small and fragmented holdings. Of the estimated 26,000 farms, over 22,000 or 87 percent are of 25 acres or less. Owner cultivators, owners-cum-tenants and tenants, all considered subsistence farmers, work on these smallholdings.

Owner/cultivators operate almost 10,000 or 37 percent of the smallholdings. The owner-cum-tenant farmers operate their own farms, but pay rent or share additional land needed to sustain their families. This group operates about 5,000 farms or 19 percent. Tenants share their crops 50-50 with owners. They operate 8,000 or 31 percent of the small farms.

The average cropping intensity of these subsistence farmers is higher than in other provinces, but crop yields are still considered low. Water storage at critical periods during the growing season, lack of management of watercourses, inadequate use of fertilizer and pesticides, use of poor quality seed, traditional cultural practices, lack of credit, poor marketing and transportation facilities and lack of new and improved technology, all contribute to low yields. Most farmers in the subproject areas must travel 15 to 30 miles to obtain agricultural inputs, which are generally not available in sufficient quantities nor delivered to the suppliers on a timely basis. Many farmers feel that the time spent in procuring the inputs and the cost of transporting them back to the farms makes their use unprofitable. A similar situation pertains to credit. Most credit is obtained from commission agents, landlords, professional moneylenders, relatives, and friends. Commercial banks are increasing their lending to small farmers, but farmers feel that the amount of time required to secure loans (usually three weeks) and the cost of travel to follow-up on applications makes commercial credit unattractive even though loans are interest-free.

4. Sindh: Naulakhi/Sehra

The Naulakhi/Sehra subproject area in Sindh is commanded by the Sehra and Naulakhi Branches of the Rohri Canal. The Rohri is a perennial canal, and its commanded area is considered to be the most fertile region in the province with a consequent high degree of agricultural activity concentrated here.

About two-thirds of the farms in the subproject area are tenant-operated, by far the highest proportion of tenant-operated farms (and the smallest proportion of owner-operated farms) in

any CWM subproject area. Farming in Sindh is a matter of social prestige for the Sindhi landowner (*Vadera*). Even small landowners with marginally economic holdings prefer to have their farms operated by sharecropper tenants or *haris*. Sharecropping or tenant farming is part of a long-existing aristocratic system in Sindh, and the *hari* is a fixture of the social fabric of the rural community here. There is a close, interdependent relationship between tenant and landlord, especially strong in the case of small and medium size *Vaderas*.

The Sind Tenancy Act of 1975 specified that all tenants who have cultivated the same unit of land for three years can claim permanent occupancy rights to that unit and cannot be ejected form it by the landlord. To circumvent the legal ceiling on individual farm size established by the Tenancy Act, landlords have subdivided their holdings into smaller units and registered them under the names of other family members. In addition, landlords now commonly shift their *haris* from one unit of land to another about every two years. Consequently, large *Vaderas* have retained their control of substantial acreage. And throughout the Sindh subproject area, *haris* have not acquired permanent occupancy rights to land for which the law provides even though the same tenant families have been cultivating the lands of the same landlord families for many years, even generations.

Decisions regarding the use of land in tenant-operated farms are made by the landlord, who also determines when and where irrigation water will be used on his land. Continued landlord control over the water resource is implicitly reaffirmed by the Sindh Water Users' Association Ordinance which permits only landowners to be members of legally constituted WUAs. Landlords and tenants share equally the costs of land preparation (if tractors are used), fertilizer and insecticides. Landlords usually provide seed and pay all taxes and water charges while the *hari* must meet any need for animal power and covers all harvesting expenses. In the latter instance, tenants typically must arrange for additional casual labor either against the higher wage rates which prevail at the time of peak labor demands, or from neighbors, friends and/or relatives on the basis of reciprocated "mutual help."

Crop production is shared on a 50-50 basis between the landowner and tenant. Purchased farm inputs and any loans for harvesting or personal family needs are deducted from the *hari's* share. Cash crops (e.g., sugarcane, cotton) are sold to government or private traders, and the *hari* receives cash, less deductions, for his share of these crops. In the case of such food crops as rice, wheat, or maize, the *hari* typically will retain a small portion for family consumption and sell the balance remaining, although the amount retained for consumption is rarely sufficient to meet family needs through the entire following season. Thus *haris* usually must approach the landlord for a loan of food grain or cash to purchase additional food. Such advances customarily are interest-free.

Tenant farming is not the only source of income for a *hari* family, most of whom also own several head of livestock--buffalos, cows, sheep, and goats. These animals produce marketable products and are an important supplementary income source. A *hari's* livestock is fed fodder produced on the farm and is pastured on the lands of the *Vaderas* as well. Indeed, there often is a degree of tension between the tenant farmer's preference to produce more fodder for his livestock, and the landlord's desire to increase the area under cash and food crops.

Haris have and do exercise the option to change landlords, and there is a reported increase in the frequency of this activity. Such a move is often a consequence of a *hari* requesting a substantial interest-free, long-term cash loan from his landlord. Because of the social prestige that accrues to a *Vadera* who does not actively cultivate his own land and additional *haris*, it is often possible for a *hari* whose request for such a loan is refused to abandon his tenancy for a sharecropping arrangement with another landlord who is prepared to meet his demand for a long-term cash advance. Rarely, however, will a *hari* make such a change if it involves a move to another district of Sindh. *Haris* are also, however, vulnerable to displacement from their tenancies as larger landlords gradually move to the increased mechanization of their agricultural operations.

Annex B

Detailed Project Amendment Description: The CWM Project Component

ANNEX B

III. DETAILED PROJECT AMENDMENT DESCRIPTION: THE CWM PROJECT COMPONENT

A. Project Component Goal and Purpose

The goal of the Irrigation Systems Management (ISM) Project, of which the Command Water Management (CWM) component is a part, is to increase agricultural production and farmer income by improving the management of irrigation water resources. The CWM component will contribute to this goal by introducing a new approach to irrigated agriculture which will optimize the use of water resources for agricultural purposes.

The purpose of the ISM Project is to increase the capabilities of institutions involved in irrigation system planning, design, research, operations and maintenance; to carry out physical improvements to the system; and, to bring about policy changes needed for proper irrigation water management. The CWM component will help achieve this purpose by strengthening the management of existing institutions, infrastructure, agricultural inputs, and services in an integrated and collaborative manner in order to remove the major constraints to increased irrigated agricultural production in selected sub-project areas.

End-of-project status indicators (EOPS) for the CWM component include the following:

1. increased agricultural production in the sub-project areas (see Section V.D., Economic Analysis);

2. improved water management techniques and programs developed which are replicable over a wide range of agro-climatic zones and land and water environments;

3. reduced inequities in actual water deliveries in the tail reach as compared to the head reach of canals at all levels in the sub-project areas;

4. capability institutionalized within provincial agencies to plan, implement and operate integrated programs for irrigated agriculture;

5. farmer-initiated, Water Users Association (WUA) - organized programs established to meet the O&M needs of rehabilitated watercourses in the sub-project areas;

6. meaningful and on-going participation by WUAs in Provincial Irrigation Department (PID) planning and decision-making concerning the operation of sub-project area surface water delivery systems and public tubewells;

7. increased private sector sales and appropriate use by farmers of fertilizer and pesticides and increased farmer use of certified seeds and institutional credit in the sub-project areas;

8. improved crop management and cultivation practices by farmers in sub-project areas as a result of improved extension services;

9. provincial and federal government policy measures implemented to reduce irrigation and input subsidies; and,

10. evidence of farmer willingness to pay increased water charges and higher prices for inputs.

Major assumptions for achieving these EOPs include:

1. the timely assignment by the Federal and Provincial Governments of an adequate number of qualified professional staff in the SMOs for the management and implementation of CWM activities;

2. high level federal and provincial support for the CWM concept and, in particular, the establishment of effective, representative WUAs;

3. the meaningful and on-going involvement of private and public sector suppliers of inputs and credit services in the sub-project areas;

4. the willingness of provincial level line department officials and field staff in the Agriculture and Irrigation Departments and the On-Farm Water Management (OFWM) and Extension Directorates to work closely together to achieve CWM objectives; and,

5. the willingness of farmers to work closely together once physical improvements are made at the watercourse level to carry out required maintenance and water management improvement activities.

The CWM Program has been designed to bring these conditions about and hence to make the assumptions valid. The speed with which they occur will determine the pace of implementation.

B. Project Component Outputs

The A.I.D.-financed CWM Project component is expected to produce the following outputs which, together with the outputs of the IBRD's CWM Project, should achieve the project purpose:

1. Institutional utputs

a. establishment of over 1,000 formally organized and registered WUAs in the seven sub-project areas;

b. integration of WUAs into a network of federations and councils in the sub-project areas; and,

c. establishment of seven functioning CWM Sub-Project Management Offices (SMOs) (four in the Punjab and one each in the other three provinces), seven supporting Sub-Project Coordinating Committees, and four Provincial Policy Committees.

2. Training Outputs

a. approximately 25 staff members of the SMOs and Federal/Provincial Government officials trained in rural organization, water management, and planning, monitoring and evaluation techniques;

b. approximately 20 members of the OFWM Directorates' Field Teams and 100 field workers from the Provincial Extension Directorates trained in multidisciplinary problem-solving techniques related to water management, WUA development, and community participation;

c. approximately 5,000 WUA members trained in planning, watercourse improvement and maintenance, and improved water management and agricultural practices; and,

d. approximately 50 PID officials trained in improved operation and maintenance of irrigation facilities.

3. Water Management Planning Outputs

a. an irrigation system operational management plan developed for one of the CWM sub-project areas (most likely Sehra/Naulaki in the Sind) that will permit optimum use of surface water, public tubewells, and private tubewells;

b. a detailed methodology developed that can be applied to other irrigation command areas for deriving an irrigation system operational management plan; and,

c. based on the methodology in b. above, irrigation system operational management plans developed for the remaining six sub-project areas.

4. Physical Outputs

a. approximately 1,000 farmer-implemented on-farm improvement programs completed;

b. about 1,000 agricultural demonstration plots, i.e., one in each rehabilitated watercourse command area, established;

c. precision land levelling completed on about 20,000 acres; and,

d. field testing completed and evaluated in several sub-project areas of such irrigation methods as pipelines, sprinkler or drip systems, small reservoirs, and tubewells.

5. Monitoring and Evaluation Outputs

a. methodology developed, field-tested, and adopted for the systematic and sustained monitoring of CWM activities, including their impact on farmer production and incomes;

b. reports and studies produced by CWM staff that record and evaluate actual progress in the sub-project areas; and,

c. reports and working documents produced by CWM staff that analyze the results and impacts of CWM, including recommendations for replication on a wider scale of those activities that have proved successful.

Annex C

Team Scopes of Work

ANNEX C

Team Scopes of Work

5.1.1 SYSTEMS MANAGEMENT SPECIALIST/TEAM LEADER

This advisor shall be the contractor's Chief-of-Party (COP) with the authority to make day-to-day policy, programmatic and administrative decisions on behalf of the contractor. He will primarily be an Irrigation System management Specialist with experience in water delivery and a knowledge of irrigation systems. a major responsibility will be administration of the TA Team, and supporting staff, so that they can efficiently advise and assist the CWM Sub-Project Managers (SPMs) in various functions including planning, management, and project members' activities, which will require, *interalia*, direct contact with each of the Sub-Project Managers, appropriate administrators in the Federal Government, USAID and the IBRD. in short, the COP is the TAT's major facilitator, coordinator and motivator in achieving CWM Program objectives.

The advisor will arrange technical assistance for the preparation of team and SMO operational plans and analyses for each subproject area. These operational plans will cover system redesign, rehabilitation and improvement; conjunctive use of surface and groundwater; water management, agronomic demonstrations and improved practices; and timely provision of other inputs and services (i.e., credit, fertilizer, marketing, etc.) necessary to assist and support the SMO's work plans for increasing agricultural production or reducing production costs etc. On an "as needed basis," the advisor shall arrange technical advisory assistance on a full range of planning, administrative, and management activities including system's operation, water scheduling, and system maintenance.

5.1.2 MONITORING AND EVALUATION (M&E) SPECIALISTS

The Monitoring and Evaluation (M&E) Specialists will be responsible for advising and guiding the M&E Unit in tracking the progress of the project. They will assist the SMO in collecting and analyzing information about the various program areas; this enables them to formulate adjustments in their activities.

The Specialists will also assist the M&E Units in monitoring the effectiveness of the WUA development approaches. This includes an ongoing monitoring process which records changes in attitudes, willingness, and ability to plan and implement collective activities. In water management, the Specialists will evaluate changes in equity, availability and reliability of water in the minors and in selected watercourses as a result of civil works, water management programs and better organization of water users. They will also work closely with the Water Management Specialists and Agronomists in designing methods to collect data; to determine crop water requirements; to develop alternative

water management plans. The M&E Specialists will work closely with other members of the TAT, the SMOs and the WUADS in monitoring and evaluating the demonstration plots, the diffusion of recommended practices, the farmer field days and other major elements of the extension outreach program.

The M&E Specialists will assess the M&E Unit staff skills and help to develop those skills required for monitoring and evaluation through both informal and formal training. They will also work with the SMOs in developing an effective information flow system so that data collected and analyzed is submitted to the appropriate persons in a timely manner. Specific duties are listed in Annex A.

5.1.3 WATER MANAGEMENT SPECIALISTS

These specialists will advise the SMOs and line agencies concerning all aspects of water conveyance, scheduling, application and other on-farm water management practices. They will also identify, design, test, and help implement packages of improved water management practices on an experimental basis; and where required, will advise and assist in the design, development and operation of both irrigation and drainage systems. They will also assist water management units with other irrigation interventions--pipelines and drip irrigation systems, small on-farm reservoirs, technical training workshops for WMU and line agencies in each province and will consult frequently with the SPMs and line agencies to ensure that proper assistance is being provided to each SMO.

5.1.4 FARMER ORGANIZATION SPECIALISTS

The Farmer Organization Specialists will focus primarily on the organization of watercourse farmers into institutionalized association of water users. Their goal is to develop, strengthen and sustain the decision-making role of farmers concerning rehabilitation, construction, operation and maintenance of watercourses and in scheduling and delivery of water. They will coordinate and assist in the training of WUA members; assist in the development of informational materials (bulletins, etc.) for WUAs; and enhance the role of WUA members in the identification, procurement and use of non-water inputs, credit and extension services. They will also work toward developing WUA-based institutions at the minor and distributary levels (i.e., through federations of WUAs).

5.1.5 AGRONOMISTS

The agronomists, working through the WUAs, will focus on increasing crop yields in the subproject areas by identifying, developing and demonstrating the effect of integrated packages of improved practices (water management, certified seed, fertilizer recommendations, weeding, etc.) on area crops. The emphasis will be on the timely implementation and application of practices and

treatment that are within the technical and financial capability of farmers. The appropriate technologies will be transferred to area farmers through training, extension meetings, the development and dissemination of extension materials and plot demonstrations.

5.1.6 TRAINING SYSTEMS MANAGEMENT ADVISOR

This advisor will design, develop and implement training programs for both Command Water Management and On-Farm Water management personnel. Such program will include both overseas degree and local and overseas non-degree training selected in response to an assessment of the various organizational needs. Much of the in-country training will be offered through the provincial training institutes. The advisor will also assist in the planning and implementation of farmer training to be provided at the demonstration farms associated with the OFWM Provincial Training Institutes and at other locations as required.

5.1.7 SOCIAL SCIENTIST

The Social Scientist will work only in Punjab's subproject areas; primarily in water user association organization and development. He will be knowledgeable in provincial and federal WUA legislation, farmer credit procedures, organizational techniques, procedures for obtaining non-water inputs for farmers and farm management concepts. Additionally, he must assist with the development/implementation of the SMO's M&E system, training SMO staff in data gathering, data analysis and interpretation, defining research needs, planning for special impact evaluations and assist in special case studies. All of the preceding is in relation to WUA development. He will also assist the WUADS in the preparation of their required duties and reports and give them day-to-day supervision, in close cooperation with the SPM and the Farmer Organization Specialist.

5.1.8 WUA DEVELOPMENT SPECIALISTS

The WUADS, under the guidance of the Farmer Organization Specialist, will help achieve the major WUA objectives of the CWM Program; i.e., (a) through the WUAs, organize and establish O&M programs for rehabilitated watercourses; (b) ensure that WUAs participate with Provincial Irrigation Departments (PID) in that planning and decision making which concerns the operation of subproject area surface water delivery systems and public tubewells; and (c) help enhance the WUA's role in the selection and management of non-water inputs and agricultural services.

The achievement of these objectives requires sustained and effective WUAs; they must be strong enough to influence PID irrigation water management decision making. Therefore, each WUA Development Specialist shall be expected to live in the subproject area to which he is assigned so that he can more effectively backstop and support his assigned WUAs. He will

receive day-to-day direction from the SPM and shall turn for professional guidance and overall supervision to the Farmer Organization Specialists and/or Social Scientist on the expatriate TA Team.

5.1.9 ADMINISTRATIVE TRAINING ASSISTANTS

These assistants will help in the administration of the training program which includes the supporting office work and the maintenance of training files and references. They will also liaison with the provincial agricultural and water management agencies including the CWM project and assist them in the development and implementation of their training programs. They will work directly under the supervision of the TAT Training Systems Management Advisor.

Annex D

Supervision Mission Report

ANNEX D

PAKISTAN

COMMAND WATER MANAGEMENT PROJECT (Cr. 1487-Pak)

SUPERVISION MISSION
November 5 to December 6, 1990

I. INTRODUCTION

1.01 A World Bank mission including M. Mushtaq, N. A. Nasri (consultants) and Usman Qamar (mission leader) reviewed the progress of the above project during November 5 to December 6, 1990. The mission visited Islamabad, Peshawar, Lahore, Karachi and Quetta and held discussions with concerned officials of Government of Pakistan (GOP), Provincial Governments (GOProvinces), various implementing agencies, and consultants (Attachment-I provides a list of persons met). The mission also visited various project sites and saw completed and in progress works and discussed project issues with farmers in various project areas. Wrap up meetings chaired by officials of Planning and Development Departments were held in each province. Finally a wrap up meeting chaired by the Additional Secretary Ministry of Water and Power (MWP), and attended by provincial officials was held in Islamabad on December 6, 1990 to discuss the draft version of this aide memoire prepared by the mission. Representatives of co-financiers USAID attended some of the Provincial wrap up meetings and the Federal wrap up meeting. This aide memoire summarizes the mission's overall assessment of the project status, the main achievements, the current issues and the various agreements reached to improve performance. The mission recommendations given here are subject to confirmation by IDA management.

1.02 The mission is grateful and wishes to thank all Provincial and Federal Government officials, project staff and the supervisory consultants (who participated full time in the mission) for their assistance and the many courtesies extended during the mission.

II. PROJECT DESCRIPTION

2.01 The CWMP is co-financed by the Government of Pakistan (GOP), Provincial Governments (GOProvinces), IDA, USAID and farmers. It is being implemented in seven sub-project areas including four in Punjab and one each in Sind, NWFP and Balochistan. Its main objectives are to: (i) increase agricultural production by better managing inputs and services and removing major physical and institutional constraints; (ii) develop replicable water management techniques; (iii) build the Provincial agencies' capability for preparing and implementing irrigated agriculture projects; and (iii) promote farmer participation in formal Water Users Associations (WUAs). The above project objectives are to be achieved by: (i) implementing physical improvements to the irrigation system, including canal rehabilitation and remodelling, surface and sub-surface drainage, and watercourse improvements; (ii) improving the management of existing facilities, and delivery of water and non-water inputs and services for agricultural production through better

coordination among Government agencies and private suppliers; and (iii) building farmer institutions by providing technical assistance and training. The project is being implemented by the Provincial Irrigation (PIDs) and Agriculture Departments (PADs). Coordination is provided by Sub-project Management Offices (SMOs) and Sub-Project Coordination (SCCs) and Provincial Policy Committees (PPCs) at the Provincial level, and by the Ministry of Water and Power (MWP) at the Federal level.

III. SUMMARY OF CURRENT PROJECT STATUS

3.01 Extension of Credit Closing Date: The credit closing date has been extended once and the current closing date is December 31, 1990. However, the Government has requested for further extension of two years up to December 1992 to allow completion of remaining project works and to carry out additional physical works of the same nature in adjoining areas by utilizing savings resulting from the appreciation of the SDR vis-a-vis the Rs. Processing of the request (for a one-year extension) is, however, awaiting submission of reports on the status of watercourse materials cost recovery by GOProvinces. The mission has requested GOProvinces to submit these status reports urgently as further delays in submission could result in the closing date not being extended. Since all provinces currently have arrears of recovery, the mission has requested that the status reports should indicate the measures that are being taken to clear the arrears by a specified target date.

3.02 Status of Non-civil Works/Institution Building Activities: The project has made good progress in non-civil works activities since the last IDA mission in June 1989, particularly in Sindh and Punjab, and to a lesser extent in NWFP[1/] and Balochistan. The main achievements include:

(i) establishment and strengthening of farmer organizations (WUAs, informal federations of WUAs, and other farmer interest groups) that have the potential of becoming viable organizations which could be expected to survive beyond the stage of watercourse lining, provided the project continues to provide support in critical areas;

(ii) demonstration of improved agronomic and irrigation management/scheduling practices under "real" farmer conditions;

(iii) improvement of equity in water distribution between head and tail reaches of channels that have been lined, as compared to the pre-lining situation;

(iv) improvement in delivery of non-water inputs particularly certified seed, fertilizer and pesticides, and in operation and maintenance of watercourses and minor canals by farmers, and creation of capital funds by WUAs and farmer sub-groups for financing cooperative activities;

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[1] In NWFP the non-civil works activities have received a major set back due to the low capacity and unreliable operation of the lift pumps.

(v) initiation of trials covering entire commands of selected watercourses to replicate successes in increasing agricultural production achieved at the demonstration plot level; and

(vi) preparation of proposals for consideration by Government and donors for continuation and strengthening of the institution building activities so that the gains made so far could be sustained and replicated after the completion of the project.

3.03 Status of Physical Works: except for lining of minors in Sindh and Balochistan, improvement of watercourses in Balochistan and NWFP, remodelling of outlets in NWFP, and implementation of sub-surface drainage component in Punjab, which are currently behind targets the remaining civil works targets originally envisaged have been completed and in some cases exceeded . The NWFP sub-project has received a major set back due to the delay in procurement and installation of electric motors for the lift pumps that are currently operating at about 50% capacity. The new pumps installed recently with funds provided from outside the CWMP cannot be operated satisfactorily with the old motors. GONWFP has agreed to take urgent action to expedite procurement of the motors.

3.04 The above achievements of non-civil works activities and physical works are indeed commendable, and it seems that the CWM Project has now reached a stage where it can no longer be accused of neglecting non-civil activities. However, in order to sustain the momentum gained on the non-civil works activities the Provinces should decide on the institutional arrangements that would be required to continue these activities after the expiry of the technical assistance teams (TAT's) contracts on June 30, 1990, and after project completion. Furthermore, monitoring and evaluation activities should be strengthened, and the Provincial Irrigation Department should periodically measure flows in all channels lined or improved under the project to check that the improvement in equity of water delivery obtained as result of lining is being maintained. Section VI. of this aide memoire (pages 11 & 12) outlines the specific actions that need to be taken to facilitate project implementation.

IV. STATUS OF PROJECT COMPONENTS ISSUES, AGREEMENTS REACHED AND MISSION RECOMMENDATIONS

Non-civil Works Activities

4.01 During the last one year the project's non-civil works activities have made visible progress. Attachment-II provides a brief summary of the main non-civil works activities currently being undertaken in the four provinces. The main thrust of these activities is to strengthen farmer organizations, demonstrate improved agronomic practices at farmers' fields by introducing simple technological packages which farmers can afford, remove shortages of essential inputs through cooperative effort (e.g. seed multiplication to meet shortfall in availability, and joint bulk purchase of

inputs e.g fertilizer and pesticide), and then replicate the achievements made at the demonstration plot level to the full watercourse level and ultimately at the sub-project level. The mission fully endorses this approach.

4.02 In NWFP the mission was pleased to see the close cooperation between the TAT (mainly Pakistani staff) and the SMO staff in developing various non-civil works programs. It is hoped that the SMO staff and agriculture extension staff trained during these activities would be able to continue these activities in the future with minimal assistance from the TAT in essential fields.

4.03 The mission also commends the hard and dedicated efforts of the Punjab SMO and sees merit in experimenting with different approaches to institution building being tried (see attachment-II). However, it seems that the SMO, which has limited staff resources, may be overly diluting its efforts by attempting too many and diverse activities at the same time. The mission suggests that (i) the SMO concentrate its efforts on those activities that are likely to produce the maximum benefits and have good chance of being replicated, e.g. introduction and multiplication of improved seed, water scheduling, balanced nutrients, and formation of communication groups and WUA federations; and (ii) GOPunjab support SMO efforts to form a core group of trained and dedicated staff which could be used to replicate the achievements made at the demonstration plot or watercourse level.

4.04 The Sindh SMO has prepared a proposal for continuing and replicating the above non-civil works activities over the entire project area. The proposal suggests that: (i) external funding should be continued for replicating the water and crop management technologies successfully introduced on the pilot watercourses; and (ii) a program of incentives should be introduced on a cost sharing basis for activities such as provision of certified seed; introduction of new crops (e.g hybrid maize, sorghum, sunflower and soybean); additional lining of watercourse; repair of tubewell; joint purchase of equipment; and construction of WUA offices and stores. The program is estimated to cost about Rs 8.9 million over two years (1990-92) of which farmers would pay 50%. The mission supports this proposal and was pleased to learn at the wrap-up meeting with the Additional Chief Secretary Sindh that GOSindh supports this proposal and intends to seek external funding from USAID or other donors. The mission recommends that other provinces also consider similar proposals.

Issues Relating to Non-civil Works Activities

4.05 Continuation of Non-civil Works activities after Project Completion: Unless appropriate arrangements are made for continuing and replicating the successful non-civil works activities after the completion of the project, the achievements made so far may be lost. The mission was pleased to learn that GOSindh plans to transfer the SMO establishment to the non-development budget to ensure its continuity. The mission recommends that other Provinces also consider similar arrangements. The mission also suggests that GOProvinces consider including the seven sub-project areas in the

proposed Second Command Water Management Project, not for implementing further civil works but exclusively for continuation of non-civil works activities.

4.06 Extension of Technical Assistance: The technical assistance team's (TAT's) contract would expire on June 30, 1991. Since its reorganization, the TAT has done a good job of designing programs and helping the SMOs in implementing various non-civil works activities some of which are now about to reach a stage when they could be declared unqualified successes. Therefore, complete withdrawal of the TAT from the scene at this stage could prove to be major set-back to these activities. The mission believes that in order to replicate non-civil works achievements over the entire sub-project areas it would be necessary to maintain at least a core group of well trained and dedicated staff with a minimum "critical mass" of expertise in the essential fields. Until such times that such core groups could be formed and fully trained it would be necessary to acquire required expertise from outside the project. The mission, therefore, recommends that the Government and USAID consider continuation of the TAT input up to project completion even if it is at a much reduced level comprising mainly Pakistani staff. The mission believes that the incremental cost of continuing a reduced TAT would be fully justified in view of the returns that are likely to be obtained. A well defined program of work with monitorable targets should, however, be a prerequisite for such an extension. In this regard, the proposal prepared by the Sindh SMO should be further refined and used as model by all provinces. The unique features of each province should of course be kept in view while adapting the model to local conditions.

4.07 Internal On-going Monitoring and Evaluation (M&E): M&E has unfortunately been a weak area in the project. Except for one report prepared by the Punjab SMO in 1988 on internal M&E, and limited monitoring of the flows in the Shahkot distributory, no other reports have been completed so far. The mission recommends that during the remaining project period increased attention should be given to this activity. Specifically the mission recommends that: (i) the PIDs/SMO of all sub-projects should periodically measure flows in all lined channels and moghas to check whether equity of water distribution is being achieved and maintained and the expected water savings from lining are indeed accruing (progress on this item should be reported in the next quarterly progress report); (ii) Punjab and NWFP should complete and issue internal M&E reports that are currently lying partially complete; (iii) special attention should be given to the monitoring of the full watercourse trials; and (iv) financing arrangements and schedule for the ex-post evaluation of the project by an independent agency should be firmed up.

4.08 Status of Physical Works: Table 4.1 below presents a summary of the status of physical works as of June 30, 1990.

Table 4.1 Status of Physical Works

Province/Item	SAR Targets	Achievement as of June 30,1990	Proposed Work Plan FY90/91	FY91/92
I. Punjab				
1. Canal Rehabilitation (miles)	116	108	95	24
2. Canal Remodelling (miles)	13	a/	--	--
3. Canal lining (miles)	98	123	82	90
4. Outlet Remodelling (No.)	663	484	444 b/	304
5. Surface Drainage (acres served)	48,000	44,600	--	--
6. Sub-surface drainage	82	36	33 b/	20 b/
7. Watercourse Improvement (No.)	530	530	208	202
II. Sindh				
1. Canal Rehabilitation (miles)	116	96	18	--
2. Canal Lining (miles)	73	73	50	--
3. Outlet Remodelling (No.)	451	402	169	--
4. Watercourse Improvement (No.)	360	393	67	--
III. NWFP				
1. Canal Covering (feet)	600	1876	1320	845
2. Canal Lining (miles)	10	20	7	5
3. Outlet Remodelling (No.)	151	25	75	51
4. Surface Drainage (acres)	7,900	b/		
5. Watercourse Improvement (No.)	100	52	25	23
IV. Balochistan				
1. Canal Rehabilitation (miles)	15	13	8	--
2. Canal Remodelling (miles)	13	11	7	3
3. Canal Lining (miles)	12	8	5	9
4. Outlet Remodelling (No.)	61	30	30	27
5. Watercourse Improvement (No.)	60	13	27	47

Source: NESPAK/NDC Annual Work Plan FY90/91, and FY91/92

a/ Not required

b/ Includes remaining works from original SAR targets

4.09 From Table 4.1 it is evident that canal rehabilitation is on or ahead of targets in all provinces; canal lining is on or ahead of targets in NWFP and Punjab and Sindh but is behind targets in Balochistan; outlet remodelling is on target in Sindh but generally behind in all other provinces with the biggest shortfall in NWFP; watercourse improvements are on or ahead of targets in Sindh and Punjab but are lagging far behind targets in NWFP and Balochistan; and the subsurface drainage component while largely completed in the Shahkot sub-project in Punjab, physical works have yet to be started in the 6-R sub-project of Punjab.

4.10 Slow Progress on Outlet Remodelling: Outlet remodelling is an important but difficult component to implement because in many cases it entails adjustment of tampered outlets back to the authorized sizes to restore equity of water distribution. This explains the generally slow progress on this component. However, this component has come to a complete stand still in NWFP because farmers in the upper reaches of the Warsak lift have raised a water rights dispute and have refused to allow remodelling of their outlets (which are generally drawing more than their authorized share of water) until the resolution of the dispute. GONWFP has referred this dispute to a committee consisting of session judges for resolution. The mission has urged GONWFP to expedite a decision on this issue by the committee, because without outlet remodelling the current situation of inequity between head and tail farmers cannot be corrected. The current situation is indeed undermining one of the basic objectives of CWMP i.e establishment and maintenance of equity in water distribution.

4.11 Need to Expedite Progress on Watercourse Improvement in Balochistan and NWFP: The watercourse improvement component in the Balochistan sub-project has had a delayed and slow start because of the predominance of absentee land lords in the area which made it difficult to organize WUAs which is a prerequisite for watercourse improvement. These difficulties were further exacerbated by the lack of trained staff in the OFWM field teams. As a result of this the first watercourse in Lasbela was completed only in December 1989. Since then the progress has improved. However, with the present staff it would not be possible to complete the project targets envisaged for FY91 and FY92. The mission has therefore suggested and GOBalochistan (GOBal) has agreed to sanction and post two additional field teams for the OFWM component and to ask Ministry of Water and Power (MWP) and USAID to extend the supervisory consultants' contract which is about to expire. The mission has also asked GOBal to seek a clarification from USAID whether it would finance the 27 watercourses (on minors 6, 8 and 9) which are proposed to be improved during FY90/92. This clarification should be obtained before work is commenced on the lining of minors 6, 8 and 9 subject to IDA's approval of the proposed work plan.

4.12 In NWFP the pace of watercourse improvement work has slowed down due to several factors including: (i) low capacity operation of the lift pumps leaves little incentive for the farmers particularly in the tail reaches to invest in watercourse improvement; (ii) GONWFP's decision to collect farmers contribution (10% of materials cost) in advance; and (iii) due to cost escalation the revised cost estimate have substantially exceeded the approved

PILs amount. The mission has urged GONWFP to solve the pump issue (para 4.13) and to resolve the PILs issue with USAID.

4.13 Need to Expedite Installation of New Motors for Warsak Lift Pumps: The old Warsak lift pumps were replaced by new pumps procured under the USAID financed ISM Project. Unfortunately, however, the old pump motors were not replaced and when the new pumps were installed it was found that the motors were under-powered to operate them. Furthermore, two of five old motors were burnt during trial operation of the new pumps. As result of this only three of the four pumps are currently operating at capacities that are even lower than the discharge of the old pumps. Consequently a large area in the tail reaches is not receiving any water. This unfortunate situation has not only marred the positive impact of canal lining but has also made it extremely difficult to secure farmer participation in non-civil works activities and to meet the watercourse improvement targets. GONWFP has requested USAID to finance the motors under the ISM project, however, a firm schedule for procurement and delivery has yet to be prepared. The mission was assured by the Secretary Irrigation NWFP that procurement of pump motors will be undertaken on an urgent basis.

4.14 Need to Finalize Civil Works Contracts in Punjab: In Punjab there are numerous contracts (about 57 Nos. involving about Rs 8 million in retention monies) that are substantially completed but some items have yet to be completed. Consequently final payments and retention monies have not been released to the contractors. In some cases the contractors have even abandoned the sites. This situation has continued for the last three years with little change. The mission has again requested the PID to invoke remedies available under the contracts to help finalize these contracts. It is expected that once this has been done disbursements would show a marked increase.

4.15 Sub-surface Drainage Component in 6-R Sub-project: The Punjab Irrigation Department has decided to implement the sub-surface drainage component (through drainage tubewells over 18000 acres) in the 6-R sub-project under the CWMP instead of including it under the proposed Fordwah Sadiqia Remaining (FSR) Project. The MW&P had earlier suggested that the latter option should be fully explored before taking a final decision. Given the estimated time required for installing the drainage tubewells following ICB procurement procedures (18 months), and in view of the fact that credit extension is being considered for only one year at this time, Punjab PID and MW&P should take a final decision in this regard as soon as possible in consultation with the IDA preparation mission for the FSR project which is scheduled for early December 1990. The mission also suggests that Punjab PID also reexamine the possible environmental impact of pumping saline effluent into the proposed evaporation ponds (Tobas). This issue could be studied as part of the proposed Sectoral Environmental Assessment of the National Drainage program.

4.16 Quality of Civil Works and Operation and Maintenance: During field visits the mission was pleased to see that the quality of completed and ongoing civil works was generally satisfactory and adequate supervision was being provided by the PIDs and the supervisory consultants including

68

compaction tests for earth work and slump and strength test for concrete. Post completion maintenance was also generally satisfactory except in the case of the Lasbela sub-project where some of the completed works are showing signs of neglect and misuse. For example the mission found that the lining of minor 4 was damaged at a few places mainly due to misuse by unauthorized traffic. Similarly on minor 1 (which is a pipe system) there were some unidentified leaks which could ultimately damage the earthen embankment supporting the pipe. The mission also noted that the Lasbela canal is being operated at a capacity far below the full design discharge due to lack of cleaning of a syphon located upstream of minor 1. In order to address these issues the mission has suggested to GOBal to consider enacting the Canal and Drainage Act (as the other provinces have already done) which provides judicial powers to canal officers to help prevent misuse and tampering of the irrigation infrastructure. The mission has also requested GOBal to urgently carry out required maintenance (including cleaning of the syphon) for which funds are available, and to prepare a detailed program of work for periodic maintenance and repairs as called for under the Second Irrigation Systems Rehabilitation project (Cr. 1888-Pak). The mission expects that once the syphon has been cleaned it would be possible to operate the main canal at its design capacity. The mission requests that the next progress report should report progress on these items.

V. PROJECT ORGANIZATION AND MANAGEMENT

5.01 Staffing: The mission found that some staff vacancies still persist. Immediate action is required to fill the following vacant posts:

--NWFP: One computer specialist, one economist and one sub-engineer in the SMO; assurances for filling these were given by the Secretary Agriculture and the Director General Extension for the first two and by the secretary PID for the third.

--Lasbela: One Agriculture Officer and two Sub-engineers; assurances were given by D.G. Agriculture extension that these posts will be filled as soon as possible.

--Sindh: One computer programmer, one sociologist, and one agricultural engineer; the Sub-project manager has indicated that action is under way to fill these positions.

5.02 Non-project use of Project Vehicles: At the time of the last supervision mission several project vehicles were under non-project use. However, these vehicles were returned to the project when the mission pointed out to the government that non-project use was in contravention of the legal agreements which require that all equipment and vehicles purchased from the proceeds of the credit should remain exclusively under direct project use until project completion. Unfortunately once again numerous vehicles (7 in Punjab (4 in agriculture and 3 in PID), 4 in Sind, and 3 in Balochistan) have again been put under non-project use. In the case of Punjab Agriculture Department some of the vehicles have been transferred to another project (not financed by IDA) and the mission was told that "the vehicles were being used for the general good of agriculture in the province". The mission has again

69

reminded the concerned officials that this was unacceptable and that vehicles should be returned to the project urgently. The mission has indicated to the GOProvinces that in case some vehicles were now considered surplus to the project, a list of such vehicles should be provided to IDA for possible re-deployment on other IDA financed project that are currently in dire need of vehicles e.g the ISR-II Project (Cr. 1888-Pak). The mission requests urgent action on this point.

5.03 Disbursements and Spot checks of Project Accounts and Documentation in Support of Reimbursements Claimed on the Basis of Statement of Expenditures (SOEs): The mission noted with concern that substantial amounts of reimbursements (equivalent of about US$ 4 million) have yet to be claimed for expenditures incurred. Following are the unclaimed expenditures:

--Punjab: Rs 45 million (m)

--Sindh: Rs 40 m

--NWFP: Rs 14 m

--Balochistan: Rs 8 m

Some of the above expenditures including Rs 2.9 m in NWFP and Rs 8 million relate to either misprocured works or disputed quality works which may not be eligible for reimbursement. For the remaining expenditures the PIDs and the supervisory consultants have assured the mission that withdrawal request will be sent within one month.

5.04 The mission made random spot checks of project accounts and documentation in support of reimbursements claimed on the basis of SOEs and found them in order. In some cases the PIDs are not using SOEs even for the small contracts and are submitting full documentation. The mission has advised them to follow the prescribed procedures and to use the SOE facility where provided to reduce the documentation submitted to the Bank.

5.05 ADP Allocations and Imprest/Personal Ledger Accounts (PLAs): The ADP for FY91 is only Rs 111 million while the proposed work plan is much higher being Rs 490 million. However the SMOs assured the mission that sufficient funds were available in the IDA civil works PLAs to finance the work plan.

5.06 Preparations for the Second Command Water Management Project: All Provinces expressed keen interest in a Second Command Water Management Project. Indeed all provinces except Balochistan have already selected possible sites for a Second CWMP. The provinces expressed preference for maintaining continuity between the first and second project to avoid disruption of the present institutional arrangements and dislocation of staff. The mission encouraged the provinces to start preparing terms of reference (TOR) for the preparation of the second project and to firm up sources of financing and schedule for the ex-post evaluation of the first project. The mission suggested ISR-II (Cr. 1888-Pak) and second UNDP Umbrella as possible sources of financing preparation of the Second CWMP.

VI. SUMMARY OF AGREED ACTIONS TO BE TAKEN

(i) Provinces to urgently submit status report on watercourse materials cost recovery and action plans to clear arrears (para 3.01);

(ii) Provinces to decide on institutional arrangements for continuing the project's non-civil works activities after the completion of the project (para 4.05);

(iii) MWP and USAID to consider extending the technical assistance team (consisting mainly Pakistani staff) up to the end of the project to help replicate the non-civil works activities over the entire sub-project areas (para 4.06);

(iv) SMOs/PIDs to strengthen and increase the coverage of internal ongoing monitoring and evaluation (M&E) activities, particularly in the command areas of those watercourses where full watercourse trials are being undertaken (para 4.07);

(v) SMOs/PIDs to initiate and institutionalize a system of monitoring flows in channels and outlets that have been lined (para 4.07);

(vi) MWP to initiate arrangements for an independent ex-post evaluation possibly with USAID funding (para 4.07);

(vii) PIDs to expedite submission of withdrawal applications for eligible expenditures already incurred totalling Rs 107 million (para 5.03);

(viii) Provinces to return to the project all vehicles currently in non-project use (para 5.02);

(ix) Provinces to fill all vacant staff positions (para 5.01);

(x) GONWFP and GOPunjab to resolve with USAID the issue of revision of PILs for watercourses where the costs have increased considerably after the issuance of PILs as is the case in NWFP, or where only partial lining of watercourses could be completed due to shortage of funds as is the case in Punjab (para 4.12);

(xi) GOBal to sanction and post two additional field teams for watercourse improvements in Balochistan, and extend the supervisory consultants' contract (para 4.11);

(xii) Punjab PID to expedite completion of numerous civil works contracts in Punjab that have been substantially completed but work is currently held up due to various reasons (para 4.14);

(xiii) NWFP PID to expedite procurement and installation of electric motors for the lift pumps of the NWFP sub-project (para 4.13);

(xiv) GOBal to enact the Canal and Drainage Act in the Lasbela sub-project to empower canal officers to check misuse of canal roads and unauthorized withdrawals of water through tampering of outlets (para 4.16);

(xv) PID BOBal to carry out required maintenance (cleaning) of the main canal syphon, and minor lining and banks damaged due to misuse by traffic, and prepare a periodic maintenance program (para para 4.16);

(xvi) GONWFP to expedite settlement of the water rights dispute between head and tail water users in the NWFP sub-project, and following this, implement the outlet remodelling component which is currently held up (para 4.10);

(xvii) GOBal and GONWFP to expedite implementation of the watercourse improvement component in NWFP and Balochistan sub-projects (para 4.11); and

(xviii) GOPunjab and MWP to decide whether the 6-R subsurface drainage component is to implemented under CWMP or as part of the proposed Fordwah Sadiqia Remaining (FSR) Project (para 4.15).

Attachment-I

LIST OF PERSONS MET

Ministry of Water & Power

1.	Major General A.M. Rauf	Additional Secretary
2.	Mr. Asif Kazi	Chief Engineering Adviser
3.	Mr. F.H. Usmani	Federal Coordinator (ISRP-II)
4.	Mr. Inayat Ali	Federal Coordinator (CWMP)

USAID

1.	Mr. Jan Paul Emmert	Project Officer
2.	Mr. Asif Mahmoud	Project Officer (ISM)

Supervisory Consultants

CWMP

1.	Mr. S.N.H. Mashhadi	Project Manager NESPAK-NDC
2.	Ch. Mohammad Akbar	Project Engineer NESPAK-NDC
3.	Mr. Qaisar H. Jafri	Project Engineer NESPAK-NDC
4.	Col. S. Hasnain	Tech. Liaison Officer NESPAK-NDC

ISRP-II/ISM

1.	Mr. Mohammad Ehsan	General Manager NESPAK
2.	Mr. Iftikhar Ali	Resident Engineer NESPAK Peshawar
3.	Mr. Abdul Samad Qureshi	Resident Engineer NESPAK Lahore
4.	Mr. Ghulam Qadir Bhutto	Resident Engineer NESPAK Karachi
5.	Mr. Hussain Sheikh	Resident Engineer NESPAK Quetta

Technical Assistance Team

CWMP

1. Mr. Sidney Bowers
2. Mr. M. Haidar
3. Mr. Cardinelli
4. Mr. Arshad Aziz
5. Mr. J. Smith
6. Mr. Rafiq Chowdhary
7. Mr. Carlos D. Isles

ISM

1. Mr. James Ringenoldus (Chief of Party)
2. Mr. Rue Boswell
3. Mr. Gene White
4. Mr. W.R. Stoneman

NWFP

Department of Planning & Development

1.	Mr. Abdul Jaleel Moghul	Additional Secretary P&D
2.	Mr. Nawab Khan Masood	Chief (Water & Power)
3.	Mr. Syed Asad Sibtain	Chief (Agriculture)

Department of Agriculture

1.	Mr. Dost Mohammad Wazir	Secretary Agriculture
2.	Syed Mahboob Ali Shah	Director General Agriculture Extension
3.	Shaikh Dost Mohammad	Director OFWM
4.	Mr. Kalim Afzal	Deputy Project Manager
5.	Dr. Abdul Waheed	Chief Planning Officer Food and Agriculture Department

Department of Irrigation

1.	Mr. Faqir Mohammad Piracha	Secretary Irrigation
2.	Mr. Mohammad Jalil Khan	Chief Engineer Irrigation
3.	Mr. Ayub Jan	Acting Provincial Coordinator ISRP-II
4.	Mr. Amir Haider	Project Manager CWMP

PUNJAB

Planning & Development Department

1.	Mr. Khalid Saeed	Member, Planning Board
2.	Dr. Bashir Ahmad	Chief Economist
3.	Mr. Fazal-e-Abbas	Chief (ECAT)
4.	Mr. Naseem Riaz	Assistant Chief (Agriculture)
5.	Mr. Zakaullah	Chief PE Cell

Department of Agriculture

1.	Mr. M.S. Cheema	Director General, OFWM Directorate
2.	Mr. Mushtaq A. Gill	Director, OFWM Training Institute
3.	Mr. Saleem Arshad	Project Manager, CWMP
4.	Mr. Mohammad Ashraff	Project Director (OFWM,CWMP)

Department of Irrigation

1.	Mr. C.M. Ashraf	Provincial Coordinator, ISRP-II
2.	Mr. M. Akhtar Rana	Chief Engineer (Irrigation)
3.	Mr. Riaz-ul-Haq	Superintending Engineer CWMP
4.	Mr. Tariq Bashir	Deputy Secretary Irrigation

Other Agencies

1.	Dr. Jamil Ahmad	Director PERI
2.	Mr. Munawar Zaheer	Director General ACOP
3.	Ch. Bashir Ahmad	Director WMED
4.	Dr. Edward J. Vander Velde	IIMI
5.	Dr. J.W. Kijne	IIMI
6.	Mr. D. T. Bandaragoda	IIMI

SINDH

Department of Planning & Development

1.	Mr. Fazalullah Qureshi	Additional Chief Secretary
2.	Mr. G.M. Abro	Chief (Water & Power)

Department of Agriculture

1.	Mr. Shahzado Shaikh	Secretary Agriculture
2.	Mr. K.B. Dodani	Director General Agriculture Extension
3.	Mr. Azizullah Tunio	Sub-project Manager CWMP

Department of Irrigation

1.	Mr. M. Idris Rajput	Additional Secretary (I&P)
2.	Mr. Nasar A. Rajput	Provincial Coordinator

BALOCHISTAN

1.	Major Ashraf Nasir	Secretary, Planning & Development
2.	Sardar Mohammad Sharif	Secretary, Agriculture Department
3.	Mr. Mohammad Azam Baloch	Secretary, Irrigation Department
4.	Mr. Mohammad Amin	Chief Engineer, Irrigation
5.	Ch. Zulfiqar Ali	Director General Agriculture Extension
6.	Mr. Shirin Khan	Provincial Coordinator, ISRP-II
7.	Mr. Abdul Hamid	Director OFWM
8.	Mr. G.N. Baloch	Sub-project Manager

Attachment-II

SUMMARY OF THE MAIN NON-CIVIL WORKS ACTIVITIES UNDERWAY IN THE FOUR PROVINCES

1. NWFP: Several innovative strategies for organizing farmers have been developed and are being tried in the project area, including (i) five "participatory pilot watercourses" under which the WUA share holders would be intimately involved throughout the watercourse improvement planning, implementation and operation and maintenance process (ii) two "full watercourse trials" which would introduce a total package of improved inputs, improved techniques and physical improvement on two watercourses during Rabi 1990/91; (iii) one WUA federation would be established this year; (iv) a WUA seed exchange and fertilizer procurement program under which WUAs would be motivated for joint procurement of improved HYV seed and fertilizer; (v) acquisition of production loans by farmers would be facilitated by arranging WUAs' meetings with the ADBP and other banks; (vi) a coordinated watercourse program under which WUAs of watercourses previously improved would be revitalized through improved coordination among all line agencies; and (vii) an irrigation scheduling program would be tested for the wheat crop involving training of farmers to follow a simple irrigation calendar that specifies the timing (number of days after planting) and amount of irrigation (inches of water applied).

2. Punjab: In Punjab the non-civil works activities are being carried by the SMO staff independently as well as in collaboration with the TAT. The SMO has prepared many reports documenting the progress in institution building activities, including internal monitoring and evaluation (M&E), flow monitoring for evaluating equity of deliveries, and overall project performance evaluation. Amongst the activities undertaken independently by the SMO the forming of a multipurpose body called "Agriculture Forward Organization (AFO)" is particularly noteworthy. One unique feature of the AFO is that it does not use the WUAs as the main vehicle for achieving its objectives of increasing agricultural production. Instead it relies on various federating sub-groups, including: (a) communication groups that aims to disseminate agro-business information to farmers through school and college students; (b) implement user groups which have been provided sets of agricultural implements to help them generate a capital fund by hiring out implements to its members with a view to ultimately purchasing their own implements and returning the original to the project for use by other groups for the same purpose; and (c) improved farming, irrigation management and marketing groups that would encourage farmers to introduce improved practices with the help of technical assistance provided by the SMO.

3. In addition to the above, the SMO is carrying out "full watercourse trials" in the Shahkot and 6-R sub-projects with the assistance of the TAT. As part of these trials the following activities would be undertaken: (i) introduction of soil shaping and irrigation techniques

focussing on improving water application efficiency; (ii) seed multiplication by "farmer seed groups" to meet shortfall in availability of improved/certified seeds for wheat and cotton; (iii) cropping pattern modification to introduce crops more suited to local conditions and water availability; (iv) use of balanced nutrients e.g introduction of the practice of using one bag of urea and one bag of DAP instead of two bags of urea as commonly practiced; (v) development of WUA federations and encouraging them to participate in water discharge measurements and equitable distribution of water, for example in the Pakpattan sub-project one WUA federation represented to the PID to seek equity in water distribution and received due attention; (vi) water scheduling trials similar to the one mentioned above for NWFP; (vii) monitoring of reliability and equity of water supplies; and (viii) monitoring and evaluation to identify technical issues and their solutions and suggest ways to sustain and replicate the achievements made under the trials.

4. Sindh: The thrust of the non-civil works activities in the Sindh-sub-project is on reorienting the WUA activities from merely watercourse civil works to undertaking other activities as well. To this end a program of strengthening the WUA organizational capabilities has been initiated. This includes involving the WUAs in the following activities: (a) recovery of 25% of the watercourse materials cost; (b) establishment of a capital fund on participatory watercourses for maintenance and joint purchase of agricultural implements (in one case the fund was used to repair a SCARP tubewell); (c) seed multiplication; and (d) maintenance of minors (this was actually done in the case of Kotri minor). These activities have demonstrated that WUAs are capable of assuming financial and administrative responsibility for activities that are normally dependent on the Government. In addition to these activities, full watercourse trials would also be undertaken in Sindh which among other activities would include water scheduling trials for wheat and cotton.

5. Balochistan: organizing WUAs in Balochistan is a difficult task as much of the land is owned by absentee land owners, and some of the watercourses have very few farmers who are reluctant to form WUAs because of the high share of the improvement cost they have to pay. Despite these difficulties 48 WUAs have been formed on the 87 watercourses in the project area. The major achievement in this sub-project area is one participatory watercourse. The WUA of this watercourse is very active and is undertaking programs for introduction of improved seed, introduction of high yielding fodder crops and improved water scheduling techniques. The farmers have also developed a fund for joint purchase of seed and fertilizer. Unfortunately, however, minor 4 which feeds this watercourse has not been improved yet and there is a shortage of water. The farmers' main concern is to expedite the lining of the minor.

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Annex E

Water Logging and Soil Salinization of the Lasbela Subproject Area

ANNEX E

WATER LOGGING AND SOIL SALINIZATION OF THE LASBELA SUB-PROJECT AREA

A reconnaissance survey revealed that the twin menace of waterlogging and salinization was increasing progressively since the induction of the irrigation system in the project area. It was estimated that about one third of the total 12,000 acres of culturable commanded area is suffering from the effect of waterlogging and salinization and this condition has restricted the agricultural practices substantially. The problem of waterlogging and salinization, quite evident to any visitor to the area, is severe and will worsen rapidly if no remedial program is launched immediately. Farmers of the area are greatly worried about this hydrogeologic disease and are reluctant to put their lands under cultivation because of it.

DESCRIPTION OF THE SITE SELECTED FOR INSTALLING THE DRAINAGE SYSTEM

The site selected for the installation and demonstration the sub-surface drainage system is located on the command of watercourse 2L of Minor 1. The site comprises 10 acres of culturable land under guava orchard and is situated approximately 1,000 feet from a natural outlet. The fall of the natural outlet is 10 ft below the ground surface at the site. The drained-off water flows towards the Hub River which is about 500 feet away from the outlet point.

SOIL PROFILE

The soil of the demonstration site is heterogeneous and anisotropic in character, varying from point to point in some areas. In the light of observations made by digging holes with auger at different places of the site, the soil profile of the demonstration site is reproduced below:

Thickness/Extent of Soil Layer	Soil Conditions
0"-6"	Soil of this layer is very moist between irrigations due to presence of a hardpan of heavy soil underlying this layer and capillary rise from the shallow fictitious water table between irrigations.
6"-12"	This layer consists of hard compacted soil. The presence of this layer is due to ineffective tillage practices and sodicity of the upper layer.
12"-60"	This layer consists of coarse soil with traces of fine soil. It becomes mobile and susceptible to sloughing when it lies below the watertable.
60"-96"	Gravel soil consisting of coarse sand mixed with gravel ranging in size upto 5". Most of the subsurface groundwater movement takes place in this layer.
Below 96	"Massive and compacted bedrock. Soil borings or seismic survey would be required to obtain the details of bedrock profile.

WATERTABLE POSITION

The data from the piezometer installed at different places of the drainage area, pertaining to watertable elevations before the installation of the drainage system is shown in Table (Appendix A).

The data in the Table reveal uneven levels in the watertable position at different places in the drainage area. This is due to the presence of shallow undulating bedrock. The average watertable level in the drainage area is approximately 2 feet below the ground surface. Thus the effective root zone of the crops grown in the area is fully saturated, which affects the plant growth adversely. But since the installation of the drainage system, it has been observed that all the pie installed at the drainage site are dry and the watertable has fallen to four feet below ground surface.

FACTORS CAUSING WATERLOGGING AND SALINIZATION

Three major factors contribute substantially to this alarming situation.

1. Seepage From Conveyance System

Although the main canal and almost all the Minors are lined with concrete blocks and mortar, the porous concrete blocks, poor quality of mortar and improper sealing of joints between blocks leads to collosal seepage, thus contributing to a major portion of the ground water recharge as evidenced by the common occurrence of pools or ponded water and significant saturation of lands adjacent to the main canal and minors.

2. Irrigation Practices

Farmers in the project area are inexperienced and untrained in adopting an effective and efficient irrigation method. They face a demanding situation of quite coarse-textured soils which need frequent applications of small quantities of water. The current practice of providing water to the fields in excess of crop requirement leads to deep percolation, which is retained in the intermediate zone and enhances the ground water recovery and augments the ground water levels.

3. Natural Obstruction to Ground Water Flow

This factor is related to hydrogeologic conditions of the project area. The region has a general topographic slope of 0.6% from the main canal to Hub River. Normally, this is sufficient for good natural surface drainage of the project lands. The occurrence of a very porous gravel layer underlying the soils accelerates the natural sub-surface drainage of the area. But very poor natural sub-surface drainage is evidenced from the rapidity and extent of waterlogging in the area. This is due to the shallow undulating bedrock which interrupts the ground water movement. This may eventually accentuate the process of raising the watertable.

EFFECTS OF WATERLOGGING

The major effects of waterlogging in the project area are reproduced below:

1. Inhibiting Activity of Soil Bacteria

The liberation of plant food is dependent upon the activity of soil bacteria, which requires adequate oxygen in the air for proper functioning. The root zone soils of the project area are fully saturated with water; hence the normal circulation of air is cut off, hampering the activity of soil bacteria which is so beneficial for plant growth and development.

2. Fall in Soil Temperature

The waterlogged soil of the area warms up slowly, and due to the lower soil temperature, the action of soil bacteria is sluggish and less plant food becomes available.

3. Defective Air Circulation

Due to saturation of the soil profile of the area, the carbon dioxide liberated by the plant roots cannot be dissolved and taken away. Consequently fresh air containing oxygen is not drawn in and bacteria activity and plant growth suffer.

4. Rise of Salts

It is evident from the color of soils of the area, that the rise of the watertable has also caused accumulation of salts in the soil profile by the upward movement of water and has impaired the fertility of the soils significantly.

5. Delay in Cultivation Operations

Waterlogging of the area has posed hindrance to cultivation operations such as ploughing and mulching. The sowing of crops and their growth are delayed. Crop yield is also decreased and it arrives late in market causing loss to cultivators.

DESCRIPTION OF THE DRAINAGE SYSTEM INSTALLED AT DEMONSTRATION SITE

Despite the construction challenges due to sloughing sandy soil below the shallow watertable, a sub-surface drainage system has been installed at the demonstration site. The layout of the system is shown in Appendix B. The components of the system are briefly reproduced below:

1. Collector Drain

Total length of the collector drain is 1560 feet of which 1340 feet are 6" in diameter and 220 feet 4" in diameter. The drain is made of perforated flexible PVC pipe and its full length has been laid at a slope of 0.1%. The collector receives water from lateral drains and discharges the drained water at the outlet point, 1000 feet from the first manhole.

2. Lateral Drains

The total length of five lateral drains is 2090 feet. These are made of perforated flexible PVC pipe, 4 inches in diameter. Three of them, (A1, A2, and A3) have been laid at a slope of .19%, with constant spacing of 200 feet, whereas the other two (A4 and A5) were laid at a slope of 0.1% with varied spacing. The lateral drains receive water from the waterlogged soil and convey it to the collector drain through manholes.

3. Manholes

Four masonry manholes of 4 feet breadth, 4 feet length and varying depth (depending on the occurrence of bedrock below the ground surface), and conforming the design criteria, have been constructed at each junction of collector and lateral drains. Each manhole receives water from one lateral drain and the portion of the collector drain on its upstream side. However, manhole-4 receives water from two lateral drains. The manholes allow easy measurement of discharge of either lateral or collector drain using volumetric methods.

4. Drain Envelope

Based on the analysis of the soil at drain depths, it was decided that a drain envelope was essential to prevent the entry of base soil into the drain pipe and choking it. The worst case scenario for the base material was selected and a mixture of sand, small gravel and large gravel (Sample 1 in Appendix B) of medium size 2.6 mm (Figure 1, Appendix E) conforming closely with the minimum limits has been used as envelope material for the drain pipes. Coconut fiber and polyester fabric have also been used on some parts of the collector and lateral drains to check the efficiency of filter material. The total length of drain pipes is 3650 feet, of which 435 feet collector from outlet point was wrapped with coconut fibre, 620 feet lateral drains (A4 and A5) were wrapped with polyester fabric in addition to gravel packing and the remaining 2595 feet were packed with gravel material only.

DISCHARGE OBSERVATIONS

The discharge from lateral drains could be measured at manholes and also for the whole system at the outlet using bucket and stop watch. Just after completion of the drainage system, the discharge measured was 3 lps and continued increasing upto 5 lps but now it is reduced to 1.95 lps, which indicates that the watertable has fallen to a significant level, which is probably due to less recharge and interception rate because of canal closure period.

WATERTABLE OBSERVATIONS

Watertable depth at the demonstration site has been collected from ten piezometers installed at different places in the drainage area. Schematic discharge of this is shown in Appendix D. The data collected before installation of the system is shown in Appendix A.

SALINITY OBSERVATION

In order to determine the drainage system's ability to alleviate salinity problems in the area and the possibility of using drained water for irrigation, the quality testing of drained water at different key points of the demonstration site is inevitable. In this regard, four samples of water, one from the outlet point and the other from manhole 4, one from the open well adjacent to the demonstration site and one with canal water were collected and analyzed in the irrigation laboratory of the Department of Irrigation and Drainage, Faculty of Agricultural Engineering, Tando Jam. The result of the samples tested is shown in Appendix E.

By comparing the quality of drained water with the quality of open well water (actually the water in the soil profile before the installation of the drainage system,), it is obvious that the quality of drained water at the outlet point has been improved by leaching and removal of salts in the soil profile due to the drainage system.

DEMONSTRATION OF THE DRAINAGE SYSTEM

Demonstration of the sub-surface drainage system installed at the site selected for reclaiming waterlogging and salinization was done by arranging a successful training session at the site. Training was attended by SPM, Sub Divisional Officers of PID, SMO staff and farmers from different watercourses of the project area. Knowledge pertaining to causes, effects and remedial measures for waterlogged soils was disseminated to the participants with the help of charts, tables and diagrams . The drainage system in process of installation was also shown to the participants and they were apprised of practices contributing to waterlogging problems and the effectiveness of the drainage system installed there to overcome such problems.

RECOMMENDATIONS

1. Presence of a hardpan at a shallow depth in the soil profile caused either by ineffective cultural practices or chemical deposition or A combination of both should be broken by chisel plow in order to minimize the formation of hardpan in future.

2. A study of current irrigation practices adopted by the farmers of the project area should by made and tendency of over-irrigation should be stopped by implementing efficient irrigation scheduling for the crops grown, thus avoid overtaxing the sub-surface drainage system.

3. Sub-surface drainage, efficient though costly, could be replicated in those parts of the project area where surface drainage system is not effective. It is suggested that an agency fund the materials used for the system and landowners be persuaded to pay the labor charges for excavation, laying, gravel packing and backfilling of the drains.

4. The sub-surface drainage system will not solve waterlogging problems on its own. A comprehensive surface drainage system (open drains) should also be designed in same parts of the project area.

5. It is not possible for farmers to drain their land on an individual basis due to non availability of natural outlets near their waterlogged lands. They should therefore integrate their needs and share outlets. A pump could lift the drained water and in lined depth convey it to the nearest nullah or natural outlet.

6. Discharge at outlet should be measured daily or every other day for at least one year in order to evaluate the drainage coefficient for the area.

7. Quality of drained water should be examined on weekly basis so as to check possibility of using drained water for irrigation purposes.

8. Deep interceptor drains should be installed parallel to canal length. The intercepted seeped water should either be pumped out into open drains or back into the canal.

Salient Features of Drainage System Installed at Demonstration Site

1.	Date of Work Started	=	12/22/90
2.	Date of Work Completed	=	02/06/91
3.	Total Length of Drainage System	=	3,650 feet
4.	Length of Collector Drain (With Diameter 6")	=	1,340 feet
5.	Length of Collector Drain (With Diameter 4")	=	220 feet
6.	Slope of Collector Drain	=	0.1%
7.	Length of Lateral Drains	=	2,090 feet
8.	Diameter of Lateral Drains	=	4"
9.	Slope of Lateral Drains	=	0.19%
10.	Spacing Between Lateral Drains	=	200 feet
11.	Area to be Drained	=	10 acres
12.	Average Watertable Depth	=	2 feet
13.	Designed Watertable Depth	=	3.5 feet
14.	Hydraulic Conductivity (For layer above the drain)	=	0.03 inches/day
15.	Hydraulic Conductivity (for layer below the drain)	=	0.12 inches/day
16.	Envelope Material Used	=	Coconut, Gravel and Polyester Fabric
17.	Manholes	=	4 No:s
18.	Outlet Point	=	Hub River
19.	Soil Profile	=	0 - 0.5 feet, Moist Layer
		=	0.5 - 1 feet, Hard Compacted Layer
		=	1 - 5 feet, Sandy Textured Layer
		=	5 - 6 feet, Gravel Soil
		=	>6 feet, Impervious Bedrock

85

Statement of Expenditure Estimated and Incurred on Drainage System

Serial No.	Activity/No.	Quantity Cost	Estimated Cost	Incurred Amount
1.	Excavation of Trenches	53,647 cft.	107,655.00	107,294.00
2.	Dewatering of Trenches	3,215 R.ft	6,430.00	6,432.00
3.	Sand	3,135.6 cft.	9,434.10	9,407.00
4.	Gravel	723.6 cft.	3,628.50	3,618.00
5.	Gravel (Large)	964.0 cft.	5,805.60	5,789.00
6.	Manholes	4	38,000.00	38,000.00
7.	Laying of Pipes	3,215 R.ft.	1,607.50	1,608.00
8.	Gravel Packing	3,215 R.ft.	3,215.00	3,216.00
9.	Backfilling of Trenches	53,647 cft.	26,913.00	26,823.00
		Rs.	202,688.60	Rs. 202,187.00

96

WATER TABLE POSITION BEFORE THE INSTALLATION OF DRAINAGE
SYSTEM ON A SELECTED SITE
LASBELA SUB PROJECT AREA

Date	Groundwater Level Below Ground Surface in Inches											
	READINGS OF PIEZOMETERS										Open Well	Remarks
	1	2	3	4	5	6	7	8	9	10		
11-12-90	19	16.5	17	14.5	18	17.5	15	18.3	25.5	22.5	30	
11-13-90	18	18	16	13.5	20.5	16	18	20.5	27.75	23.75	33	
11-14-90	18.5	17	13.5	9.5	16.5	18	17	21	Dry	24.5	34	
11-20-90	16	13.5	12	14	22	18	20	22.5	Dry	29	36	
11-25-90	21.5	24	Dry	No pipe	30.5	Dry	29.5	30.3	Dry	30.5	39	
12-08-90	20.5	13	15	No pipe	24.5	Dry	28.5	26	Dry	29.5	39.5	
12-12-90	13.5	12.5	18	No pipe	23.5	18	17.5	23.5	26.5	28.5	31	
12-26-90	17	15	18	No pipe	32	20	25.5	23	29	34	31.5	

87

GEOTECH CONSULTANTS

SOILS AND MATERIALS TESTING LABORATORIES

45/3 CP & BERAR
HOUSING SOCIETY
OFF SHAHEED-E-
MILLAT ROAD
KARACHI.
Phone : 413980

Report No. : GEO/USA/CWM.GS.90062.I

Table No. : 01

Date : 21-03-90

Reporting Date : 21st, March, 1990.

PROJECT : Command Water Management.

CLIENT : M/S, USAID.

CONSULTANTS :

SUBJECT : Sample supplied by client.

S. No.	Identification No.	Atterberg Limit			Sieve Analysis %Passing										
		LL	PL	PI	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	# 50	#100	#200
1.	Sample No. 1. Mixture of. Sand A-1.65% Gravel (S) B-1.15% Gravel (L) C-1.20%	-	-	-	99.2	93.0	83.7	79.2	71.0	49.7	22.	3.8	0.5	0.2	0.1
2.	Sample No. 2. Mixture of. Sand A. 60% Gravel (S) B. 20% Gravel (L) C. 20%	-	-	-	99.2	96.0	89.2	83.6	77.8	52.6	21.0	3.3	0.4	0.2	0.1

(HUSAIN ABID)
B.S. (CIVIL) MECH
M.S. SOIL MECH (FLORIDA)
REGD. PROFESSIONAL ENGINEER
(M.E. (PAK) - MEMBER OF P. E. C.

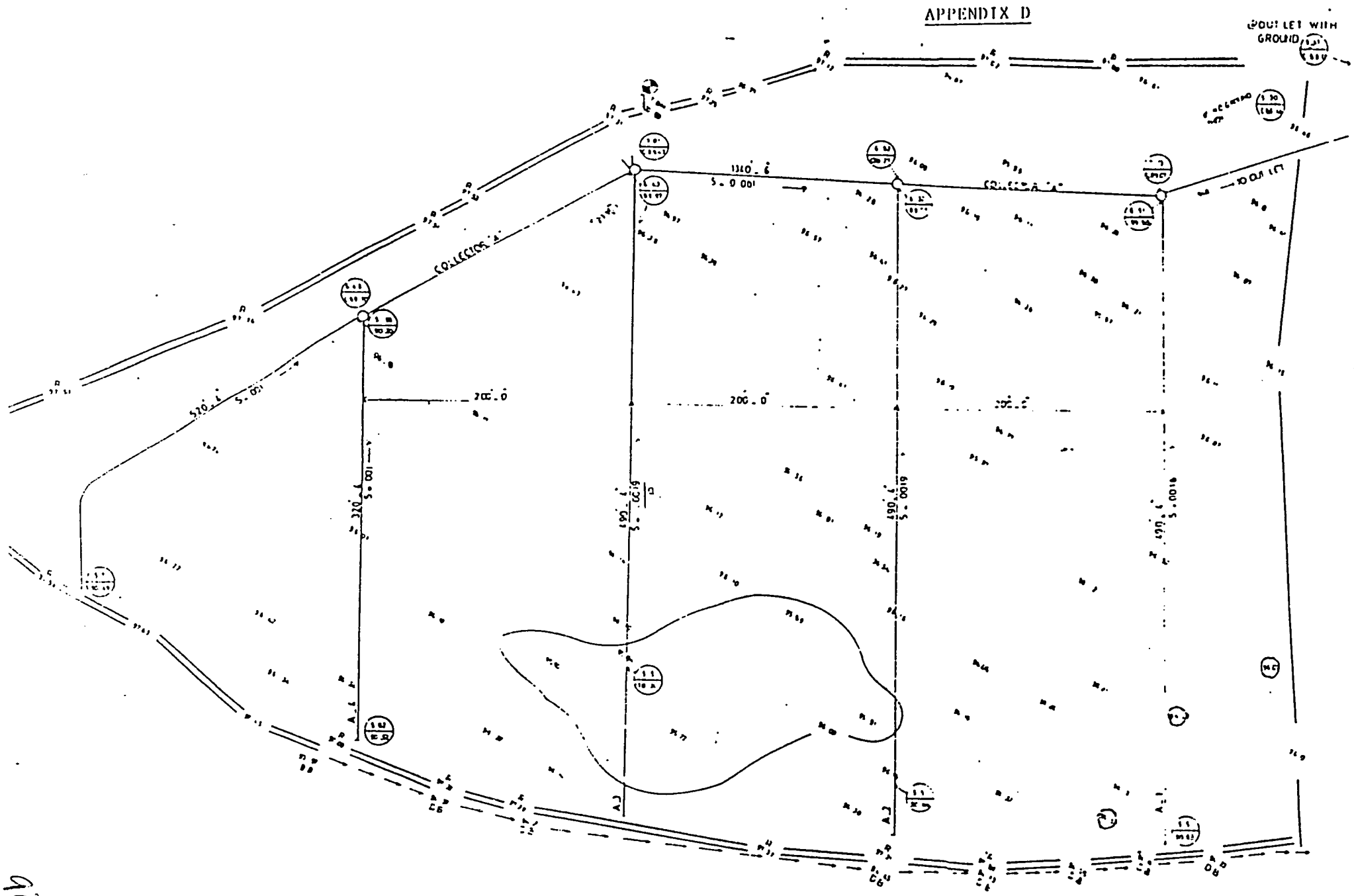
21/3/90

GEOTECH CONSULTANTS

Quality of Water Samples

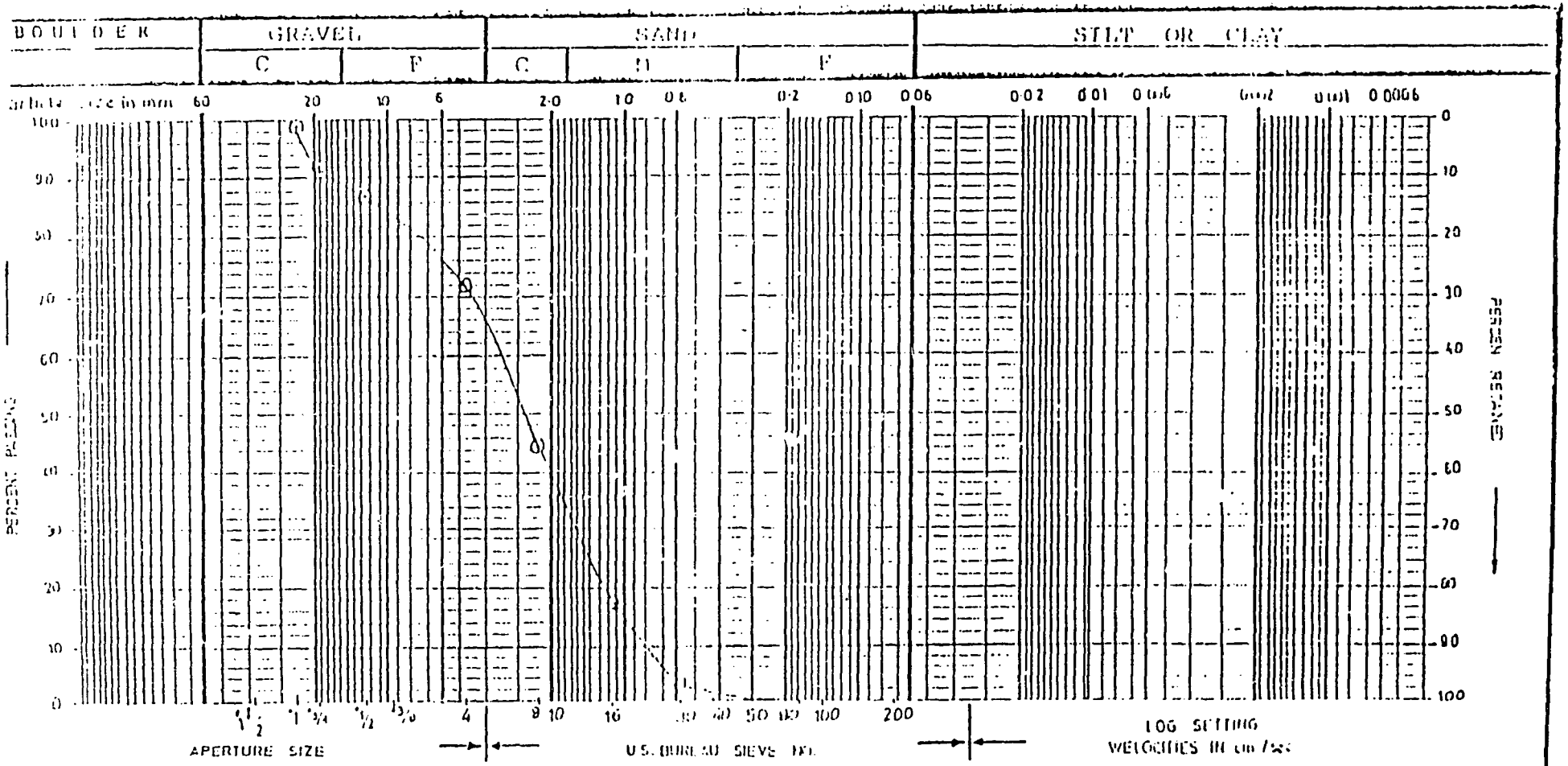
Sample Lable	Sample Description	Electrical Conducitivity ECx10 = U mohs at 25 C	Total Soluble Salts TSS ppim	PH Value	Class of Water	Remarks
A	Drained Water at outlet	6000	3840	6.80	Third Class	Not fit for Irrigation
B	Water of Manhole well (Adjacent to demonstration Site)	8500	5440	7.20	Third Class	Not fit for Irrigation
C	Water of open well (Adjacent to demons tration site)	1100	7040	8.00	Third Class	Not fit for Irrigation
D	Canal Water	600	384	8.20	First Class	Fit for Irrigation

APPENDIX D



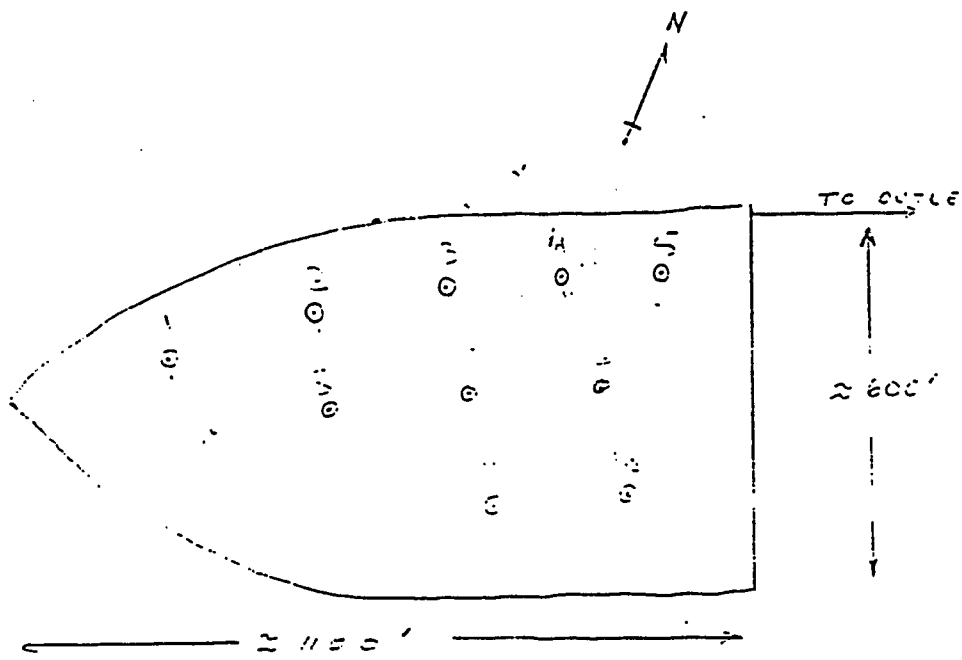
Layout of Sub-surface Drainage System

GRAIN SIZE DISTRIBUTION



VOID	LINE NO	SAMPLE	DEPTH	CLASSIFICATION	BOULD %	GRAV %	SAND %	SILT %	CLAY %		L_L	P_L	P_x	REMARKS
⊙	- -	1	- -	$C_u = \frac{3.5}{.08} = 44$ $C_c = \frac{1.6^2}{3.5 \times .08} = .91$										

HOTBCH



Layout of Piezometer Installed at Demonstration Size

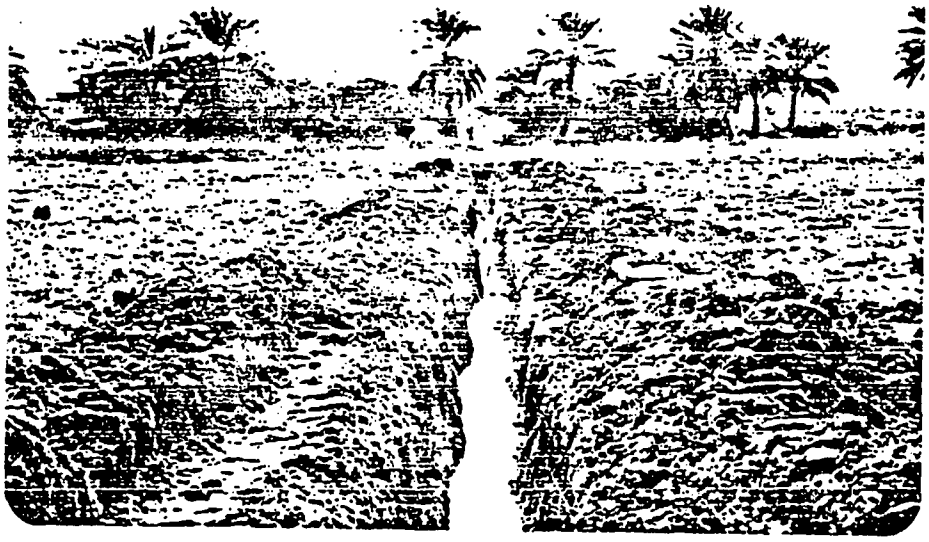


Plate: 1 Trenche Excavated For Laying Drain Pipe

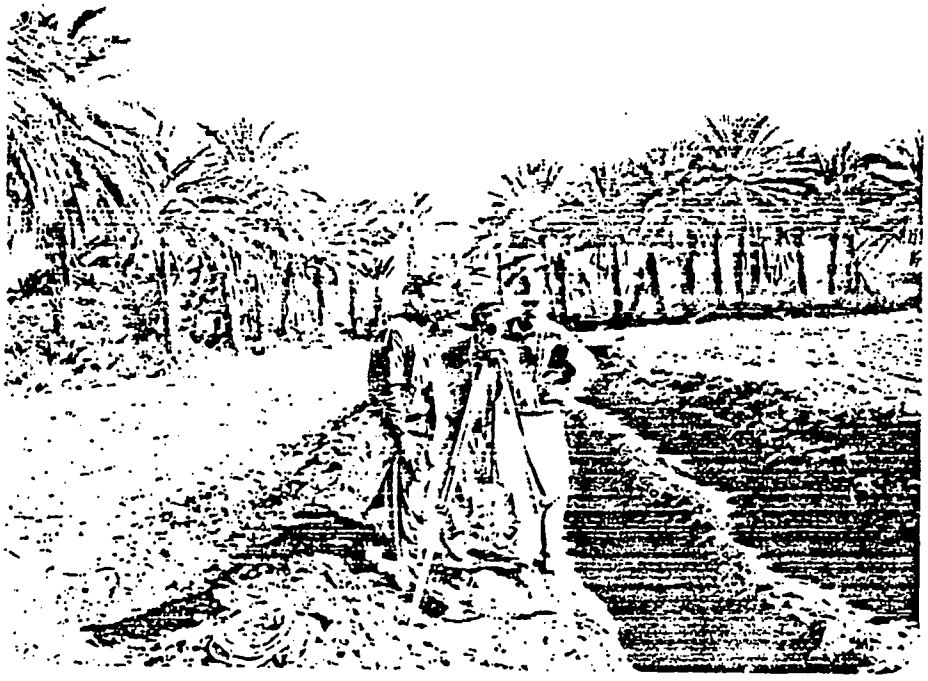


Plate: 2 Checking of Slope of Drain Line By Dr. Bhutto

Plate: 3 SMO Staff Checking The Excavation Work

Plate: 4 Laying of Drain Pipe

94

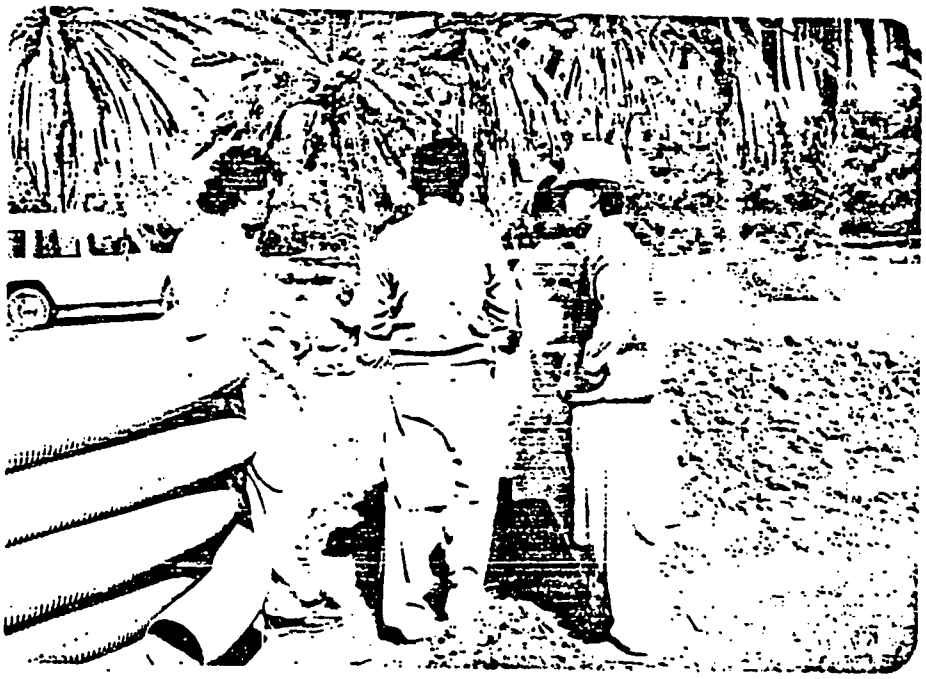


Plate: 5 Dr. Bhutto is Giving Instructions to SMO Staff and Contractor

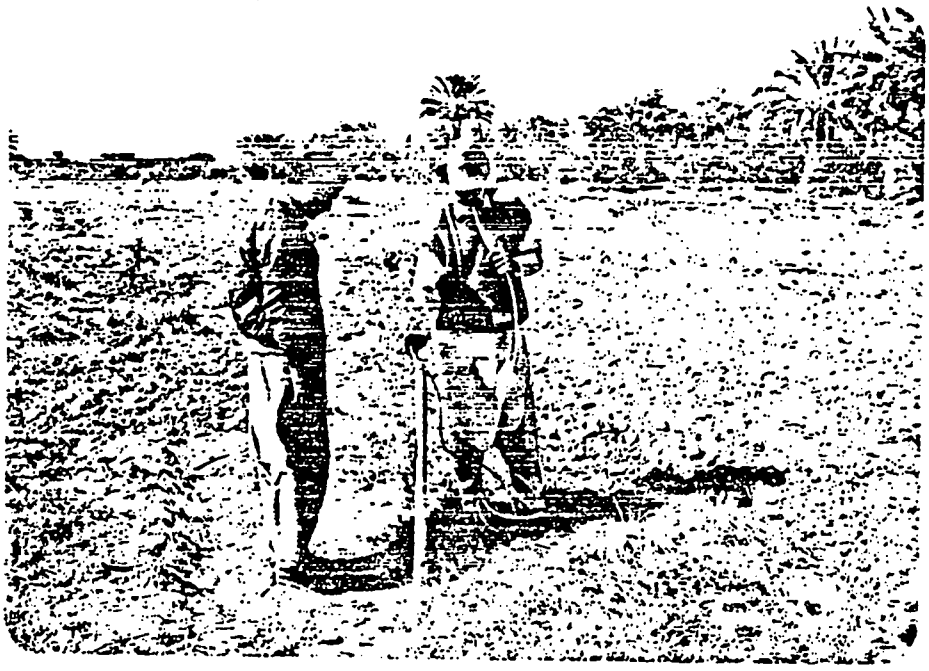


Plate: 6 Watertable Elevation Observations

95

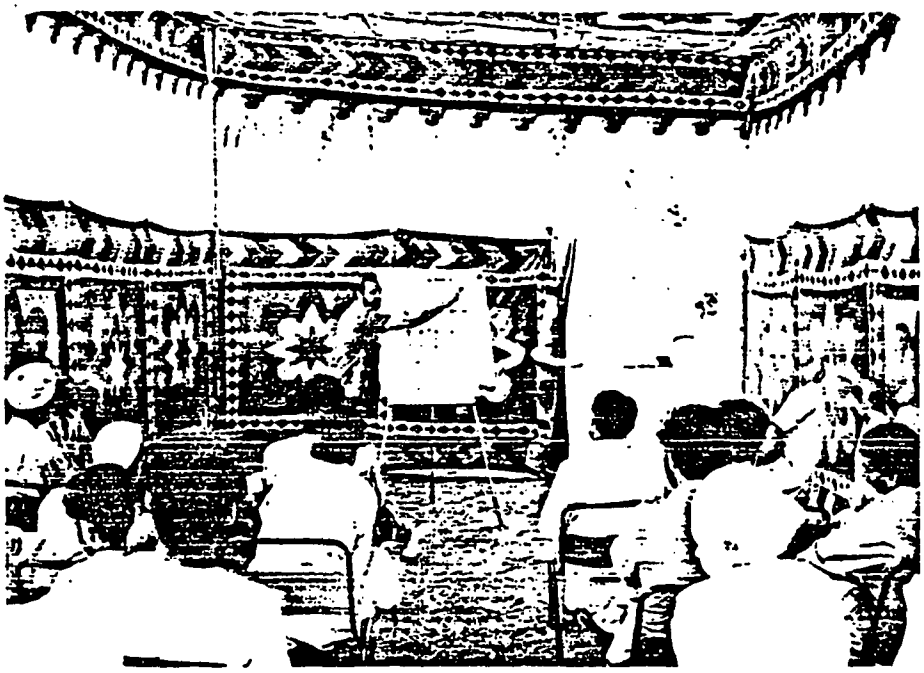


Plate: 7 Dr. Bhutto, WMS, is Delivering Lecture on the Drainage System Installed at Demonstration Site

Plate: 8 Participants are listening the Lecture of Dr. Bhutto

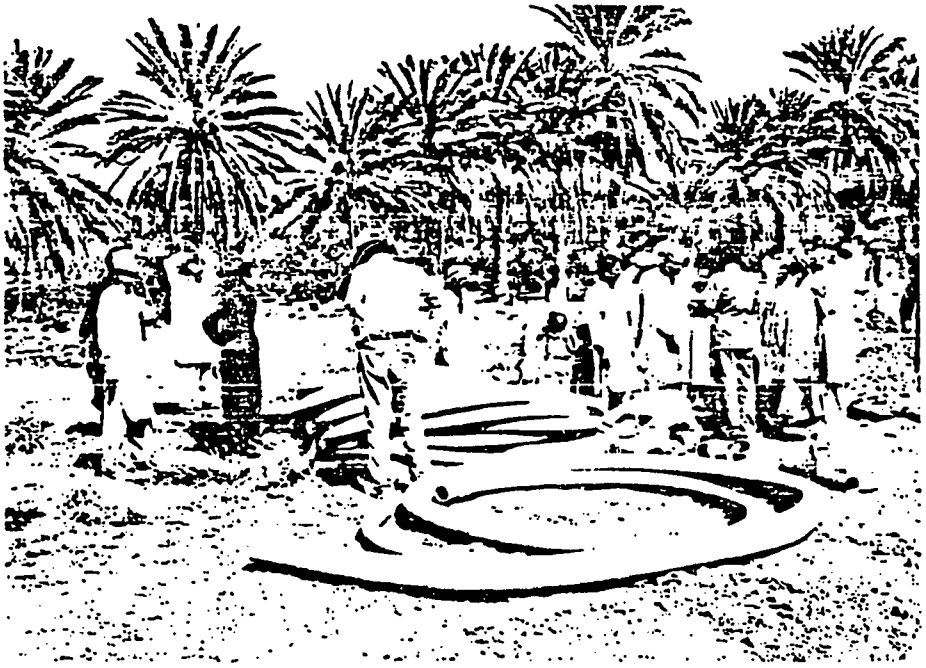


Plate: 9 Dr. Bhutto is Showing Materials Used in the Drainage System to Participants

Plate 10: Dr. Bhutto is Briefing about the Drainage to Participants at Outlet Point

97

Annex F

Irrigation Scheduling Practices Review and Development of Recommended Improved Irrigation Management Programs**--Executive Summary

**Full report is available from USAID/Islamabad.

ANNEX F

IRRIGATION SCHEDULING PRACTICES REVIEW

AND

DEVELOPMENT OF RECOMMENDED IMPROVED

IRRIGATION MANAGEMENT PROGRAMS

CWM-ARDINC/USAID/PAKISTAN

By: Robert W. Hill, Irrigation Engineer, Utah State University
and
Rafiq Choudhary, Irrigation Engineer, CWM - ARDInc

EXECUTIVE SUMMARY

Background and Findings

The study described herein was conducted in Pakistan during the period 15 March to 9 April, 1990 as part of the Command Water Management (CWM) Project sponsored by USAID and GOP. Approximately seven days, out of the twenty-six days in country, were spent in field visits to CWM Project areas in Sind (Naulakhi/ Sehra), Balochistan (Lasbela), Northwest Frontier (Warsak Lift Canal) and Punjab (Shahkot). The majority of the office time was devoted to computer program modification and development of data sets to simulate selected irrigation scheduling opportunities under Pakistan conditions. The CRPSM crop yield and irrigation scheduling computer simulation model was used in the calendar analysis methodology. CRPSM was extensively modified to better provide desired scheduling options and suitable output for the CWM Project.

The main objectives included assessing present irrigation practices and possible opportunities for irrigation scheduling improvement in selected CWM project areas; development of recommendations for feasible improved irrigation scheduling programs which would be consistent with the desired CWM project outcome (i.e. assuming improved watercourses); test expected crop response to existing and proposed irrigation scheduling options with any readily available (historical) weather, soils, irrigation and crop data; and assist in developing recommendations for staff training and implementation of improved irrigation scheduling.

Farmers were interviewed (as many as time permitted) in each of the areas visited. Questions solicited information on cropping patterns, planting dates, rooting depths, water sources, timing of irrigations for wheat, maize and other pertinent crops, adequacy and reliability of water supply and the farmers' notion of when crop water needs were critical.

Generally, the farmers in the Punjab had a better knowledge of desired improved irrigation (and other practices) than farmers in other areas. Farmers

91

in the Lasbela area seemed less knowledgeable. The lack of farmer knowledge of the watercourse and/or tubewell flowrates (as reaching his farm) precluded any quick estimates, from interviews, as to typical irrigation amounts and minimum practicable irrigation depths for various field areas.

Main Conclusions

- Farmers generally lack knowledge of some important aspects of plant-soil-water relationships, including rooting depths, water supply flowrates and the relationship between irrigation application time, available flowrate in the watercourse, field area and needed depth of applied water.

- Farmers seem to relate crop growth and irrigation occurrences to days after sowing rather than to crop growth stage progress (phenologic development).

- Better timing of irrigations alone can provide significant benefits in water and fertility (perhaps) savings even without controlling the amount applied.

- Irrigation scheduling methods most likely to be used by the farmer and to remain in place over the long term will be simple, applicable to a wide area and require minimal subsequent advisory service.

Recommendations

The full potential of irrigation scheduling will be realized only when the irrigator understands and utilizes sound principles of irrigation water management. These include not only correct timing but adequate uniformity of irrigation and proper applied water amounts. It would be the goal of the "Extended" level of advisory service to provide such additional information to the farmer. In a simpler approach, the farmer would receive training and assistance relating only to irrigation timing (the "when") at the "Basic" level of advisory services. The transferred information would be consistent with the selected irrigation scheduling method.

The following recommendations are made assuming that the CWM project objectives were met, i.e. an improved watercourse, water deliveries closely match design flowrate conditions, equitable and reliable water distribution along the watercourse. It is not known if the design flowrate would provide adequate irrigation amounts.

Recommended Irrigation Scheduling Methods for CWM

1. Calendar of irrigation occurrences expressed in days or weeks after sowing and corresponding with the warabandi. The infiltrated irrigation depth would be assumed to average more than two inches (or other appropriate depth) for each event. Calendar irrigation dates determined from five or more years of recent weather data (if available) assuming either no rain

100

or average rainfall. Farmers would be given a rule of thumb for adjusting irrigation date when rain occurs.

2. Feel method to estimate soil water content and irrigate at 50% depletion of available soil water in the top two feet of the root zone. This would involve using a soil auger (or other sampling tool) at two or three locations in a field at 7 to 14 day intervals (less frequent as the farmer gains more skill). Soil samples should be taken at 6, 12, 18 and 24 inch depths.

3. Combination of methods 1 and 2, with soil samples being taken prior to suggested irrigation dates to verify need and compensate for any antecedent rain, etc. which may delay the next irrigation or for unusually hot, high evaporative conditions which would hasten the next irrigation.

4. A suggestion, not a recommendation, is to use some mechanical or electronic "gadget" such as tensiometer (not recommended for prevalent field crop and soil combinations), electrical resistivity moisture sensors (some gypsum blocks are being used in Shahkot and other areas), evaporation pans in field (serious operational problem) or neutron probes (high cost, sophisticated maintenance requirements, sensitive to rough handling). The device, read periodically, would provide a "diary" record of soil water contents. As such the information (readings) could be used as a warning for imminent irrigation at the next warabandi turn.

5. Combination of methods 1 and 4, in similar context as for method 3.

Once a farmer learns and consistently uses the calendar and/or feel methods to schedule irrigations the level of needed future advisory service is almost negligible. However, with methods such as gypsum blocks (or weekly updated Et data from current weather, or neutron probes, etc.) continued field level outside technical service is required. Where resources may be limited, the longevity of "gadget" related methods is problematic at best.

Calendar Development Analysis Strategy

The calendars will be generalized as much as possible to better suit widespread public usability. This suggests wide regional applicability with two planting periods (such as mid-November and mid-December for wheat) and perhaps two soil types: coarse (loamy sand or sandy loam) and medium (loam or silt loam). The irrigation schedule would be determined assuming no rain, then rain would be included and schedule changes compared. The calendar approach deals mainly with the timing of irrigation, although the soil water depletion at the indicated irrigation date could be included for estimating needed field water application amounts. The weather data is not to be updated in near real time (although the simulation model would work in an update mode), rather all the calendar development analysis is based on historical weather data (preferably five or more years at each representative site). The methodology demonstrated herein is transferable to any site in Pakistan where sufficient weather data is available.

101

The irrigation scheduling calendar development approach was demonstrated herein with one crop (wheat) at one site in the Punjab using one year of data (Jamali Baluchan 1979). Irrigation schedules were developed for wheat assuming two planting dates (mid-November and mid-December) with sandy loam (70% depletion initially) and loam (50% depletion initially and following rice) soils with and without the influence of rainfall. It was assumed that two inches or more would be stored in the soil water reservoir with each irrigation. Irrigations were scheduled when the soil water depletion exceeded two inches on a day coinciding with the 7-day warabandi interval. For the given example, the effect of rainfall eliminated the second or third irrigation which would have occurred in mid-December through early January.

Implementation

A few farmers should be selected from each of one or two CWM improved water courses in each project area for introducing the proposed irrigation scheduling methods at the "Basic" advisory level. Perhaps no more than three or four farmers would be selected for each of the methods, representing a cross section of typical farm situations (size, cropping pattern). A few more could be selected for the "Extended" advisory service with a given method.

CWM advisors would work with the farmers (individually and in group meetings) to introduce the scheduling method and train them in its use. The advisors could help the farmer select specific fields at the beginning of the season and work out corresponding schedules. The use of video tapes (many are available from different universities in the United States) describing soil-water-plant relationships and irrigation scheduling methods would enhance training of CWM personnel and farmers. In subsequent visits, perhaps weekly or biweekly, the farmer would receive further instruction and technique demonstrations (for the "feel" method). The advisor should record the irrigation dates and monitor the actual amounts, if possible, on the selected fields. Where the extended level of advisory service is provided, additional water course flowrate and application time information for specific fields would be given to the farmer so he could apply the desired amount of water.

The advisors should also record any farmer comments regarding the use and practicality of the scheduling method. After the season is over, the advisors should evaluate, with the farmer, the performance of the method and solicit suggestions for improvement.

Implementation Details

1. Calendar

   - Limit number of different calendars i.e.: two sowing dates (example for Rabi wheat - mid-November/mid-December)

   - Two soils: coarse (sandy loam) and medium (loam)

   - Irrigation dates (days after sowing), perhaps should be translated to lunar month intervals or other local time accounting.

106

- Coding of some sort (color or alphabetic) could be used for different sowing dates, soils, crops, position on watercourse, etc., to get rid of technical numeric detail.

- Field size and W.C. flowrate available at headgate for Extended (translate W.C. flowrates into duration time of irrigation to apply desired depth).

- Simplify transfer of information to farmer (Urdu script added to all)

2. Feel

Separate specific soil type from general feel chart which fits farmer's field. Teach farmer how to determine approximate soil moisture depletion by examples from his own field; dig holes, etc. Irrigation occurrence would be indicated when soil water availability in upper two feet of root zone gets close to 50% depletion. Show (and help) the farmer (or local village shops) how to make augers. Show how to take samples (with auger or hoe, etc.) at 6, 12, 18 and 24 inch (or deeper) depths and how to squeeze the soil into a "ball" and interpret the results.

3. Resistance Block

Technician required to do readings on weekly basis. Use as "warning" indicator of impending irrigation. Perhaps graph relative moisture readings (in top two feet of soil) versus time to show drying out of soil due to crop water use. Both "full" and "refill" (irrigation needed) lines could be drawn for reference. The graphs could be developed from crop and soil moisture data available from PARC reports.

Miscellaneous Other Observations and Recommendations

CWM Demo Plots and Improved Watercourse Construction

The general appearance of the wheat demo plots in the Sind and NWFP was impressive. Head size was significantly larger, stands more uniform and with better color than adjacent farmer plots. The anticipated results should be noteworthy. The inputs also seem to be within the farmers grasp. It was unfortunate that the recent heavy storm had caused so much plant lodging in the plots near Peshawar.

The high quality of masonry finish work on the improved watercourses was obvious. The aggregate (as observed in the NWFP) was also clean and of especially high grade. However, special care should be taken in compacting the pad and embankments for improved watercourse channel concrete work. Excavation spoil should be promptly cleared away from watercourse banks to avoid being dislodged and falling into lined channels causing unnecessary maintenance.

103

Software Purchases for CWM-ARDInc, Lahore Office

1. CRPSM is written in Fortran. Any future on-site modifications will require a compiler. The Microsoft Fortran Compiler (MS Fortran Version 4.0 or later) is recommended.

2. Efficient editing of data and program files requires a good ASCII editor. The Program Editor (PE Version 4.0) sold by the WordPerfect people (SSI) is recommended.

3. A file and directory handling utility would increase user efficiency. Quick DOS (Gazelle Systems Version 2.0) is inexpensive and convenient. All computers should have it installed. (QDOS may have been already purchased by CWM as part of the recent computer training course).

4. Presentation of the calendars in graphical form is essential. The use of spreadsheet software with good graphics capability (and a laser printer) will enhance calendar production. Quattro Pro is recommended.

Computer Operating System

The XEBEC AT compatible seemed to have strange Hard disk setups (an ST11R Bios was installed for an ST238R hard drive #1). No SETUP program could be found. A mix of IBM DOS (and BASICA) did not work with the clones. Printer graphics (MSTAT, other) were not working. The Compuadd MSDOS - when used on the XEBEC also caused some problems. It is strongly recommended that a XEBEC compatible DOS operating system be installed and correct SETUP procedures followed.

Annex G

Full Watercourse Trial
Lasbela and Kandiaro
Subproject Areas

ANNEX G

FULL WATERCOURSE TRIAL
LASBELA & KANDIARO
SUBPROJECT AREAS

INTRODUCTION

The purpose of the full watercourse trial was to introduce a fully integrated range of technical and organizational improvements to farmer members of a water user association. In the past, the project had introduced various types of agricultural improvements to watercourses, but had not focused a full range of improvement intensively on a single watercourse, nor had it attempted to involve all of the WUA members so fully in these activities. Many of the improvement programs had been successful, but the project did not have the opportunity to see the impact of these various programs focused on one watercourse.

One Watercourse was selected for testing in Lasbela and one in the Kandiaro subproject areas. The full watercourse trail programs were carried out by the technical assistance team assigned to the Karachi office. Although the agricultural and social conditions are quite different in these two areas, there were many conclusions that can be drawn which are valid for both of the areas. As one of the objectives of this exercise was to determine whether the full watercourse trial is a valid procedural concept and can be replicated in other areas, this report will combine the lessons learned for both areas.

The implementation of the Full Watercourse Trial began in the kharif season of 1990. In the Lasbela subproject area, the Technical Assistance Team concentrated its efforts on developing the organizational capability of the WUA and the production capability of watercourse 24 on minor 4 and in Kandiaro on watercourse 2L on Abji minor. This effort continued until the project was closed on March 31, 1991. The project was scheduled terminate in June 1991 and the Technical Assistance Team had planned to complete the rabi season cropping analysis and prepare comprehensive reports about the impact on crop production and the organization of the WUA. However, the evacuation of the expatriate technical assistance team caused by the Gulf War and the termination of the project before crop maturity and harvest, made unavailable cropping information and the irrigation scheduling information that was to be collected and analyzed for the 1990-91 rabi season.

I. WUA DEVELOPMENT AND FARMER PARTICIPATION

A. Watercourse Selection:

The selection of an appropriate watercourse was a key element in the success of this exercise. Experience has shown that unless the farmers on a watercourse [illegible]

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criteria, the potential for success in organizing them to carry out technical improvements is greatly diminished. Basic selection criteria include: 1) Demonstration of interest by farmers, 2) Identification of farmer benefits, 3) A large number of shareholders, 4) Respected local leaders, 5) A long history of cooperation, and 6) Most farmers belong to the same bradari (kinship group).

Most of these criteria were met by the farmers on the selected watercourses in Lasbela and Kandiaro. Watercourse 24 was near the tail of minor 4 and was not receiving water from the minor. This problem provided a focus of interest to the 17 farmers on the watercourse and the project felt that bringing canal water to the watercourse and the attendant increase in production would be a direct and highly visible benefit to the farmers. Although the 17 farmers on this watercourse was not as large a group as hopped for, it was the largest number on a single watercourse in the project area. Among this group there were no large land holders who dominated the others by wealth or political influence. On the other hand, there were several farmers who were highly articulate in identifying their problems and motivated to work together in solving their problems. The farmers belonged to two bradaris, but there was a history of cooperation among them.

In Kandiaro, farmers on watercourse 2L at the head of Abji minor had a long standing request for their watercourse to be lined. Watercourses on nearby watercourses had been lined by the project and the farmers on 2L had seen and had been told about the benefits of this. Farmers on this watercourse planted a larger than average (for the area) portion of their land in high value fodder and vegetables and they were particularly interested in the benefits of a better water supply and access to non-water inputs. Watercourse 2L commanded about 400 acres and there were 51 small to middle size landholding farmers. As in Lasbela, there were no large landholders on the watercourse to dominate the WUA by wealth or political influence. There were two bradaris which had some disputes in the past, but both groups were anxious to work together in improving the watercourse. Several of the farmers were literate and were respected as leaders of the watercourse.

B. <u>WUA Organizational Procedures:</u> The objectives of organizing the farmers into a strong WUA were: to fully participate in Watercourse rehabilitation--lining a portion of the watercourse and improving the unlined portion through which there would be greater equity, adequacy and reliability in water distribution within the watercourse. The WUA would then have the

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capability of developing a cooperative, reliable, timely watercourse maintenance plan. On the cropping side, an active WUA would promote the cooperative, timely procurement of non-water inputs and the farmers would have a greater voice in the management of water inputs.

The steps in the organizing the WUA were first to present the farmers with the concepts, objectives, and the benefits of the program and secondly to select a "Membership Committee", enroll members, elect WUA officers, open a bank account and register the WUA with the SMO.

C. Watercourse Rehabilitation Procedures: The WUA contacted the OFWM Field Team responsible for watercourse rehabilitation and submitted the required documents. The WUA appointed a survey committee of farmers to accompany the OFWM team during their survey of the water course to advise on elevation problems, and the placement of naccas and culverts. The WUA formed a committee was to organize the farmer labor and hiring of labor for the rehabilitation. A cost and quality control committee was appointed to inspect the quality of materials used in the lining of the watercourse.

In general there was good cooperation between the WUA members on the survey committee and the engineers involved in the survey. The farmer survey committee accompanied the engineers in their field survey and reviewed the final survey design. This not only helped the engineers in designing the rehabilitation that was most suitable to the farmers, but in the discussions between the engineers and the farmers, the farmers developed a better understanding of what their responsibilities were and of the technical and financial constraints of the farmers.

The labor committee was effective in hiring labor and coordinating the labor work periods with the schedule of the OFWM staff, but the cost and quality control committee came under criticism by the engineering staff. The staff felt that the members of the committee did not have the technical knowledge necessary for valid oversight over the material they were using. The dispute was resolved by a careful delineation of the responsibilities of the cost and quality control committee. Although the effectiveness of this committee was limited by the controversial nature of its function, in the long run it did serve to give the farmers confidence in the watercourse rehabilitation work undertaken by the OFWM staff. On the basis of this confidence, in Lachola the WUA members gave full support to the OFWM staff and contributed Rs 125,000 for the rental of equipment and payment of laborers.

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188

In Lasbela, the WUA members decided that they preferred a closed pipe on the lined section, rather than the usual open lining. The rationale for this was that it would reduce maintenance from sand accumulations which were likely to blow into the watercourse. This was opposed by the OFWM staff as it was more costly and harder to maintain. The WUA members were adamant about the installation of the pipe and about half of the lined section was laid in pipe.

In Kandiaro, there was no controversy about open lining, nor about cost and quality control. Part of the reason for this was that the engineers involved in the watercourse rehabilitation were very experienced and they followed the rehabilitation of the neighboring watercourses.

D. Watercourse Maintenance: Conceptually, an important function of the WUA is to provide timely, and appropriate maintenance on the rehabilitated watercourses. As the rehabilitation of the watercourse in Lasbela and Kandiaro was completed only in May 1990, and no major maintenance was needed, there was little opportunity to see if a long term, systematic maintenance program could be established. However, in Kandiaro, the WUA had adopted a plan to meet weekly to discuss WUA activities which include watercourse maintenance.

E. Procurement of Non-Water Inputs: Adequate quantities of Non-water inputs of seed, fertilizer and chemicals are not locally available to the farmers in the Lasbela subproject area. They can be purchased in Karachi which is about an hour's drive from the project area, but this limits accessibility of the inputs. Inputs are normally brought into the area by farmers and traders with access to truck transportation and sold to the small farmers.

The 17 WUA members on the full trail watercourse felt that greater accessibility of inputs in the project area was a high priority need for them and farmers on neighboring watercourses. As a consequence, they have opened an inputs store. The use of a building to store and distribute the inputs was donated by the Chairman of the WUA. The Extension Department arranged to supply the some of inputs. WUA members with access to transportation also supply the store. The choice of inputs to be stocked is recommended by the TA Team Extension Specialist and Agricultural Extension Agents. Training and information about the use of these inputs is also given by those persons.

In Kandiaro, improved seed was the only input which was not readily [illegible] to the WUA members. Farmers said

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concern was locating sources of good seed. The Sindh Seed Corporation was the major supplier of seed, but the farmers were mistrustful of quality of seed that they purchased from the local retail outlets that stocked seed said to be from the Sindh Seed Corporation. There was a particular problem with the germination of cotton seed. Another problem was that the demand for certified wheat seed was far greater than could be met by the Sindh Seed Corporation. The result of this was that small farmers with little wealth or political influence could not obtain certified seed.

In the full watercourse trail exercise, the project arranged for the purchase of certified wheat seed from the Sindh Seed Corporation. The farmers gave orders for wheat seed through the WUA and the project acted as the intermediary in obtaining the seed for them.

F. Farmer Training: Training for watercourse farmers in various improved management practices was coordinated through the WUA. Training was scheduled in conjunction with watercourse activities, such as demonstrations, farmer days, etc. The role of the WUA was to inform farmers of the training, help promote their attendance and help provide a suitable training site.

II. PHYSICAL IMPROVEMENTS (CIVIL WORKS)

Lining on Minor 4, where the Lasbela full watercourse trial is located, had been started but was stalled for administrative reasons beyond the responsibility of the project. While waiting for lining to resume, the problem of bringing canal water to the watercourse was temporarily resolved by placing a cement collar below the outlet to watercourse 24 to raise the head. This had the effect of raising the discharge above the sanctioned level and caused overtopping of the open lined section in several places. The members of the WUA purchased materials and added several inches of freeboard to the effected areas.

In Kandiaro, the lining of watercourse 2L was completed before the lining of Abji minor was begun.

A. Role of WUA/farmers in Rehabilitation: Specifically, under this participatory approach, the WUA have an approval role in the watercourse design and in the placement of the various control structures. Through their Quality Control Committee, through the provision of labor and through the payment of 25 percent of the required funding, the farmers play a major decision-making role in watercourse rehabilitation.

III. Farmer Training

The results from this full watercourse trial is primarily a function of farmer activities. To realize the full potential of

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farmers were trained in the purpose and use of the recommended improved practices. The general training procedure is described below:

A. <u>WUA Training Role:</u> The WUA's primary training functions were to inform farmers of the training, help ensure their participation, locate and secure suitable training sites on or near the watercourse, and generally assist in coordination. The WUA also invited WUA members from neighboring watercourses to participate in training.

B. <u>Trainers:</u> Trainers were primarily from the TA Team, the SMO and cooperating line agencies such as Agricultural Extension and OFWM. Where particular required skills were not available through these sources, personnel from other organizations such as Seed Corporation, Universities, and commercial fertilizer companies, were used.

C. <u>Length of Training:</u> The length of most training was half a day or less. Generally, it was associated with field days and WUA meetings. Brief, informal "hands-on" training was provided to individual farmers who had specific problems.

D. <u>Training Topics:</u> The training topics were determined by the type of program that was being implemented. Training supported the recommended water management and production packages practices. In all training, timeliness, which strongly influences crop yields, was emphasized.

Watercourse Maintenance
Conveyance Efficiency
Irrigation Scheduling
Irrigation Application/Practices
Improved Seed and Recommended Varieties
Soil and Seed Bed Preparation
Sowing Methods and Rates
Fertilizer Types, Rates and Application Methods

IV. ADVISORY SERVICES

A. <u>Personnel:</u> To test the models, advisory services were made available. The services came from the TA Team and the SMO staff including cooperating line agencies such as OFWM, FID and Agricultural Extension.

B. <u>Methods of Advising Farmers:</u> WUA members received advice during WUA group meetings, through training sessions and demonstrations and through day-to-day personal contacts either in the field or in the SMO.

V. CREDIT

Credit for procurement of non-water inputs has been constrained by changes in the government lending policy and procedures, a reluctance to provide loans to landless tenants, and a lack of interest on the part of various banks. The ADBP was queried about policies which would enable the WUA to secure a loan as a corporate entity, but was told that this was not possible.

The normal practice for farmers who must purchase inputs on credit is to obtain inputs from the local dealers for in kind exchange at harvest. The problems here are that the dealers charge a premium on the inputs sold on credit and purchase the farmers' produce at a discount price. Although the project would have liked to follow up on the credit situation for the watercourse under trial, this was not pursued.

VI. WATER MANAGEMENT

On the trial watercourses in Lasbela and Kandiaro the major thrust of water management was through improvement of irrigation scheduling. Farmers generally lack knowledge of some important aspects of plant-soil-water relationships, including rooting depths, water supply flow rates and the relationship between irrigation application time, available flow rate in the watercourse, field area and needed depth of applied water. Farmers seem to relate crop growth and irrigation occurrences to days after sowing rather than crop growth stage progress. Better timing of irrigations can provide significant benefits in water and fertility even without controlling the amount applied.

On watercourse 24 in Lasbela the farmers had been irrigating with tubewell water only for the past two years, there was very little over irrigation. Because the farmers paid the cost of pumping from tubewells from their own pockets, farmers were careful with water management. Because of the costs involved, the less fertile land was not cultivated and on the better land, high value crops, particularly fodder was common. However, there was a very poor understanding of the relationship between plant growth and irrigation.

In Kandiaro, farmers on the trial watercourse were experienced irrigators, but there was poor management of the water. As in Lasbela, the problem derived primarily from a misunderstanding of the relationship between plant growth and irrigation. Contributing to over irrigation on watercourse 21 was a tampered turnout from the minor from which they were receiving 50%-75% more flow than sanctioned by the irrigation department.

Computer generated irrigation schedules for Lasbela and Kandiaro were developed from a computer model using agro-climatic data from the local area. In Lasbela, the irrigation scheduling

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calendar was implemented on two demonstration plots. These demonstration plots had a total of about four acres. In Kandiaro it was implemented on three plots of three to four acres each. A "Basic Advisory Service" with proposed irrigation scheduling information was provided to the farmers of the demonstration plots and the WUA as a whole. In one plot in each of the project areas an "Extended Advisory Service" was provided in which more detailed water flow rate and application time information was given to the farmer and this data recorded during irrigations.

A. **Watercourse Maintenance:** In both Lasbela and Kandiaro the WUAs developed a watercourse inspection and maintenance program/schedule to maintain water control, minimize conveyance losses, and ensure equitable water delivery to each farm on the watercourse.

B. **Water Availability/Cropping Patterns:** Through a TA Team developed computer program, the cropping pattern/intensity was matched to the available water to avoid plant-water-stress and thus maximize crop production.

C. **Improved Leveling:** Farmers improved leveling (planking) to promote even distribution of water, uniform crop-stands, to minimize irrigation time, to save water and to increase yields.

D. **Irrigation Scheduling:** Through the process of evapotranspiration, soil water gradually diminishes to a critical plant-water-stress level resulting in reduced crop yield or possible plant death. Irrigation schedulings are procedures for periodically assessing the soil water status, determining the water deficit, and restoring the soil-water depletion by timely irrigation procedures to avoid the onset of plant-water-stress and the associated reductions in crop yields.

For the 1990 Kharif season, irrigation scheduling, was base on development of the crop, inspections and assessment of the soils in the root zone. In the Rabi season, scheduling procedures were based on a computer analysis of historical and current weather data. The scheduling programs available for Balochistan include an irrigation calendar which predicts when each crop should be irrigated and the amount of water required. A stress warning system was used which informs farmers of impending stress conditions for each crop so that, following his visual assessment of soil-water conditions, he decides which crop receives water. A corrective use scheduling program which advises when [illegible], how much to irrigate, how long the [illegible] must operate to provide the additional [illegible]

required etc. All the scheduling program will make corrections for rainfall received. The advantage of computer based irrigation schedulings is that they tell when to irrigate, what crops to irrigate and how much to irrigate and therefore conserve water and reduce the probability of stress-related yield. Additionally, because they rely on historical data, they can, within reasonable probability, predict possible stress periods. All these programs make adjustments for current rainfall. Although they are complicated in their development, their implementation will be simple and entirely within the capability of farmers.

E. Application Practices: Only surface application irrigation methods were used. Because of the shortage of project time, the lack of required equipment, lack of training, etc., the non-traditional irrigation methods such as sprinkler and drip irrigation were not tested during these trials. The models recommend and utilized "basin flooding" and various adaptations. One adaptation will be the method presently recommended in Kandiaro. Each acre is divided into quarters and each quarter irrigated sequentially. The smaller plots allow more uniform distribution.

F. Instruction/Training: Farmers were trained in the various components of water management (including irrigation scheduling) through farmer days, demonstrations, and WUA meetings. The instructors were TA Team members, SMO staff including staff from cooperating line agencies.

VII. IMPROVED PRODUCTION PACKAGES

A. Crop Selected: All crops selected for a particular subproject area will be compatible with agroclimatic conditions and have a local market demand. These crop varieties will be recommended for their area; the seed will be certified seed secured either from the provincial Seed Corporation or from the several large commercial seed production organizations.

B. Soil and Seed Bed Preparation: Soil preparation will primarily be done with local farmer equipment and procedures. The soil will be plowed and improved - leveled to promote even, rapid distribution of water in the basins and uniform crop-stands. In the Punjab, with cotton, raised beds will be utilized; these will be built with a bed shaper available through the Project.

C. Sowing: Both early and late varieties will be sown at the recommended times. Generally, seed [illegible]

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broadcast crosswise to ensure there are no gaps in the crop-stand. In the Kandiaro area, broadcasting is essential, because the heavy soils (clay) make line sowing (drilling) difficult. The cloddy soil will not break down sufficiently fine to allow line sowing. In the other provinces, drilling will be permitted where equipment is available. The emphasis will be on timely sowing and proper seed coverage. Seed will be sown at the rate recommended for certified seed. Because of the high viability of certified seed, the sowing rate (kgs/acre) is usually 10-20 percent less than farmer seed. WUAs will be helped by the TA Team Agronomist and Agricultural Extension personnel in the timely procurement of seed.

D. **Fertilizers:** Balanced fertilizers (proper combinations of nitrogen and phosphorous) will be applied. For field grains, the rate will normally be 1 bag urea and 1 bag DAP or some other equivalent applications. For cotton and vegetables, larger amounts of fertilizer are required. Again, the timeliness of application is critical as is the use of both nitrogen and phosphorous. The TA Team's Agronomist and the cooperating Agricultural Extension personnel will assist the WUAs in the timely bulk procurement of recommended fertilizers.

E. **Weeding:** Although weeds in farmer fields rob the crops of both water and fertilizer nutrients, the project had limited success in getting the farmers to do any but the most limited weeding in the wheat and fodder crops. Hand-weeding was recommended in most cases, but the project did provide some chemical weedicide. One problem is that farmers tend to view weeds as an auxiliary crop: mature weeds are often cut and used as green fodder for dairy animals. The farmers consider weeds to have considerable economic value. It should be noted that the farm gate price of a unit of wheat grain and wheat straw (including weed residue) is about equal. Cutting the mature, but still green weeds is a task usually performed by women and by leaving the weeds to mature, it relieves the men of an arduous task of weeding the young weeds when they have no economic value. Weeding was recommended early in the season when weeds are easy to pull or hoe and accessible. In the instances when this was done, farmers were pleased with the results, but this didn't catch on generally.

F. **Seed Production/Exchange:** The project planned to increase the availability of improved wheat seed in the project areas, by selecting [illegible] farmers with a weed free and well rogued crop to produce a seed-crop for sale to or exchange with other [illegible] farmers. They were to be trained in roguing, [illegible], clearing the

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seed, treating the seed, storing seed, etc. At harvest, this seed was to be sold (or traded) at a premium price to other WUA members or farmers from neighboring watercourses. This exercise was to be used as a first step in demonstrating the value of high quality seed production. The second step was to develop contacts between the WUA farmers and the Sindh Seed Corporation to develop seed multiplication contracts with selected farmers on the watercourse.

G. **Instruction/Training:** Training in the improved production activities were coordinated through the WUA. Training sessions with the WUA members from watercourse 24 and neighboring watercourses were held at the field site. Training of farmers was presented by the TA Team Agronomist, cooperating line agencies. Training formats and materials included lectures, practical demonstrations in the field, and video cassettes.

Annex H

Improved Irrigation Techniques for Cotton in Punjab

ANNEX H

Improved Irrigation Techniques for Cotton in Punjab

by

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Punjab

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Draft

118

TABLE OF CONTENTS

Title	Page
SUMMARY	1
INTRODUCTION	1
OBJECTIVES OF PROGRAM	3
REVIEW	
TRADITIONAL PRACTICES	4
Sowing	5
Irrigation Application	5
Weed Eradication	5
METHODOLOGY	5
Site Selection	7
Criterion of Comparison	7
Implementation	7
Data Collection	7
RESULTS	8
Water Saving	9
Crop Yield	9
Salt Movement	10
PROBLEMS FACED DURING IMPLEMENTATION OF TRIALS	12
Design Problems	12
Operational Problems	13
Fallow up Problems	14
RECOMMENDATIONS	15
REFERENCES	16

119

SUMMARY

The report summarizes the outcome of trials on irrigation techniques under cotton crop carried out during Kharif season of 1990 at Pakpattan and 6R Hakra sub projects under the Command Water Management Project.

The planning, execution and data collection for these trials were done by the water Management Specialist of the Technical Assistance Team, ARDINC Lahore in consultation and coordination with the staff of Command Water Management, On Farm Water Management and the Adaptive Research wing of the Department of Agriculture Punjab. The data collection was assisted by Mr. Khalid Mahmood of ARDINC and field staff of the line agencies.

Both Haroonabad (6R Hakra sub project) and Vehari (Pakpattan sub project) fall in the cotton zone but with distinct characteristics of soil, groundwater, climate, suitability to crop varieties and irrigation water supply system.

The field trials mainly comprised testing of irrigation techniques such as Border/Basin, furrow-ridge and furrow-bed methods of irrigation to develop and demonstrate methodology that can allow the farmers to use their water resources more efficiently and improve farm income. Except at one location the trials concluded a saving of irrigation water ranging ~~farm~~ 25 to 53 percent in case of furrow-bed and 24 to 33 percent under furrow-ridge irrigation as compared to the water applied under flat border/basin irrigation method. The cotton yield also improved by 6 to 52 percent at 6R Hakra but decreased by 2 to 10 percent at Pakpattan sub project. Saving of water accompanied by improvement in yield is a break through for the farmers with constrained water availability. The salt movement through the beds improved the soil plant environments for better plant growth. A number of problems associated with the design and operation of bed shaper and ridger were identified. The farmers were encouraged by the water saving and improved crop yields but conditionally approved the use of beds for cotton crop.

INTRODUCTION

Pakistan is primarily an agricultural country. Total commanded area is estimated to be 34 million acres. Cotton stands as one of the major cash crops which not only satisfies the fibre needs of the country but also a source of foreign exchange earning. Cotton seed contributes to 55% of the edible oil production (Javaid and Khoso, 1986).

In view of the importance of cotton crop, the area under cotton crop is increasing each year. In 1985-86 4.3 million acres or 12.7 percent of the CCA was under cotton crop which increased to 14.9 percent of the CCA during 1989-90.
Although cotton yield is far below the potential, yet efforts are

120

being made to increase the per acre yield. In 1985-86 the average yield of cotton was 223 kg/acre (18.07 mounds/acre) where as in 1989-91 the average yield has been estimated as 252 kg/acre i.e. 20.25 mounds/acre (Adaptive Research Punjab, 1990).

The major constraints on cotton production include limited farmers' resources, unavailability of right kind and amount of fertilizers, high cost of inputs such as seed, fertilizer and chemicals; illegal mixing of fertilizers and chemicals, and above all, the shortage of irrigation water.

Although Pakistan's irrigation system is the world's largest contiguous irrigation system, yet it faces water shortages in most of its irrigated areas, as crop water requirements exceed the available water supplies during the periods of highest demand.

The canal system in the Indus Basin delivers water to the irrigated areas at the rate of 1 cfs to 330 acres in the non SCARP areas, and 1 cfs to 150 acres in SCARP areas at a fixed weekly or 10-days rotation schedule. Each farmer/share holder on a watercourse receives the full watercourse supply for the period of time proportional to the area of his holding.

Low water conveyance and application efficiencies combined with inequity of water distribution, poor land levelling and traditional irrigation methods (flooding or basin irrigation) have resulted in low cropping intensities and crop yields. Therefore it is evident that more cost effective means of increasing water availability must be pursued. The On Farm Water Management program that mainly focusses on watercourse improvement has contributed positively in improving the conveyance efficiencies. Maximum benefits of such a program could only be realized if efficient means of utilizing the available water supplies at the farm are adopted. The existing situation of water logging and salinity in many parts of the country further emphasizes the need to utilize the available canal water supplies most efficiently.

The four sub project areas of the CWM in the Punjab are Commanded by Niazbeg, Shahkot, Pakpattan and 6-R Hakra distributories. Niazbeg and Pakpattan sub projects are underlain by sweet ground water and therefore receive additional ground water supplies. In Shahkot the groundwater is marginally useable, where as in 6R Hakra the ground water is totally unfit for irrigation. Further, the distribu-tories of Hakra canal operate on warabandi delivering full water supplies for one week followed by reduced water supply in 2nd and almost no water supply in the third week. During the two weeks period the flow necessarily depends on the available discharge in Hakra canal. The water logging and salinity in 6-R Hakra further aggravates the situation. Thus the 6-R Hakra sub project is the most affected irrigated area with a high degree of shortage and uncertainty and therefore needed priority consideration for implementing water management

121

programs.

Pakpattan sub project on the other hand constitutes useable groundwater. However the canal water supply is much below the crop water requirements and therefore the farmers have to supplement with tubewell water. The tubewell water being a costly substitute needs to be minimized by improving the water management at farm level. Therefore, the water saving through irrigation techniques was also extended to the Pakpattan sub project. Both the 6-R Hakra and Pakpattan sub projects fall in cotton growing zone. Therefore demonstration of water saving techniques was tried on cotton crop in both the selected field areas.

During planning phase of the technical Assistance team activities in early March 1990, trials on irrigation techniques on cotton crop were included to demonstrate the benefits of furrow-bed and furrow-ridge irrigation techniques to the farmers of CWM project areas. In view of the acute shortage of available water supplies at 6-R Hakra sub project, the demonstration of water saving through irrigation techniques was considered a useful activity during Kharif 1990 season.

OBJECTIVES OF PROGRAM

The master work plan of the ISM/Command Water Management (1989) described the overall goals and objectives of the project as:

> "The goal of the Irrigation System Management (ISM) project, of which the Command Water Management (CWM) program is a component, is to increase agricultural production and farmer income by improving the management of irrigation water resources. The CWM program contributes to this goal by introducing new approaches in irrigated agriculture which <u>optimize the use of water resources</u> for agricultural purposes."

The specific objectives pertaining to the water management component of the project where the Water Management Specialist was most concerned include:

1. Substantially increased agricultural production in selected pilot areas through improved water management i.e. by delivering water in response to the crop water requirements to the maximum extent possible, and to integrate into this program the necessary agricultural support services and non water inputs.

2. Develop water management techniques and programs replicable over a wide range of agro-climatic zones, and land and water environments for subsequent application in other parts of the country.

122

Developing replicable water management techniques is the key to achieving the above mentioned objectives. Therefore a set of workable field programs were needed to be implemented in the sub projects with a close coordination of the line agencies of the GOP and Technical Assistance Team that should not only benefit the farmer in increasing crop production but also should be reproducable by the Government agencies and adaptable by the farmers without external aid following the end of project. With this motive in mind the program of irrigation techniques was initiated to utilize the available water supplies most efficiently, particularly in the areas of acute water shortage or where the water was considered as a major constraint on crop production.

REVIEW

Based on the research conducted at the University of Agriculture,Faisalabad, sowing of maize on ridges and beds saved irrigation water to about 12 percent and 30 percent respectively, as compared to border irrigation. Currently, the farmers' practice is to plant cotton on flat basins followed by ridging about 40 days after planting, in order to eradicate weeds. Such practice may eventually save some water, but the crop remains exposed to the danger of submergence under rains expected at the time of germination as well as during monsoon season. Therefore, the Water Management Specialist planned in consultation with the farmers and the SPM, CWM to introduce the planting of the cotton crop on ridges and beds. During our visit to the coordinated watercourse at 6R Hakra Sub Project the farmers showed great interest in the introduction of the proposed irrigation techniques on their fields.

Khurshid and Bashir (1990) have also evidenced the benefits of cotton raising on ridges as compared to sowing on flat. These benefits have been observed to include increased production, water saving, safety against risk of submergence and better plant growth particularly on saline soils.

Merrey and Langah (1979) concluded through field experiments at Mona Reclamation Project that the respondent farmer was impressed with the usefulness of beds and furrows particularly in relation to the protection against surface crust formation and heavier rains. The farmer was encouraged to plant cotton on beds with certain modifications in cultivation practices and easier access to the economical bed shaping equipment.

TRADITIONAL PRACTICES

Traditionally, the cotton growers follow the following practices regarding the sowing, weed eradication and irrigation application of cotton crop.

Sowing

Sowing of cotton is accomplished on flat fields in three traditional ways after preparing the seed bed.

(a) The farmer drops seed behind the plow driven by a pair of bullocks in a shallow furrow cut by the plow. This is traditionally called Kera.

(b) A pore is attached behind the plow using a pair of bullocks. The seed is dropped through the pore in a shallow furrow cut by the plow, called Pora.

(c) Sowing with tractor drawn cotton drill.

(d) Cotton sowing on a flat field, followed by ridging when the crop is almost 1 ft high.

Irrigation Application

Traditionally basin method of irrigation is practiced by the farmers which necessarily means application of irrigation water on flat diked field comprising one-fourth to one acre area. The same has been termed as Flat/Basin or Border Irrigation in this report. Generally a farmer tends to apply as many irrigations as he deems necessary subject to the crop soil condition and the availability of water under the prevailing Warabandi System. The time of application mainly depends on when the water reaches the farther end of the field.

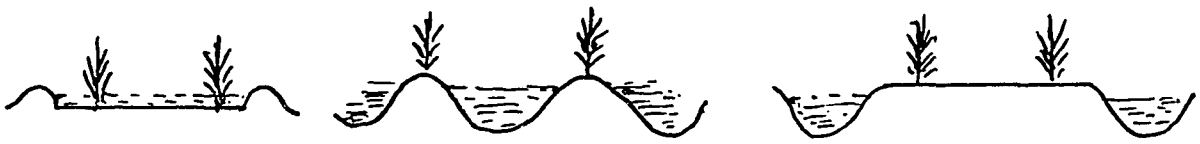
Weed Eradication

Eradication of weeds is accomplished either by chemical means or by mechanical means using a three tine tiller (Tarphali) or by plowing in between the plant rows. In some cases a ridger may be used after first irrigation that develops a furrow between plant rows and moves soil towards plants and strengthens plant stand. These practices help to eradicate weeds in addition to opening the soil. The furrows thus developed also save irrigation water to some extent.

METHODOLOGY

The cotton crop trials on improved irrigation techniques were implemented during the Kharif season of 1990. These improved irrigation techniques consisted of furrow-ridge and furrow bed methods to demonstrate a more efficient use of irrigation water as compared to traditional practices of basin or border irrigation (i.e. irrigation on flat fields). Fig. 1 shows the schematic diagram of the above named irrigation techniques.

124



Flat Furrow-Ridge Furrow-Bed

Fig. 1: Schematic Deagram of Irrigation Techniques

Site Selection

Four farms in 6-R Hakra and two in the sub project were chosen to demonstrate the benefits of sowing on beds and ridges as compared to sowing on flat fields. The selected farmer fields were located on the coordinated watercourses in both sub project areas. One of the sites at Vehari was located at the Adaptive Research Farm of the Department of Agriculture. This site was specially chosen to provide an opportunity to the line agency to directly participate in the program. The senior subject specialist (Engineering) took keen interest in the program. The Water Management Specialist and Agricultural Officer of the On-Farm Water Management Project at Haroonabad took part during the implementation process. One of the sites chosen under this activity was the Technology Transfer Center of the On-Farm Water Management. Therefore, this activity was carried out with full participation of the cooperating line agencies and farmers. Each irrigation activity covered at least one acre field at each site. Furrow-bed irrigation was tried at all locations but furrow-ridge irrigation was included only at two locations in 6R-Hakra and one location at Pakpattan sub project.

Criterion of Comparison

The trials on cotton were mainly focussed to demonstrate saving of irrigation water through various soil shaping and irrigation techniques. Primarily, furrow method was used to irrigate cotton through furrow-ridges and furrow-beds and was compared to the basin or border irrigation (irrigation on flat field). The criteria of comparison was based on the time taken to accomplish individual irrigation as well as total time taken to complete all irrigations under each technique.

Implementation

The beds were constructed using a bed shaper that was originally constructed at Mona Reclamation project during 70's. The bed shaper was tested at Mona Reclamation project in cotton experiments by research team from Colorado State University. Later, the same bed shaper was used for many years to carry out

115

research on maize crop at Shahkot project area by the Water Management Research project, University of Agriculture, Faisalabad. The research on maize crop showed a significant saving of irrigation water amounting to as much as 40 percent by furrow-bed irrigation technique. The furrow-ridge irrigation techniques also saved considerable amount of water ranging from 10 to 15 percent.

Necessary modification in the design of bed shaper was incorporated to allow the desired row to row distance for cotton crop. The original design permitted row to row distance of 20 inches that was not suitable for cotton crop. Plate 1 shows the bed shaper developed for the reported trials.

Sowing of cotton on ridges was accomplished with the help of a ridger. For this purpose, manually operated pores were attached to the ridger which was available from the machinery pool of the coordinated watercourse. The ridger alongwith planting attachment is shown in plate 2. The cotton seeds were placed at the sides of beds and top of ridges. Sowing on flat field was accomplished by the farmer in his traditional way i.e. with pore attached to the traditional wooden plow.

Plates 3 and 4 show the sowing of cotton on beds and ridger in progress respectively.

NIAB 78 variety of cotton was planted at all sites in Haroonabad and one site in Vehari. At Adaptive Research Farm S12 variety was tried. The recommended doses of fertilizer were applied by the farmer.

At Adaptive Research Farm the beds and ridges were developed using bed shaper and ridger respectively but sowing was accomplished with manually drawn single row drill.

The time and amount of irrigation applied under each technique was based on farmer's judgement. The farmer usually filled the furrows to a depth permitted by the plant location. However in a few cases water overtopped the beds or ridges. Under such circumstances the farmer was advised to avoid overtopping of beds or ridges.

To update the knowledge of farmers for better understanding of the program necessary field training was imparted to the farmers. The training focussed on soil-water-plant relationship, gravity and pressurized irrigation methods, benefits of sowing on beds and ridges and methods to improve irrigation efficiency.

Data Collection

The trials were designed to collect the following data at each site to provide a comparison between various irrigation techniques.

126

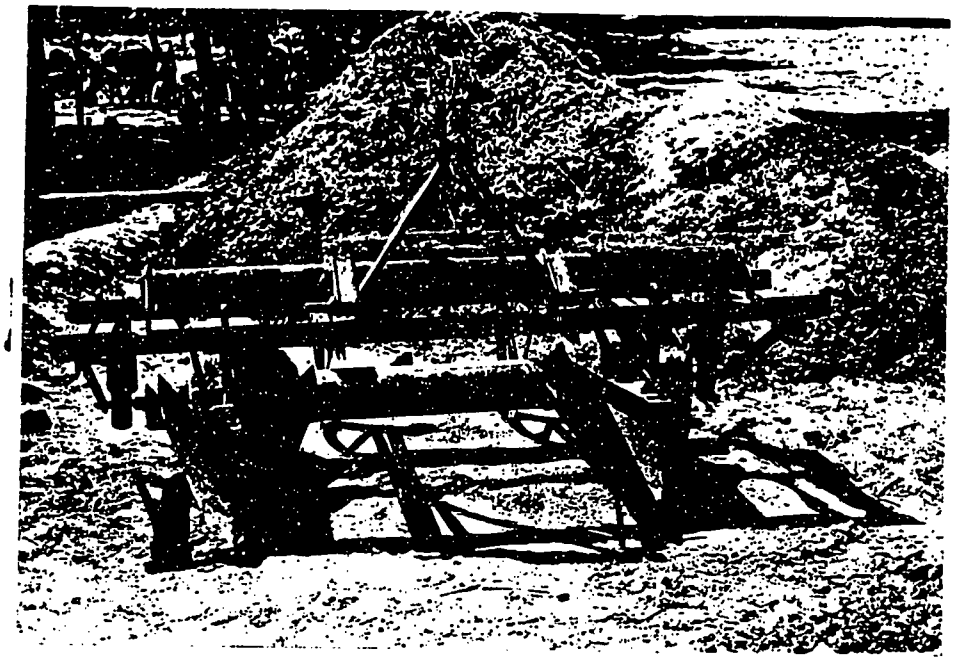


Plate 1: Bed Shaper with Seeding Attachment

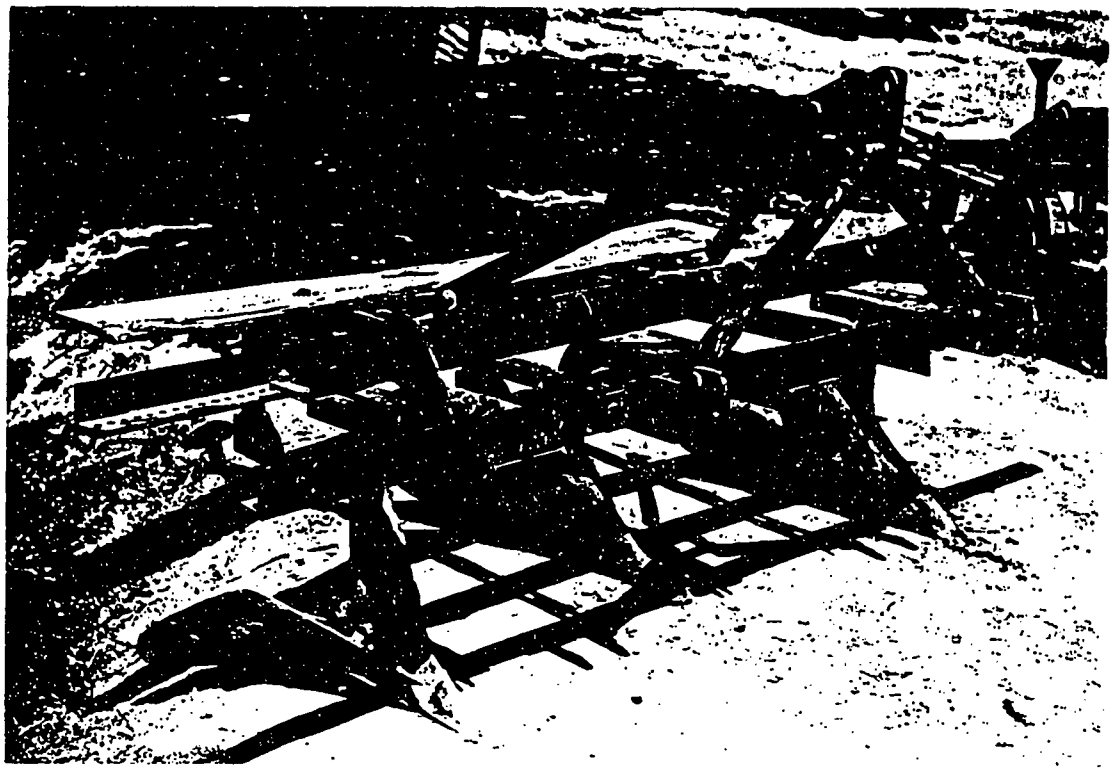


Plate 2: Ridger with Seeding Attachment

Plate 3: Construction of beds and Cotton sowing in Progress

Plate 4: Construction of Ridges and Cotton sowing in Progress

- Irrigation amounts applied per acre under each irrigation technique. This required monitoring of sources of water supply, available flow rates from each source and number of irrigations applied during the season.

- Crop yield per acre obtained from each irrigation treatment. This was also supported by the measurement of areas under various irrigation treatments.

- Chemical analysis of soil after sowing and before crop harvest to determine the salt movement as affected by the irrigation treatments through the growing season.

During implementation of the trials, the Director CWM suggested to drop off measurement of flow rates as only the time of irrigation would be able to provide a reasonable comparison of irrigation amounts needed under each irrigation treatment as the sources and water supply rate would influence all treatments equally at a given site. Thus flow measurement was dropped off at 3 sites in Haroonabad and one site at Vehari. However in view of the significance of flow measurement in estimating the correct amount of irrigation water applied to a field, flow measurement with the help of cut throat flume was carried out at two sites in 6-R Hakra and one site in sub projects.

The yield data collection was accomplished by the field staff incoordination with the farmer through various pickings that continued from November 1990 through January 1991.

As a result of soil surface shaping in the form of furrows, ridges and beds followed by irrigation applications, the salts were expected to move towards higher locations and towards centre of the beds. Movement of salts from bottom and sides of beds to the centre of the beds (i.e. out of plant root zone) would facilitate better plant growth, where as movement of salts at the top of ridges (i.e. towards plant zone) may adversely affect plant growth. Therefore soil samples were collected from one site at Haroonabad (Khadim Hussain farm) and one site at Vehari (Adaptive Research Farm) for incremental depth of 15cm from top of ridges, within furrows, and the sides and centre of beds. Further, the flooding on flat fields could also change the salinity level of the top soil. Therefore samples from flat fields were also collected to compare vertical as well as lateral movement of salts in basin, ridges and beds.

The soil samples were analysed at Soil Testing Laboratory. Adoptive Research Station, Vehari for total soluble salts (TSS)and soil PH.

RESULTS

The primary purpose of the irrigation techniques trials was to demonstrate their water saving capability and improvement of their water application efficiency. However, for economic considerations, crop yield data is an important component of such trials. Therefore yield data were collected through various pickings during the month of November and December. The data collection on irrigation water was completed by the end of the Oct or early part of Nov 1990.

Table 1 shows the number of irrigations, time taken by individual irrigations and total seasonal time of irrigation applied per acre under flat, furrow-ridge and furrow bed irrigation techniques during Kharif season for cotton crop. The cotton yield for various irrigation techniques is summarized in Table 2.

Table 3 shows the saving of irrigation water (based on individual irrigation and total seasonal irrigation time per acre) and yield improvement under furrow-bed and furrow-ridge irrigation techniques as compared to flat border or basin.

Water Saving

The comparison of irrigation amounts and the saving in irrigation water under each irrigation technique can be based either on individual irrigation or all irrigations applied through the season. Some farmers believed that furrow-ridge and furrow-bed methods require smaller amounts but more frequent irrigations as compared to basin or border irrigation. Table 1 shows the total seasonal time as well as average time taken per irrigation (minutes/irrigation/acre).

The estimated water saving based on individual irrigation time (table 3) showed that the furrow-bed irrigation saved from 27 to 54 percent, where as furrow-ridge saved about 24 to 35 percent of time needed under flat irrigation.

On seasonal basis the amount of saved water, as presented in Table 3, ranged from 25% - 54% for the furrow-bed irrigation and from 24%-34% for the furrow ridge irrigation as compared to flat irrigation.

The water saving estimated on the basis of individual irrigation remained higher than that estimated on seasonal basis as the farmers tended to apply more irrigations to beds. This intention was merely out of their fears that furrow-beds stored less water and therefore would exhaust earlier. With this assumption the farmer at site 6 applied excessive irrigations to beds resulting in an excessive irrigation of about 17 percent in case of beds. These excessive irrigations were partially attributed to the short root system developed as a result of irrigation applied just after germination.

130

TABLE-I: COMPARISON OF IRRIGATION WATER APPLIED UNDER VARIOUS IRRIGATION TECHNIQUES FOR COTTON DURING 1990

IRRIGATION TECHNIQUES	IRRIGATION NUMBER	SITE NUMBER 1	2	3	4	5	6
BORDER/ BASIN (FLAT)	1	120	90	110	105	86	90
	2	75	90	100	90	60	75
	3	35	75	93	75	70	70*
	4	45	90	85	75	60	70
	5	67	95			60	120*
	TOTAL SEASONAL TIME (MINUTES)	342	440	388	345	336	425
	MINUTES/IRR.	68	88	97	86	67	85
	AREA (ACRES)	1.15	0.89	0.89	0.87	0.34	1
	MIN./IRR./ACRE	59	98	108	99	194	85
FURROW RIDGE	1	50	45			43	
	2	40	45			50	
	3	45	47			62	
	4	30	44			50	
	5	45	45			50	
	TOTAL TIME	210	276			255	
	MINUTES/IRR.	42	55			51	
	AREA (ACRES)	0.94	0.86			0.34	
	MIN./IRR./ACRE	44	64			148	
FURROW BED	1	45	40	90	35	37	75
	2	35	40	70	30	40	60
	3	45	40	65	30	67	60
	4	25	41	65	30	45	70*
	5	45	38			50	45
	6						40
	7						57
	8						90*
	TOTAL TIME (MINUTES)	195	199	290	125	239	497
	MIN./IRR.	39	40	72	31	47	62
	AREA (ACRES)	0.94	0.88	0.89	0.42	0.34	1
	MIN./IRR./ACRE	41	45	81	73	136	62

* TUBEWELL WATER ONLY

TABLE-2: COTTON YIELD (MAUNDS) IN 6R HAKRA AND VEHARI SUB PROJECTS DURING 1990 AS AFFECTED BY IRRIGATION TECHNIQUES

FARMER/FARM	VILLAGE	COTTON VARIETY	IRRIGATION TECHNIQUES	PICKING NUMBERS 1	2	3	4	5	TOTAL YIELD (Mds)	AREA (Acre)	YIELD Mds/ Acre
KHADIM HUSSAIN	95/6-R	NIAB 78	FURROW-BED	7.00	6.80	4.75			18.55	0.94	19.73
			FURROW-RIDGE	7.00	5.15	3.25	-	-	15.40	0.94	16.38
			FLAT		10.50	9.50			20.00	1.15	17.47
MOHD SALEEM	95/6-R	NIAB 78	FURROW-BED	5.25	14.23				19.47	0.88	22.13
			FURROW-RIDGE	5.75	13.13	-	-	-	18.87	0.86	22.07
			FLAT	8.00	13.15				21.15	0.90	23.63
ABDUL SATTAR	94/6-R	NIAB 78	FURROW-BED	2.50	8.00	13.50			24.00	0.89	26.97
			FURROW-RIDGE				-	-	-	-	-
			FLAT	2.50	7.75	11.25			21.50	0.89	24.16
MOHD NAWAZ	94/6-R	NIAB 78	FURROW-BED	1.60	2.53	1.75	1.25	1.00	8.13	0.42	19.35
			FURROW-RIDGE						-	-	-
			FLAT	1.58	3.45	2.10	2.35	1.50	10.97	0.87	12.64
ADAPTIVE RESEARCH FARM	VEHARI	S 12	FURROW-BED						10.73	0.35	30.64
			FURROW-RIDGE						-	-	-
			FLAT						10.98	0.35	31.37
KHURSHID AHMAD	28/W-B VEHARI	NIAB 78	FURROW-BED	3.25	5.50	5.50	3.40		17.65	1.00	17.65
			FURROW-RIDGE						-	-	-
			FLAT	3.00	5.25	5.37	6.00		19.62	1.00	19.62

Md = Maund (40 Kg)

TABLE-3: COMPARISON OF TIME OF IRRIGATION AND COTTON YIELD AS AFFECTED BY IRRIGATION TREATMENTS

IRRIGATION TREATMENT	S1			S2			S3			S4			S5			S6		
	FLAT	RIDGE	BED	FLAT	RIDGE	BED	FLAT	RIDGE	BED	FLAT	RIDGE	BED	FLAT	RIDGE	BED	FLAT	RIDGE	BED
Individual Irrigation																		
Time Applied (Min./Irr./Acr)	59	44	41	98	64	45	108	-	81	99	-	73	194	148	136	85	-	62
Saving (Percent of flat)	0	25.4	30.5	0	34.7	54	0	-	25	0	-	30	0	-	27	0	-	27
Seasonal Irrigation																		
Total Irrigation Time (Min./Acre)	298	223	207	491	325	226	436	-	326	397	-	297	976	741	694	425	-	497
Saving in Irrigation Time (Percent of flat)	0	25.16	30.53	0	33.8	53.97	0	-	25	0	-	25	0	24	28.89	0	-	-16.94*
Yield																		
Yield/Acre	17.47	16.38	19.73	22.63	22.07	22.13	24.16	-	26.97	12.69	-	19.35	31.39	30.64	-	19.62	-	-17.65
Yield Increase (Percent of flat)	0	-6.23	12.93	0	6.34	6.34	0	-	11.64	0	-	52.48	0	-	-2.32	0	-	-10.00

* EXCESSIVE WATER APPLICATION IN CASE OF FURROW-BEDS AT SITE 6 WAS DUE TO EXCESSIVE NUMBER OF IRRIGATIONS APPLIED BY THE FARMER

Crop Yield

The cotton yield from bedded fields increased at almost all locations in Haroonabad and ranged from 6 to 52 percent. In Vehari, however, the yield decreased by 2 percent at Adaptive Research Farm and by 10 percent at Khurshid Farm. The decrease in yield at Adaptive Research Farm, although very small, may be associated with cotton variety S12 which is thought to be more sensitive to water deficits as compared to NIAB 78. The yield reduction at Khurshid Farm may be due to over irrigations. Further it may be concluded that the furrow-bed method proved better at Haroonabad than at Vehari for reasons that may be explained later by salt balance created by furrow-beds.

At Pakpattan sub project the yield from flat border remained higher than beds at both sites (0.73 mounds/acre at Adaptive Research Farm and 1.97 mounds/acre at Khurshid Farm). Although the factors responsible for such a change in the relative performance of irrigation techniques in two sub projects remained unknown, it may be very well related to the soil salinity, cotton variety and uncertainty of irrigation water supplies.

With furrow-ridge irrigation, the yield decreased by 6 percent at one location and increased by 6 percent at another location. Results indicate that the furrow-bed method of irrigation showed promising potential both in terms of saving of water as well as improving cotton yield.

As shown in Table 3 the average per acre yield of cotton obtained from flat fields ranged from 12.69 mounds (507 kg) to 24.16 mounds (966 kg) in Hakra sub project. Under furrow-bed method the per acre yield ranged from 14.25 mounds (570 kg) to 26.97 mounds (1078 kg). The furrow ridge method gave 16.38 and 22.07 mounds at two sites. Thus the per acre yield obtained from furrow-bed irrigation technique remained the highest among the tested irrigation techniques in 6R Hakra sub project.

Inspite of the problems associated with the bed shaper design and the cultural practices, the furrow-bed method has shown its worth and should encourage farmers to adopt this improved irrigation technique. During personal discussions, the farmers indicated their interest in the program, provided the problems of the design and operation of the bed shaper are taken care of. Therefore, it is recommended that the bed shaper design should be reviewed and updated to meet the field demands as observed during the reported trials.

As the farmers gain more experience in the use of the furrow-bed irrigation equipment, the benefits may be realized better. The results of the trials on efficient utilization of water and improved crop yield through improved irrigation techniques are consistent with the objectives of Command Water Management for developing replicable water management programs since they

134

encourage the adoption of these techniques by both the farmers and the scientists.

Although the furrow-ridge irrigation method also showed an appreciable saving in irrigation water compared to basin irrigation, this method was observed to suffer from poor germination due to accumulation of salt and therefore reduced yield at certain locations.
The farmers have shown interest in replicating furrow bed irrigation technology subject to the improvements in the design and operational aspects of the bed shaper. They however, seem to be reluctant in sowing on ridge tops particularly in Haroonabad because of the salinity imbalance as discussed below.

Salt Movement

Table 4 and 5 summarize the results of soil chemical analysis at Khadim Farm (6-R Hakra) and Adaptive Research Farm (Pakpattan sub project), respectively. Generally the salinity at Khadim's farm was much higher than that at AR Farm with average total soluble salts (TSS)being 387.5 and 302.5 respectively. Moreover Khadim Farm had relatively more heterogenous salinity distribution where as the soil at AR Farm had homogeneous salinity distribution over the field.

Two parameters of soil salinity namely Total Soluble Salts (TSS) and PH have been presented to predict the salt movement as affected by various irrigation techniques. PH at Khadim field generally increased at varying degrees under each irrigation treatment, while at AR FArm, it remained almost constant over the cotton growing season.

Localized salt movement as a result of soil surface shaping and subsequent irrigations was observed and evaluated by comparing the salinity status after sowing (i.e. beginning of growing season) and before harvest (i.e. end of growing or irrigation season) at each location of trials. Since there was a great variation in salinity among the tested locations particularly at Khadim's Farm, it seems difficult to draw general inferences regarding the potential of salt movement under each treatment. Further each irrigation technique behaved differently at both locations. Therefore, salt movement as influenced by irrigation treatment is described independently at each location.

A) Khadim Farm

As observed from table 4 there was a significant decrease in TSS ranging from 13 to 75 percent under flat irrigation technique over the season. The PH was, however, found to increase by 0.2 to 0.5 with, relatively greater increase in the top 15 cm depth.

Under furrow-ridge irrigation technique the soluble salts concentration increased in the central zone of the ridge with top

135

Table-4: Impact of Irrigation Techniques on Salt Movement During Cotton Crop Season (1990) at Haroonabad

Site	Irrigation Technique	Replication	Sample Location	Sample Depth (cm)	Soil Chemical Status: After Sowing TSS	After Sowing PH	Before Harvest TSS	Before Harvest PH	Perc TSS Increase/ Decrease
Khadim Farm	Flat/Borde	1	Centre	0-15	280	8.3	280	8.6	0.0
6R Hakra				15-30	270	8.3	235	8.5	-13.0
		2		0-15	620	8.0	150	8.5	-75.8
				15-30	380	8.4	190	8.7	-50.0
	Ridge	1	Centre	0-15	470	8.0	620	8.5	31.9
				15-30	410	8.2	690	8.4	68.3
			Side	0-15	250	8.3	220	8.4	-12.0
			Furrow	15-30	470	8.3	350	8.5	-25.5
		2	Centre	0-15	860	8.4	900	8.6	4.7
				15-30	540	8.5	720	8.6	33.3
			Side	0-15	720	8.6	630	8.7	-12.5
			Furrow	15-30	920	8.6	890	8.7	-3.3
	Bed	1	Centre	0-15	820	8.2	900	8.4	9.8
				15-30	570	8.5	810	8.5	42.1
			Side	0-15	950	8.2	220	8.4	-76.8
				15-30	770	8.5	250	8.7	-67.5
			Furrow	0-15	520	8.4	115	8.6	-77.9
		2	Centre	0-15	920	8.1	1030	8.6	12.0
				15-30	600	8.3	850	8.7	41.7
			Side	0-15	1000	8.3	350	8.4	-65.0
				15-30	580	8.4	260	8.6	-55.2
			Furrow	0-15	620	8.2	450	8.5	-27.4

(Negative Values Indicate Percent Decrease in TSS)

Table-5: Impact of Irrigation Techniques on Salt Movement During Cotton Crop Season (1990) at Vehari

Site	Irrigation Technique	Replication	Sample Location	Sample Depth (cm)	Soil Chemical Status: After Sowing TSS	After Sowing PH	Before Harvest TSS	Before Harvest PH	Percent TSS Increase/ Decrease
Adaptive Research Farm Vehari	Flat	1	Centre	0-15	310	8.2	410	8.2	32.3
				15-30	240	8.8	320	8.7	33.3
		2		0-15	320	8.4	440	8.4	37.5
				15-30	300	8.5	330	8.5	10.0
	Ridge	1	Centre	0-15	420	8.1	480	8.2	14.3
				15-30	450	8.2	460	8.2	2.2
			Side	0-15	450	8.4	470	8.4	4.4
			Furrow	0-15	670	8.3	600	8.3	-10.4
		2	Centre	0-15	400	8.3	450	8.3	12.5
				15-30	300	8.5	320	8.4	6.7
			Side	0-15	330	8.3	330	8.3	0.0
			Furrow	0-15	310	8.5	300	8.5	-3.2
	Bed	1	Centre	0-15	390	8.2	440	8.2	12.8
				15-30	290	8.5	320	8.4	10.3
			Side	0-15	370	8.1	430	8.2	16.2
				15-30	280	8.5	310	8.5	10.7
			Furrow	0-15	300	8.4	290	8.4	-3.3
		2	Centre	0-15	350	8.3	410	8.3	17.1
				15-30	280	8.5	300	8.5	7.1
			Side	0-15	380	8.2	460	8.1	21.1
				15-30	350	8.5	390	8.5	11.4
			Furrow	0-15	330	8.4	310	8.4	-6.1

(Negative Values Indicate Percent Decrease in TSS)

15 cm accumulating less salts as compared to the lower 15 cm depth. On peripheral section (Side of ridge) the salts decreased by about 12 percent over the season. Within furrows the salinity level decreased by 3 and 25 percent at both sample location due to leaching phenomenon.

The beds also showed a positive salt movement from sides (plant row) towards centre of the bed (between plant rows) resulting in a decrease of salinity by 60 to 72 percent at bed side and an increase of about 11 percent in the top 15 cm and about 41 percent in the lower 15 cm at the central region of the beds. There was a net decrease of salts (about 27 to 80 percent) in the furrows between beds due to leaching process in the furrows (Plate 10).

Moreover it can also be seen from table 4 that both under the ridges and beds the lower 15 cm depth attracted more salts than top 15 cm, where as at the sides the decrease of salts in the upper 15 cm was more as compared to lower 15 cm depth.

The above mentioned results explain why crop yield would tend to increase on beds under salt affected soils as the salts move out of root zone to facilitate better growth environment. Sowing of cotton on top of ridge reduced yield because of excessive accumulation of salts in the root zone (top as well as lower central region). Cotton planted on the sides of ridges where salinity tends to decreases, would perform better than at the top of ridges in Haroonabad. However no such trial was done to test this hypothesis.

B) <u>Adaptive Research Farm (Vehari)</u>

At Adaptive Research Farm, the salinity in case of flat field increased through the season at each sampled depth. The increase in salinity ranged from 10 to 37.5 percent. The PH value on the other hand remained almost the same through the growing season. Thus, salt movement behaved entirely different than what was observed at Khadim Farm.

In case of ridges, the total soluble salts generally increased both at sides and central zone ranging from 2.2 to 14.3 percent. At one location the salinity at ridge site remained unchanged.

Similarly, under bed irrigation, the salinity got elevated both at the sides and central region. However the 0 to 15 cm depth attracted more salts than 15 to 30 cm depth both in case of ridger and beds. The salinity in furrows reduced by 3 to 6 percent in case of furrow-bed irrigation and about 3 to 10 percent in case of furrow-ridge irrigation.

It can evidently be observed that salt movement phenomenon was different at low salinity area (Adaptive Research Farm) than at higher salinity area (Khadim Farm).

138

PROBLEMS FACED DURING IMPLEMENTATION OF TRIALS

Inspite of a successful completion of the program in achieving the project objectives, a number of problems were encountered during the implementation phase of trials on irrigation techniques. These problems were associated with the implement design, operation and follow up by the farmers. A brief summary of the problems is given below:

Problems Associated with Design

1. There was no depth control both on ridger and bed shaper. Each time the implements were used, a different depth of planting seed was achieved depending on:

   - The vertical adjustment of plow mould
   - Adjustment of top link
   - Depth of prepared seed bed
   - Relative position of pores with respect to the moulds.

2. Both the ridger and bed shaper did not have automatic planting system. The seeding mechanism consisted of a pore attached to the implement behind each furrow opener. The position of the furrow openers and pores was adjustable on tool frame. Seeds were dropped manually by two persons sitting on the implement at the same time when ridger or bed shaper was operated. This seeding mechanism used additional manpower that could be eliminated by providing an automatic seeding mechanism.

3. One of the major problems encountered with the existing design of the bed shaper was the smaller width of the mould board resulting in smaller row to row distance across the furrows. Thus the mould boards were remodelled to maintain a row to row distance of 24 to 28 inches.

4. In the absence of a depth wheel a predetermined precise seeding depth was not possible. The pores also choked a number of times and had to be watched closely during the sowing process. The furrow openers were modified by increasing the height and length of furrow opener wings to overcome the choking problem.

5. Both the ridger and bed shaper were adjusted to create row to row distance of 28 inches. Thus the outer mould boards of the ridger and both mould boards of the bed shaper almost followed the tractor wheels.

139

Operational Problems

1. Where the soil was not pulverized and seed bed was not properly prepared, during the sowing phase of cotton on ridges, it was observed that excessive weeds, grasses and straw present in the field alongwith soil clods accumulated between the ridger mould and around the pores causing the following problems.

   - Moving soil into the central furrow, causing it to be much shallower than outer furrows. This resulted in unequal distribution of water among various furrows during an irrigation (Plate 4).

   - Flattening of ridge tops and uncovering the cotton seed (Plate 5).

   - Accumulation of excessive soil at the end of furrows or at a turning point when ridger was raised causing unlevelness in the field (Plate 6).

   A similar but less serious problem of this nature was observed with the bedshaper. Therefore both implements needed a well prepared seed bed ~~fee~~ free of grasses, weeds or straw.

2. During construction of ridges or beds, one of the tractor wheels followed the constructed furrow that was built in the first pass. Therefore, the net output in one pass of the bed shaper was one bed with two rows of plants and one new furrow as the other mould board followed the previously constructed furrow. Similarly the ridger produced two furrows, two ridges and ~~tow~~ two planted rows.

   Traversing of one furrow twice not only lowered the implement performance efficiency but also put additional amount of soil on planted row (on one side of bed or on one of the two ridges) in the subsequent passes thereby reducing the chances of seed germination (Plat 7).

3. Keeping one tractor wheel in the furrow while the other wheel on soil surface resulted in a tilt in the implement causing deeper seed placement in inner row and shallower seed depth in outer row (Plate 8).

Fallow up Problems

1. Since both the implements were used for the first time for planting cotton in the project area, the farmers were not accustomed to their use. They were not prepared to face the difficulties with the implements regarding construction of beds and ridges, sowing, irrigation, weeding and cultural practices under the tested irrigation techniques.

140

Plate 5: Effect of Poor Seed-bed on Ridge Construction and sowing

Plate 6: Accumulation of soil at the end of Implement Pass

Plate 7: Beds showing the Problem of Excess soil on one row and germinated cotton on other row

Plate 8: Traversing of one Furrow twice

The farmer's response to the new experience was varied depending on their level of awareness, patience, acceptance to new ideas and techniques, tolerance to risks and fears of crop success or failure, investment of time and labour and working aptitude with the field staff. The tractor drivers were also not trained to use these implements.

2. The trial fields in Haroonabad were hit by rain about 3 days after sowing causing hard crust formation and thereby reducing the seed germination.

   Farmers replanted their crusted fields adjoining to the trial fields as it was the only solution to assure crop germination. The project staff on the other hand could not afford to spend additional time and efforts to replant the trial fields. Therefore, instead of replanting the trial field it was decided to break the crust, that was accomplished using either one of the following means.

   - Mechanically/Manually breaking crust using Kasola, Dodanta or by hand.

   - Light irrigation application. Plate 9 shows germination around irrigated furrows and almost no germination across dry furrows (top left corner of Plate).

   The effect of crust formation was move pronounced in case of highly saline soils such as in Haroonabad. The farmers manually planted seed on missing spots that took ~~farmer's additional~~ time and effort. Breaking of crust and filling the missings was frustrating to the farmer which would have not happened if rain/crust formation had not occurred, or the fields were replanted with the same implements. Mechanical/Manual crust breaking was not encouraging as most of the tender seedings were injured and died inspite of necessary care. Light irrigation applied to a few fields temporarily facilitated germination but did not allow the plant roots system to develop deep enough resulting in shallower and frequent irrigations of crop in the later part of the season offsetting the benefits of water saving as observed at one of the Vehari trials (Khurshid Farm).

3. The farmers are generally reluctant to replace their traditional practices even if the innovative approach shows certain benefits.

4. Traditionally the farmers sow cotton on flat fields. This is followed by the use of Tiller (Tarphali) or ridger for the purpose of hoeing, weed eradication and earthing of plants. In case of furrow-beds and ridges use of such

143

Plate 9: Light irrigation facilitates germination

Plate 10: Movement of Salts from Sides to the Centre of Bed Facilitates Plant Growth

implements could not be practiced by the farmers. Necessary modification in hoeing implements is needed for appropriate follow up program of weed control.

RECOMMENDATIONS

1. The field which has to receive a ridger or bed shaper should have a well prepared seed bed free of grasses, weeds or straw.

2. Both the implements should be designed to incorporate the following:

   - Automatic seeding/planting mechanism

   - A depth control on seed placement
   - Adjustable effective width of mould board in bed shaper to allow a row to row distance of atleast 30 inches.

   - Both implements should facilitate construction of beds, ridges and furrow without entering into previously constructed furrow to improve performance efficiency and avoid dumping of soil over previously planted cotton seeds.

3. The farmers should be educated, and demonstrated the water saving and yield benefits of sowing on ridges and beds with improved design of implements in the light of above mentioned recommendations.

4. High salinity areas should preferably be put under furrow-bed irrigation to save water and achieve better salt balance thereby improving crop yields. Plate 10 shows salt accumulation towards centre of bed under full grown cotton on beds.

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146

Annex I

Farmers Seed Multiplication Program of Cotton in Punjab

ANNEX I

FARMERS SEED MULTIPLICATION PROGRAM OF COTTON IN PUNJAB

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148

TABLE OF CONTENTS

Title	Page
SUMMARY	1
INTRODUCTION	2
BACKGROUND	3
BRIEF HUSTORY OF COTTON	3
JUSTIFICATION/NEED FOR PROGRAM	5
SEED INDUSTRY	6
PROGRAM DESIGN AND IMPLEMENTATION STRATEGY	7
RESULTS	12
RECOMMENDATION AND CONCLUSIONS	15
PROCEDURES FOR SEED CERTIFICATION	16
SEED STANDARDS	17
APPLICATION FOR FIELD INSPECTION	20
FIELD INSPECTION REPORT FORM	21
APPLICATION FOR SEED SAMPLING	22
CERTIFICATE OF LABORATORY TEST	23
OTHER FORMS FOR CERTIFICATION	27

149

SUMMARY

Cotton commonly known as the silver fibre of Pakistan, not only meets the local requirements but also is an important source of precious foreign exchange earning. In Punjab Province during Kharif 1990 it was sown on 5.345 million acres.

The quality seed produced by the Punjab Seed Corporation and private enterprises has met only 40% of the cotton acreage. The remaining 60% was sown with uncertified seed. Where as betterment of inputs has a direct influence on the improvement of agricultural production. Seed is the basic and cheapest input and can be a dynamic instrument to bring about a transformation of the package of technology.

During Kharif 1990 on W/C NO. 9-A 22620/TPI IR/6R Hakra a farmers seed multiplication program was tested.

The goal of the farmers seed multiplication program is to increase the amount of improved high yielding seed available to the farmers in a shortest possible time.

All the 24 farmers on the said watercourse were involved in the program. Initially 42 acres were sown by these farmers. After the inspection of the fields 6.5 acres were rejected.

After the harvesting of the crop the produce was ginned on a local made small machine which is usually used for the ginning of Desi Cotton for home consumption. Then the seed samples were analysed by the Federal Seed Certification Staff at Sahiwal Laboratory. The purity of the seed produced by these small growers was 1% higher than the standard fixed by the Federal Seed Certification Department. The germination rate of produced seed by these groups is 2% to 10% higher than the certified seed and the germination rate of seed of three groups is 2 to 5% higher than the basic seed standards fixed by the Federal Seed Certification Department. These farmers succeded in attaining the higher quality seed standareds due to proper techanical assistance provided to them.

Under the Standard practices of cotton marketing in the area these farmers would have sold their total output of 301.5 mds of raw cotton for Rs.1,08,160.00 where as by ginning they have sold their lint and seed after the deduction of ginning cost for Rs.1,52,560. Due to which these farmers were able to increase their income by Rs.44,400 or 41%.

Small local made machine which are operated by Diesal Engines can be used successfully for the cotton ginning for quality seed, especially in the remote area like 6R Hakra sub project. The cotton inspectors of Agric. Extension Department can assist the growers for the maintenance of quality.

150

FARMERS SEED MULTIPLICATION PROGRAM OF COTTON

INTRODUCTION

The economy of Pakistan is mainly agrarian. Cotton, commonly known as the silver fibre of Pakistan, not only meets the local requirements of country but also is an important source of precious foreign exchange earning. Cotton crop area is increasing every year. In 1985-86 the area under cotton was 4.3 million acres. Where as in 1989/90 it was 5.03 million acres and in 1990/91 it was 5.325 million acres. This shows an increase of 5.8% over 1989-90 area and 35% over 1985-86. It is, however, a matter of real concern that the per acre yield of this important kharif crop is not improving for the last so many years. The gap in yield is very wide, inspite of the fact that soil, irrigation water and climatic conditions in the country are comparable to the cotton growing countries obtaining maximum yield per unit area. At present the average yield of seed cotton in Pakistan is 1350 kg/ha against 1833, 2032, 2500, 2302 and 1556 kg/ha for U.S.A. Turkey, Egypt, Mexico and Iran respectively (Govt. of Pakistan 1985).

The average yields is far below the potential yield yet efforts are being made to increase per acre yield. In 1985-86 the average yield was 18.07 mds/acre (723 kg) where as 1989-90 it was 20.25 mds/acre (810 kg). In 1990-91 it is 20.54 mds/acre (822 kg). This shows an increase of 1.3% over 1989/90 and 13% over 1985-86.

Analysis of low yield of cotton crop indicates that besides so many other factors use of low quality seed is an important constraint.

Betterment of inputs has a direct influence on the improvement of agricultural production. Seed is the basic and cheapest input and can be a dynamic instrument to bring about a transformation of the package of technology.

Among the various inputs quality seed occupies a unique position. It is neutral to scale in the sense that this input is equally projected per unit area on small and large farms. Thus use of quality seed remains an area of high priority over other agricultural inputs in both market oriented and subsistence level farming. It, therefore, sharpens the theme of our agricultural policy for raising the quality of life of our people through a focus on small farmers.

Making good quality seed available to the farming community is a highly organizational intensive operation. This specific requirement has restricted availability of good quality seed to the farming community of the developing world as a whole whereas other inputs like fertilizer has been earlier entrants in the agricultural production system in such situations.

151

Seed is a living tissue and, therefore, differs from any other agriculture input. It carries a genetic potential and has served as a vehicle of transformation. It, therefore, needs a very careful handling both in the process of production as well as handling thereafter, to ensure preservation of its genetic composition and other important quality aspects like germinability etc. In view of these very special characteristics, a close control on its quality has to be maintained. This control of quality is to be exercised on all the stages of seed production system starting from the breeder leading to certified seed through an intermediary generation of basic seed. It is difficult to keep the authenticity of the material unless all the actors in the system accept their responsibility and work as partners in the certified seed production and distribution chain.

BACKGROUND

A modest start in the improvement of cotton crop was made for the first time in 1905, when the Agriculture Department in the Punjab was constituted. These arrangements continued upto 1925 when the Indian Central Cotton Committee and the Punjab Government jointly started "Punjab Botanical Research Scheme" with headquarter at the Agricultural Research Institute in Lyalpur (now Faisalabad).

The Research Sub-Station, Multan was up-graded in 1959 by Pakistan Central Cotton Committee. This arrangement continued upto 1963, when the Station was taken over by the Provincial Government.

Due to ecological variations, Sahiwal and Bahawalpur were also put under independent Cotton Botanists in the year 1972 and 1975 respectively.

In view of the importance of cotton crop in the country Cotton Research Institute was established at Rahimyar Khan in the year, 1977-78. With the new set up, the programme of cotton research and development received a new impetus and the work was taken up more vigorously on all aspects of cotton.

As the research programme dealing with the genetic improvement of the crop is never ending procedure the cotton breeders with devotion and dedication evolved number of varieties like B557, MNH93, MS84, SLH41, MNH129, CIM70 (Upland Cotton), Ravi and Rohi (Desi cotton) which revolutionized the whole cotton production in the country. NIAB Faisalabad contributed a lot in cotton breading and NIAB 78 brought almost a revolution in the Province.

Brief History of Cotton

Work on the improvement and development of cotton crop was taken up in the first decade of the present century and in the year 1914 first improved variety of Upland cotton namely 4F was

157

approved for general cultivation in the Punjab. This variety was released from the original material which was imported by the officials of East India Company in 1818 as a first instalment and further in 1840 as second instalment. Generally this material was non determinant, low ginner, short staple length and inheritently low yielder. Improvement in work since 1940 to 1947 only revolved around the exploitation of the existing genetic variability which consequently gave varieties after 4F like LSS, 289F, 289/43F, 238F, 124F and 199F which gave a ginning out turn range from 30-32%, staple length 20-23 mm and a spinning performance from 20's - 40's. With this material in 1947 our yield of seed cotton was 179 Kg per acre.

After analyzing the entire situation of cotton research and the need of the new raw cotton for the country a comprehensive research programme was taken in hand involving both inter and intra specific crossing programme. As a result of this programme in the year 1959, AC-14(148F x 199F) was released for general cultivation in the central Districts of the Punjab. This was a high yielding, high ginning and better quality type, possessing a dependable genetic base for tolerance against the attack of sucking insects specially the Jassid. As a result of the introduction of this variety, its area increased from few thousand acres to more than 2.5 million acres in the early 70's and yield increased from 58.96 Kg (130 lb) of lint during 1947-48 to 142.86 Kg (315 lb) of lint per acre in 1971-72 in the Punjab. As the research programme dealing with the genetic improvement of crops is never ending procedure, the cotton breeders with their dedication produced many other varieties like B557, MNH93, MS84, NIAB78, SLH41, MNH129, CIM70, S12, Ravi and Rohi which by the adoption of recommended production technology have given as much higher yield as has been obtained in other advanced cotton growing countries. Side by side, a package of production technology emphasizing the fertilizer dose, quality of the seed, adequacy of plant protection measures with an adequate number of irrigations was also developed and was publicized for information for the farmers through all the possible communication media for its adoption. Those farmers who adopted this technology have obtained a higher yield of good seed cotton ranging from 1680 Kgs(45 mds) to 2053 Kgs (55 Mds) which very much speak about the higher achievable potential of these types under our conditions.

At the same time, tremendous improvement in ginning out turn and staple length has been effected. Ginning out turn of 4F and L.S.S. was 32% and staple length 23 mm. With the release of the present varieties, the ginning out turn increased from 32.0 to 37.5% and staple length from 23 mm to 33 mm.
From this whole description it becomes quite obvious that the varieties produced by cotton breeders have the maximum adaptability to our local conditions accompanied with a higher genetic potential for higher yield. How to exploit it, rests with the adoption of complete package of cotton production technology by the farmers.

153

Justification/Need for Program

Why was the Program Needed?

Over the years a large number of high-yielding seed varieties have been imported or developed in Pakistan. However, the rate of multiplication of these has been slow. A shortage of high-quality improved seed has been noted by the farmers as a major constraint.

According to the rapid appraisal about 92% farmers of 6R Hakra sub project are using the seed kept by themselves from their previous produce. The main benefit from the use of certified seed is to achieve higher crop yield. Assuming no change in existing cultural practices or other farming inputs, the use of quality seed has resulted an increase of 15% for cotton.

According to the Agricultural Officer, Extension Faqirwali, about 34,000 acres have been sown under cotton in the 6R Hakra sub project during Kharif 1990, although there are no reliable arrangements for the supply of certified cotton seed to the growers in this area.

The Punjab Seed Corporation (PSC) is a major source of certified seed for the Punjab farmers. According to its Director of Marketing, PSC and private sector at present can meet up to about 40% of the Punjab's need for certified cotton seed. The seed is produced on PSC-owned farms and on the farms of contract growers. This means that about 60% of the area has to be sown with seed either kept by the farmers themselves from their previous crop or by seed purchased from the open market. This seed was found to be of poor quality and farmers are uncertain about their germination rate and yield potential.

The goal of this program is to increase the amount of improved seed available to the farmers in a shortest time possible within the project.

Why was Program Important to CWM and GOP

Seed plays basic role in enhancing the crop yields. But when grown over a long period of time under ordinary farming conditions without being replaced at regular intervals, seed deteriorates in quality. This necessitates the replacement of old seed at regular intervals. Adequate availability of improved seed is a pre requisite for obtaining projected returns from inputs like additional application of water, fertilizer and plant protection materials.

The survey carried out by WAPDA Master Planning and Review Division has shown that better seed purchased from Government departments in general has performed better and gave higher yields as compared to the seed retained from farm produce. The

154

survey conducted in the project area indicates that the average common farmer uses poor quality seed.

SEED INDUSTRY

The realization that quality seed plays a vital role in increasing quality and quantity of all crops gave rise to the establishment of the Punjab Seed Corporation in 1976.

The main benefit from seed industry project was to achieve higher crop yield in cereal and cotton by the end users of certified seed. Assuming no change in existing cultural practices or other farming inputs, the use of quality seed has resulted an increase of 15% for cereal and cotton. In addition to, increased crop production, a significant quality improvement has also achieved in case of cotton and paddy, which are major foreign exchange earning crops. Better lint quality of cotton and rice would fetch higher price in the national and international markets. But unfortunately in case of cotton Punjab Seed Corporation and three or four private industry can only met 40% of the farmers requirements. So it looks essential that small groups of farmers as seed producers should be established to decrease the burden on the Government Agencies and to supply the quality seed to the remaining 60% farmers.

The Feasibility Report, Diagnostic Analysis Study, and TA Team field investigations have all revealed that the availability of improved seed is a major constraining factor for increasing production. The Punjab Seed Corporation and the existing private sector firms are not able to meet the farmers' demand for quality seed. Hence, the TA Team launched an effort to pilot test a program for production of quality seed by the farmers. This can be viewed as small agribusiness firms owned and operated by groups of farmers.

The goal of a farmer-based seed multiplication program (FSM) is to increase the amount of improved high yielding seed available to the farmer in the shortest time possible within the project areas. It is estimated that about 40% of the farmer's need for improved seed is met from public and private sector sources. The objective is to increase improved seed rapidly through selected farmers. Technical assistance have been provided to assure farmer production of seed that was free from mixtures, had good germination, weed free, and had no seed borne-diseases. In order to assure these objectives, a series of technical interventions during the cropping season from land preparation to storage, and seed distribution have been planned and implemented.

155

Table-I: Basic Cotton Seed procured from Punjab Seed Corporation and sold to the farmer for demonstration of better quality seed and seed multiplication by the farmers

Date	Name of the Farmer	Sub Project	Village/ W/C	Seed Variety	Quantity Supplied	Rate of per Kg	Cost Paid by the Farmer
	Group-I						
04-30-90	Mohammad Saleem	6R-Hakra	C. No.94/ 1-R/6R	Nayab-1978	24 Kg.	6.87	164.88
	Haji Noor Ahmad				8 kg.		54.96
	Allah Ditta				8 Kg.		54.96
	Group-II						
04-30-90	Mohammad Nawaz		C. No.94/ 1-R/6R	Nayab-1978	24 Kg.	6.87	164.88
	Mohammad Ashraf				8 Kg.		54.96
	Mohammad Aslam				8 Kg.		54.96
	Group-III						
04-30-90	Mohammad Azim	6R-Hakra	C. No.94/ 1-R/6R	Nayab-1978	32 Kg.	6.87	219.84
	Manzoor Ahmad				8 Kg.		54.96
	Group-IV						
04-30-90	Farzand Ali	6R-Hakra	C. No.94/ 1-R/6R	Nayab-1978	8 Kg.	6.87	54.96
	Mohammad Boota				8 Kg.		54.96
	Mohammad Sarwar				8 Kg.		54.96
	Akbar ali				8 Kg.		54.96
	Abdul Sattar				8 Kg.		54.96
	Group-V						
04-30-90	M. Sharif	6R-Hakra	C. No.94/ 1-R/6R	Nayab-1978	8 Kg.	6.87	54.96
	Nizam Din				8 Kg.		54.96
	Rustam Ali				8 Kg.		54.96
	Faqir Mohammad				8 Kg.		54.96
	Talib Hussain				8 Kg.		54.96
	Group-VI						
04-30-90	Naseer Ahmad	6R-Hakra	C. No.94/ 1-R/6R	Nayab-1978	8 Kg.	6.87	54.96
	Mohammad Hussain				8 Kg.		54.96
	M. Munir				8 Kg.		54.96
	Khan Mohammad		C.No.180-		8 Kg.		54.96
	Bashir Ahmad		138/6R		8 Kg.		54.96
	Khadim Hussain	6R-Hakra	C. No.95/ 1-R/6R	Nayab-1978	24 Kg.	6.87	164.88
	Manzoor Ahmad	6R-Hakra	C. No.94/	Nayab-1978	8 Kg.	6.87	54.96
	Riaz	-	C.No.103/ 1-R-6R	Nayab-1978	8 Kg.	6.87	54.96
	Khadim	-	C.No. 95/ 6R	Nayab-1978	8 Kg.	6.87	54.96
	Soofi Bashir	-	C.No.133/ 6R	Nayab-1978	24 Kg.	6.87	200.00

156

What was Program Expected to Show?

One of the indicators for measuring the success of the CWM Project is increasing the use of certified seed. In project documents, the private sector is noted as a potential mechanism for dealing with the shortage of improved seeds. Farmer-owned small seed multiplication companies were tested by the TA Team as a potential mechanism for solving the problem of seed shortage.

Program Design and Implementation Strategy

How were the program and activities designed?

The basic cotton seed of Niab 78 was procured from the Punjab Seed Corporation and distributed to all 24 farmers of the full trial watercourse No.9A-22620-TR-I-1R-6R (as shown in table-I). Forty two acres were sown by these farmers, varying from one to three acres by each farmer. These farmers were given assistance in the proper use of fertilizer, interculturing, and plant protection.

The fields were inspected by the TAT Agronomist and representative of the Federal Seed Certification, Sahiwal. Out of 42 acres, 6.5 acres were rejected on the basis of mixture of other varieties and 35.5 acres were initially approved for seed multiplication.

Inspection of the following fields were conducted from August to October, 1990 with the assistance of Mr. Khushi Mohammad Khurshid, Seed Certification Officer, Sahiwal. The fields of Cotton Niab-78 of the undermentioned farmers were upto the standard for seed multiplication as shown in Table-II. These farmers were assisted in a minor roughing. The Agric Extension Agents were also given training in inspections of cotton field.

Table-II

	Name of the Farmer	Sq. Nos.	Acre Nos.	Total Area (Acre)	Village
1.	Mohammad Nawaz	44 45	10 6	3	94/IR/6R
2.	Mohammad Aslam S/O Nawab Din	44	18	1	"
3.	Mohammad Ashraf S/O Nawab Din	44	13, 15 (0.5)	1.5	"
4.	Asghar Ali S/O Khushi Mohammad	59	16, 11 (0.75)	1.75	"

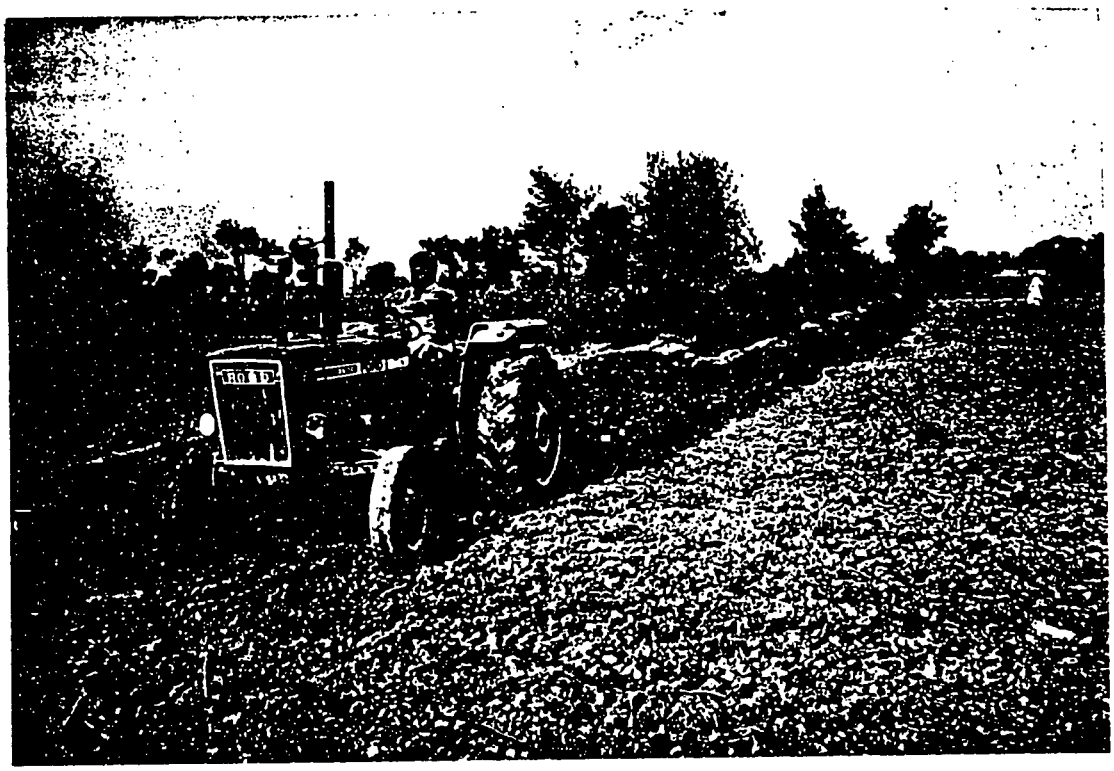
57

5.	Naseer Ahmed	42	11, 20 (0.5)	1.5	"
6.	Mohammad Azeem	42	3, 8, 13	3	"
7.	Munir Ahmad S/O Ghulam Mohammad	60	3, 2 (0.5)	1.5	"
8.	Akbar Ali S/O Mohammad Khushi	62	17, 14 (0.5)	1.5	"
9.	Ghulam Sarwar	61	5, 6 (0.5)	1.5	"
10.	Mohammad Saleem	40	2, 3, 4	3	"
11.	Mohammad Sharif	39	22, 14 (0.5), 25 (0.5))	2	"
12.	Khan Mohammad	41	23, 20 (0.25)	1.25	"
13.	Manzoor Ahmed	63	4, 5	2	"
14.	Mohammad Boota	61	29 (0.5)	0.5	"
15.	Allah Ditta	63	11, 12	2	"
16.	Bashir Ahmed	41	6, 17	2	94/IR-6R
17.	Noor Mohammad	39	6, 9 (0.25)	1.25	"
18.	Khadim Hussain (Noor Ahmed)	63	8, 7 (0.5)	1.5	"
19.	Khadim Hussain	16	9, 12, 19	3	95/1R/6R
20.	Talib Hussain	37	5		
			Total:	35.75	

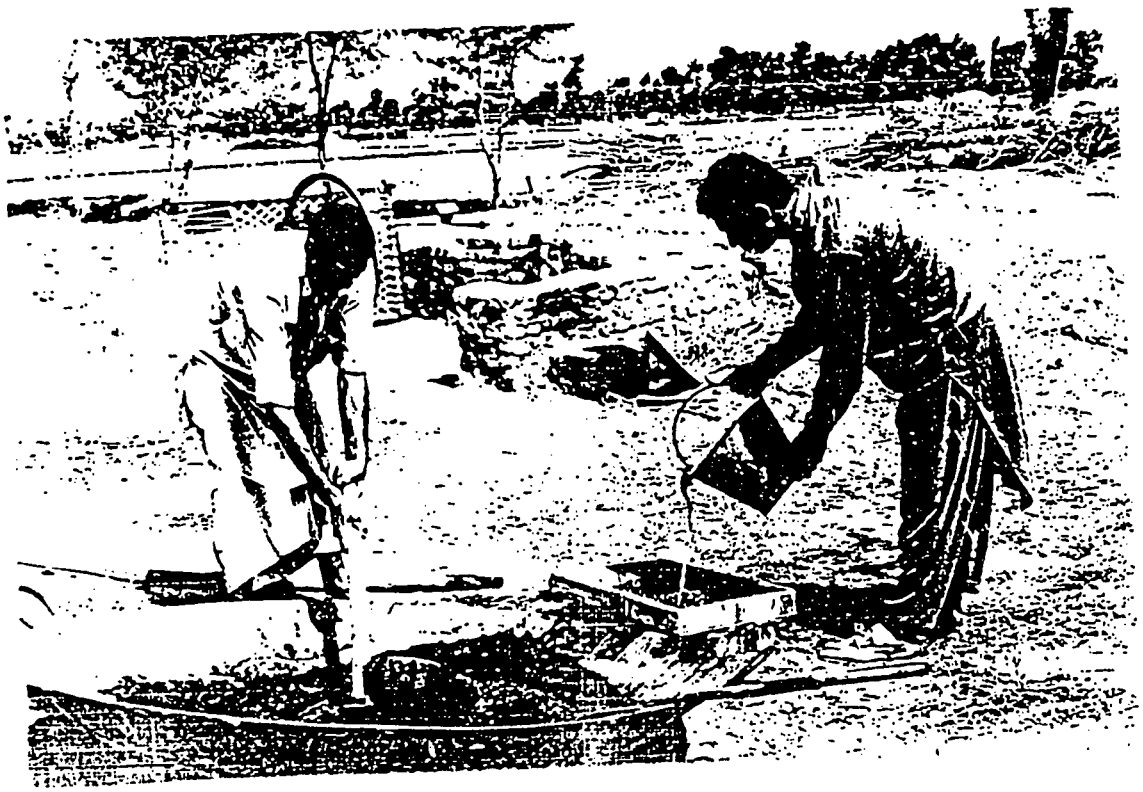
The fields of the following farmers were found with mixture and needs heavy roughing especially with Desi Cotton. The seed certification representative rejected these fields for the purpose of seed multiplication. These farmers were told that they can sell their crop produce because it is not upto the standards fixed by the Federal Seed Certification Department.

1.	Abdul Sattar	58	10	1	94/IR/6R
2.	Talib Hussain	37	4 (0.5)	0.5	"
3.	Rustam Ali	38	19, 22	2	"
4.	Faqir Mohammad	37	19, 13	2	"
5.	M. Nawaz	44	11	1	"
			Total:	6.5	

158



1. Land Preperation



2. Delinting Of Cotton Seed

3. Pest Control

4. A Field Is Being Inspected By The FSCD Representative

All these farmers whose fields were upto the standard of seed multiplication were given assistance for picking and storage of seed cotton before ginning through Mr. Ashraf Ali Agric. Officer of Agric. Extension Department. These farmers were also assisted by the TA Team Sociologist and WUAD for the ginning of seed cotton.

After ginning the produce from these fields, seed samples were taken and analyzed by the Federal Seed Certification. The approved seeds were then packaged in 20 kgs/bag. Almost 1/3rd of the produced quality seed has been sold to other farmers in the area.

On-the-job training was given to all these farmers by the TA Team Agronomist and Seed Certification Officer of the Federal Seed Certification Department for proper picking, time of picking, and methods of storage before ginning. The 35.5 acres would have produced about 500 mds of quality seed but due to farmers first time participation they sold some of the seed cotton directly in the market due to economic constraints. The low yield in this area can be attributed to water logging, and shortage of irrigation water. The 201 mds seed produced by these farmers will be sufficient for cultivation of 1206 acres in the next Kharif season, which is equivalent to about 4% of the cotton area in the 6R Hakra sub project.

The TA Team Sociologist and the Water Users Association Development Specialist assisted in rearranging the seed producers groups after inspection by the Federal Seed Certification Representatives. Yield data was collected with the assistance of Agriculture Extension Agents and assistance in the analysis of data was obtained from the TA Team Farm Management Specialist.

How were Farmers Included in the Programme

Several meetings with farmers were arranged before implementing the programme. Importance of improved seed and production of cotton seed at their own field was thoroughly discussed. As there was a village based religious/political conflict affecting adversely the cooperation of farmers at watercourse level also it was decided that groups may be formed for this seed multiplication program. Accordingly 6 groups were formed and basic seed Niab 78 was provided to them for multiplication on cash payment. (Table-I) These group were given training in the method of sowing, delinting of cotton seed and other agronomic practices needed for successful production of cotton on these farms.

Several field inspections were carried by the F.S.C.D. representatives and TAT Agronomist, five farmers fields not upto the standard of F.S.C.D. So those fields were rejected for seed production. The group were re-arranged and finally three groups were emerged to carry out this programme. These group performed

16'

5. Undesired Plants Are Being Uprooted At The Time Of Inspection By FSCD. Representative

6. Cotton Picking

well and carried out all the process from picking, ginning and marketing of lint and seed. Assistance was provided to them at each and every step, like seed analysis by the F.S.C. Department, bagging of seed and printing of analysis results, storage and marketing.

Due to small holdings the cotton output was not sufficient to arrange with a big cotton ginnery to gin the produce. It was not economical for the large ginnery owner to clean the machines and separately gin the cotton output for seed. This problem was resolved by the use of small ginning machines available at the nearby village. These locally manufactured machines are normally used for ginning Desi cotton for home use by the farmers. This was the first time that this type of machine was used for ginning cotton for seed in this area. A good effort was made to clean the ginning machine in order to prevent mixing with other varieties. To further insure high quality seed the first and last picking was excluded from use for seed multiplication.

How did you gather data and how often?

A questionnaire was designed by the TA Team. The Agricultural Officers of OFWM and Extensions were given training for the collection of data. Both the Agric. Officer visited these farmers atleast once a week. They were assisted by the FA's of Agric. Extension Department who was assisting these farmers and were visiting them twice a week.

What was important to monitor and why?

Model tested will show that small groups of farmers can produce quality seed with the technical assistance from the Agric. Department and Federal Seed Certification Department. As it will not be possible for the public sector to invest more for seed industry and the private sector (large enterprise) will gain more profits. Especially in the remote areas like 6R Hakra where the average holdings of the farmers are small and the economic conditions of these farmers are not sound private large enterprises may not found it economical to invest in the seed industry in this area. Where as these small farmers can join together for their need of quality seed production. This program can be monitor on two aspects 1) weather the quality is liked by the buyers or not. 2) weather it is economical for these small groups to produce quality seed or not.

What involvement was required of the SMO and Line Agencies

SMO was suppose to give the assistance through their agronomist and liaison officer. But due to the involvement of their agronomist in Shahkot sub project it was not possible for him to participate in the program. The two line agencies OFWM and Agric. Extension both participated in the program fully. Both Agric. officer of OFWM and Agric. Extension assisted the TA Team

163

Sociologist And WUADS With A Member Of Seed Multiplication Group

Agronomist With The Farmers During One Of His Inspection Of The Fields

Director, Punjab Seed Corporation With A Chairman Of The Farmers Seed Multiplication Group Of 6-R Hakra At Pirowal Farms

Farmers Visiting The Cotton Field At Seed Multiplication Farms Of Punjab Seed Corporation At Pirowal

Farmers At Cotton Fields Of Perowall Farms Of Punjab Seed Corporation

COP Visited The Cotton Seed Multiplication Fields at 6R

agronomist for the field activities and collected the data also for the report. Punjab Seed Corporation supplied the basic seed for this program and Federal Seed Certification Department officials assisted these farmers during field inspections and in the analysis about the quality of the seed.

How would the program would be expanded

This model can be used as cottage industry and in each Union Council (Comprising of 20 to 30 watercourses) a small ginning machine can be installed which costs only Rs. 12000 (US $600) and can gin 6 mds of seed cotton which produces 4 mds of seed and 2 mds of lint. In 8 hours one can gin 48 mds of seed cotton and get 32 mds of seed.

Small groups of interested growers can be selected in the same area and can be registered as seed growers. The Agric officer of Agric. Extension Department can assist these growers for roughing etc. The seed certification department officials can be involved for inspections and quality analysis. Basic seed can be purchased from the Punjab Seed Corporation or Breeders.

RESULTS

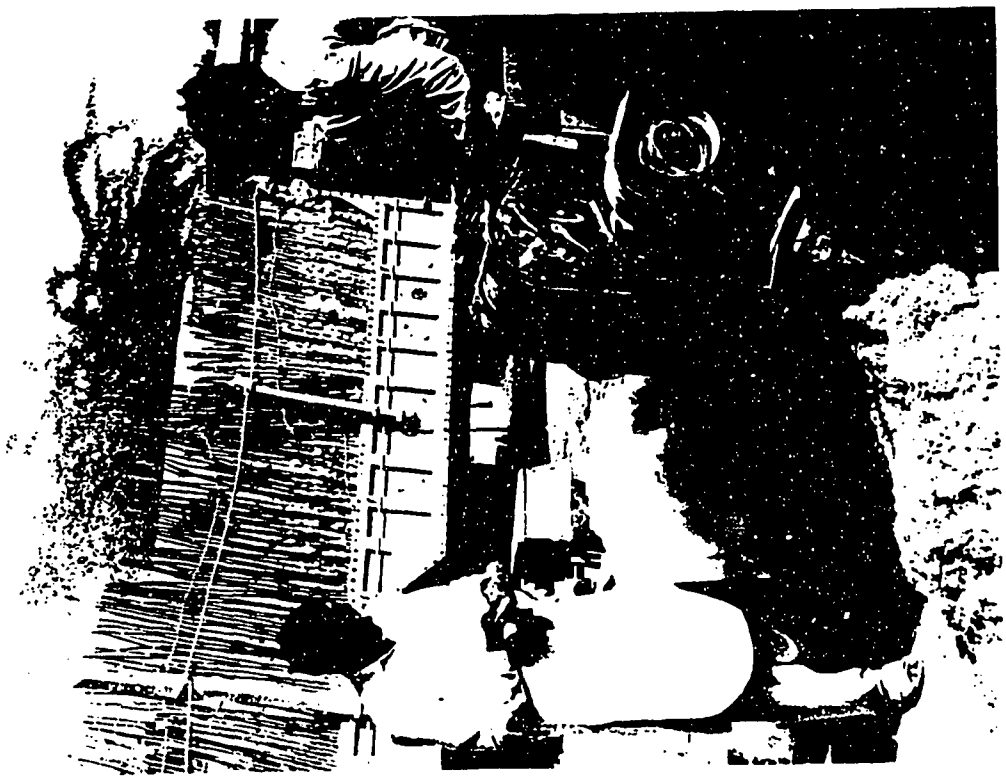
This program was started with all the 24 farmers in the watercourse No.9A-2262-1R-6-R. After field inspections, the seed quality analysis of 18 farmers was upto the standard of Federal Seed Certification Department. A total of 8040 Kgs of seed was produced by these three seed multiplication groups or associations. Details of the seed production are presented in the following Table-III.

Table-III. Output of the Seed Production Associations in Full Trial Watercourses, 6R Hakra.

Name of the farmers	Raw Cotton (Md)	Qty. of Seed (Md)	Qty. of Lint Sold (Md)	Price/ Md. (Rs.)	Total Amount of Lint
Mohammad Saleem Khan Mohammad Bashir Ahmed Munir Ahmed Manzoor Ahmed	117.0	78.0	39.0	750	29,250
Khadim Hussain	39.0	26.0	13.0	750	9,750
Naseer Ahmed	30.0	20.0	10.0	640	6,400
M. Asghar Ali M. Boota Sarwar Akbar	46.5	31.0	15.5	800	12,400

167

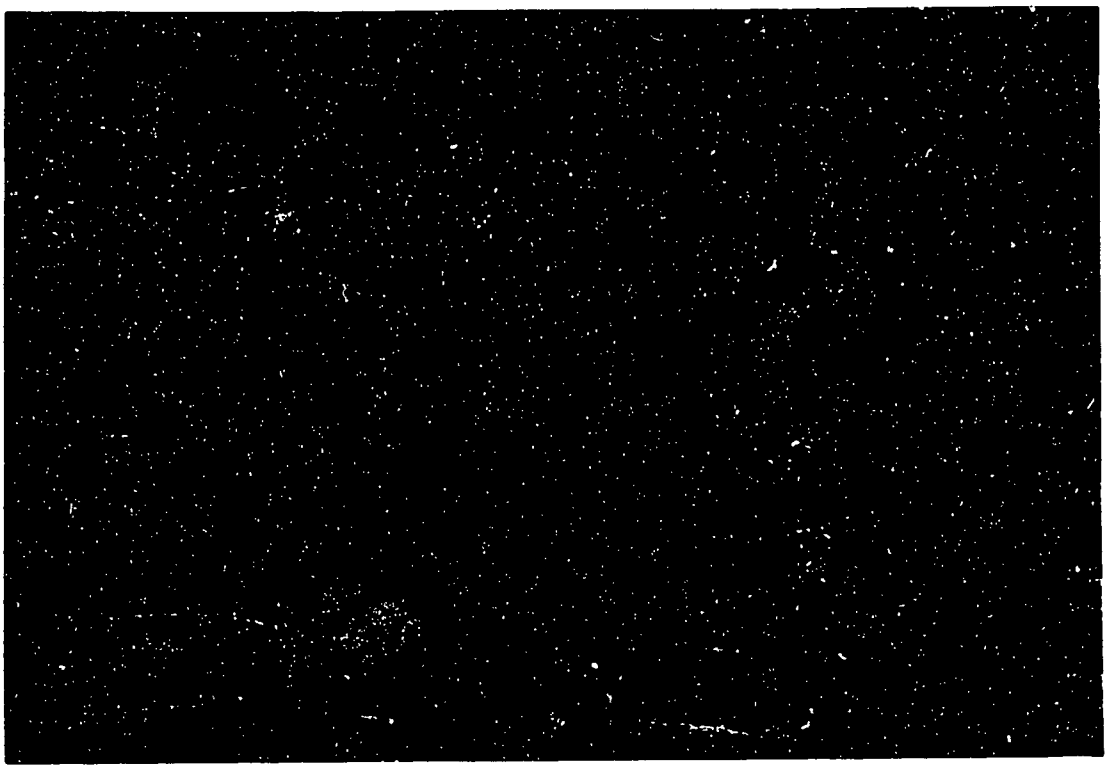
7. Cotton Ginning In Operation



8. A Cotton Grower/Seed Producer Checking The Seed & Lint Quality

9. Seed Is Being Weighed

10. Baging Of Seed And Stitching



11. Seed Bags Printed With Seed Analysis

12. A Farmer With His Seed Bags

Mohammad Sharif M. Ashraf M. Aslam Noor Mohammad	40.5	27.0	3.5	750	10,125
Mohammad Nawaz	6.0	4.0	2.0	700	1,400
Abdul Sattar	15.0	10.0	5.0	750	3,750
Mohammad Azeem	7.5	5.0	2.5	750	1,875
Total:	301.5	201.0	100.0		74,950

Seed samples from the produce of these seed growers were collected after ginning and analyzed by the Federal Seed Certification Department Sahiwal.

The seed quality analysis of the farmer's group that has been completed is compared with the Federal Seed Certification (FSC) standards in the following Table-IV.

Table-IV Comparison of Seed Produced on full Trial Watercourse with FSC Standard.

	Quality of Seed Produced by the farmers					FSC Standards	
	Saleem	Sharif	Naseer	Khadim	Asghar	Basic Seed	Certified Seed
Purity	99.01%	99.18%	96.47%	97.87%	99.46%	98.0%	98.0%
Other Varieties	0.52%	0.70%	1.23%	0.73%	0.38%	0.1%	0.2%
Inert Matter	0.47%	0.12%	1.51%	1.29%	0.16%	2.0%	2.0%
Desi	-	-	0.29%	0.11%	-	-	-
Germination Rate	82.00%	85.00%	77.00%	83.00%	78.00%	80.0%	75.0%

The purity of seed produced by this group is almost 1% higher than the standard fixed by the Federal Seed Certification Department. The germination rate of the seed produced by these groups is 2 to 10% higher than the certified seed and the germination rate of seed of three groups is 2 to 5% higher than the basic seed standards fixed by the Federal Seed Certification Department.

Seed production and distribution need to be economically sound if the seed industry is to be further developed in the private sector. The case of these small farmers seed multiplication associations is presented here as an example illustrate the potential for increasing income by specializing in production of quality seed.

Under the standard practices of cotton marketing in the area, they would have sold their total output of 301.5 mds of raw cotton to the private traders or ginneries for the price of Rs.360/md. This would have generated a gross income of Rs.1,08,160.00.

Ginning of cotton for seed multiplication program generated 8040 Kg of seed. Lint was sold from 640 to 800 rupees per md as given in table-II and seed at 10 rupees per kg. This resulted in a gross income of Rs.1,52,560.00. Ginning and transportation cost paid by these farmer is Rs.2,790.00. These farmers were able to increase their income by Rs. 44,400.00 or 41%.

Table-V. Gross income from marketing cotton before ginning and processing cotton for lint seed.

Income/Marketing Cost	If Sold as Seed	When Sold as Lint
Sold before ginning (30 md x Rs.360)	Rs. 1,08,160	
Sold as lint 67.5x750 10.0x640 15.5x800 7.0x750		Rs. 74,950
Sold as seed (8040 x Rs.10)		Rs. 80,400
Gross Income	Rs. 1,08,160	Rs. 1,53,350
Cost of Ginning (279mds x Rs.10)		Rs. 2,790
Gross Income less Cost of processing	Rs. 1,08,160	Rs. 1,52,560

Net Income when sold as seed and lint

Rs.1,52,560 - 1,08,160 = Rs. 44,400

172

Recommendations and Conclusions

What was the major out come of the program

The quality of the seed produced by these small growers is equal to basic and certified seed standards of federal seed certification department. Due to good quality of the seed two growers had already disposed their seed just after ginning. The remaining are selling @ Rs.12/kg which become Rs.480/40 kg. Where as the Punjab Seed Corporations is selling certified seed of cotton seed at the rate of Rs.290/40 kg and basic seed at rate of Rs.370/40 kg. The two farmers Nawaz and Naseer had sold their seed @ Rs.10/kg which becomes Rs.400/40 kg. The adjoining farmers are paying more money because they are confident that the seed which they are purchasing were produced in their area and it has the correct quality standards as printed on the bags.

If the program could be expanded who and how would it be done?

The Agric Extension Department can take up this program with the assistance of Punjab Seed Corporation and Federal Seed Certification Department.

The Agric. Extension Department have cotton inspectors who are agricultural graduates and are trained in the quality of cotton. The Agric. Officer can select some interested farmers with in one watercourse or village and can assist them in the procurement of quality seed from Punjab Seed Corporation. These farmers should be assisted in the selection of fields, cultural and agronomic practices from sowing to harvesting. These groups should be registered as seed growers.

The Federal Seed Certification representatives can be involved for the inspection of fields grown for seed production.

These farmers can be trained for proper picking. Then the seed cotton can be ginned at local machine. Sale of Lint can be arranged to large ginnery owners or local merchants. Where the farmers can earn the reasonable price of lint. Then the samples of these seeds can be analysed by the Federal Seed Certification department. If the sample are upto the standards of Federal Seed Certification as shown in Table-IV. Then it can be bagged and the analysis about purity and germination should be printed on these bags.

Is it necessary to test examine another component of the program or is the program now ready for expansion?

It will be better if this program can be tested once more to get these farmers registered and the line agencies involved after the registration of these growers. As these farmers involved in seed production are now trained but needs assistance for registration

13

as association of growers. Once they are registered then the fields can be inspected by the Federal Seed Certification representatives officially and later on seed will be analysed by them in their laboratories.

The procedures of application for certification and requirements and procedures for registration of growers and crop inspections are given as under:

Application for Certification

An person intending to produce seed shall apply to the Seed Certification Department using Form No. 01 for certification of his seed fields. The application should be received by the Federal Seed Certification Department on or before the prescribed dates.

Requirements and Procedures for Registration of Growers and Crop Inspection

Submission of lists of growers:

i) The details of growers selected and registered by the Seed Corporation/Procurement Agencies shall be submitted to the Federal Seed Certification Department for record purposes. The registration of a grower for producing seed shall be effective for such period, not exceeding five years, as may be prescribed;

ii) Lists of stocks of the various seed lots that the Seed Corporations/Procurement Agencies are intending to utilize in their production programme, are to be sent to the Federal Seed Certification Department for checking. The following information should be included in these lists:

   a) Crop species and variety.

   b) Categories and number of the seed lots.

iii) Following the approval of the lists of stocks, the Seed Corporations/procurement Agencies must then submit to the Federal Seed Certification Department full details of crops to be sown during the season. The information should include:

   a) Crop species and variety.

   b) Category and registration/lot number of seed. (pre-basi-, basic or certified).

   c) Grower's name and address etc.

   d) Area to be sown.

174

iv) This information is then be checked against the preceding details to ensure that the seed stock is eligible for certification at the required grade/category and that the grower is registered.

When this procedure is completed, the Federal Seed Certification Department will then arrange for the necessary field inspections to be carried out by the qualified Seed Certification Staff of the department. After the completion of each inspection, the relevant Seed Corporation/Procurement Agency shall be informed of the results and action to be taken if any i.e. rouging etc. On completion of the final inspection, the results will be communicated to the Seed Corporations/Procurement Agencies and arrangements made for the first sampling to take place after harvest.

175

Cotton Seed Standards of Federal Seed Certification Department

Factor	Pre-basic (%)	Basic (%)	Certified (%)
Cotton Seed Standards			
Pure Seed (minimum)	99.99	98.00	98.00
Other varieties (maximum)	None	0.10	0.20
Desi varieties (maximum)	None	None	None
Inert Matter (maximum)	0.10	2.00	2.00
Germination (minimum)	80	80	75

Source: Seed Certification Manual

List of the farmers participated in cotton seed multiplication program.

Name of the Farmer	Area (Acre)	Produce		Mds.
Mohammad Nawaz	1.75	12.70x1.75	=	22.23
Mohammad Aslam	0.50	7.75x0.50	=	3.88
Mohammad Ashraf	0.50	17.83x0.50	=	8.92
Abdul Sattar	1.00	25.00x1.00	=	25.00
Asghar Ali	1.75	15.00x1.75	=	26.25
Naseer Ahmed	1.50	23.33x1.50	=	35.00
Munir Ahmed	1.50	13.00x1.50	=	19.50
Akbar Ali	1.50	25.00x1.50	=	37.50
Mohammad Azeem	3.00	17.00x3.00	=	51.00
Ghulam Sarwar	1.50	20.00x1.50	=	30.00
Mohammad Saleem	3.00	29.00x3.00	=	57.00
Mohammad Sharif	2.00	30.00x2.00	=	60.00
Khan Mohammad	1.25	21.50x1.25	=	26.88
Manzoor Ahmed	2.00	22.40x2.00	=	44.80
Mohammad Boota	0.50	30.00x0.50	=	15.00
Allah Ditta	2.00	25.00x2.00	=	50.00
Bashir Ahmed	2.00	17.88x2.00	=	35.76
Khadim Hussain	4.50	22.15x4.50	=	99.68
Noor Mohammad	1.25	18.00x1.25	=	22.50
Talib Hussain	0.50	20.00x0.50	=	10.00
Rustam Ali	2.00	15.00x2.00	=	30.00
Faqir Mohammad	2.00	25.00x2.00	=	50.00

REFERENCES

1. Ahmed, S.I, 1989 - Seed Certification Manual, Federal Seed Certification Department, Ministry of Food, Agriculture and Cooperation Islamabad.

2. Ahmed, S.I, 1986 - Cotton - Field Inspection Techniques, General Guidelines, Federal Seed Certification Department, Islamabad.

3. Agriculture University Faisalabad Staff Paper No.89-2. Cotton Varietal Adoption and Yield in the Irrigated Punjab from 1986-88.

4. Ali Ahmed Minhais, Cotton - 1986.

5. Faisalabad University, Zari Digest - March 1987

6. Ayub Agricultural Research Institute, Faisalabad - Annual Report 1987-88.

7. Ayub Agriculture Research Institute, Faisalabad 1987, Achievements and Functions of Cotton Research Institute.

APPLICATION FOR FIELD INSPECTION

(In Terms of Sub-Section (I) of Section 13 of the Seed Act, 1976).

To

_____ _____

Name of applicant _____ Address _____ Telephone No. _____

Name of Grower _____ Farm on which the seed is produced _____

Approach to Farm _____ Milage from _____ Town and exact location _____

CROP	VARIETY	NO. OF ACRES SOWN	TAG COLOUR/CLASS OF SEED PLANTED	FEES SUBMITTED WITH THE APPLICATION. RS. _____ BY BANK DRAFT/CHALLAN FORM NO. _____

I understand and agree to abide by the Rules and Regulations of the Federal Seed Certification Department. I confirm that the entire acreage planted and offered by me as above was planted with the seed represented by tags. I further confirm that I have taken adequate steps to prevent contamination at the farm by other means.

_____

Signature of the applicant/grower.

178

21

FORM NO. 02

GOVERNMENT OF PAKISTAN
FEDERAL SEED CERTIFICATION DEPARTMENT

No. FSCD/_____
DATED: _____

FIELD INSPECTION REPORT
(In Terms of Sub-Section (3) of Section 13 of Seed Act, 1976).

Name of Grower_____ Address_____ No. of tags submitted_____

Acreage sown_____ Crop/Variety inspected_____ Acreage Inspected_____

Expected Yield_____ Category of seed sown last year_____ Category declared this year_____

FIELD INSPECTION REPORT

Isolation	Insp ction	Contaminents	1	2	3	4	5	6	7	8	9	10	Average	%

Remarks:_____ Inspected by:_____

Final action:_____

FORM NO. 01

22

FORM NO. 03

GOVERNMENT OF PAKISTAN
FEDERAL SEED CERTIFICATION DEPARTMENT

APPLICATION FOR SEED SAMPLING

(In Terms of Section 13, Sub-Section(1) of Seed Act 1976).

Fees submitted with the application. Rs._____
by Bank Draft/Challan Form
No._____
Dated_____

To

_____

_____

Please arrange to draw seed samples from_____Seed Lots lying with_____grower/factory/place. The details are as under:-

Name of Grower & Address_____

Crop_____Variety_____Category_____

Quantity_____(m.tons) (Approx). Storage_____

_____
Signature of applicant grower.

183

23

FORM NO. 04

GOVERNMENT OF PAKISTAN
FEDERAL SEED CERTIFICATION DEPARTMENT

CERTIFICATE OF LABORATORY ANALYSIS

(In Terms of Sub-Section (3) of Section 13 of Seed Act, 1976).

NO. FSCD/_____

DATED:_____

Crop_____ Variety_____ Lot No._____ Sampled by_____

Name & Address of Grower_____ Date received_____ Date results completed_____

Class of Seed_____ Total quantity of seed tested_____ M.Tons. Total Number of samples tested_____

Fees paid Rs._____ Date_____ vide Bank Draft/Challan form No._____

1. Pure Seed_____ %
2. Other distinguishable varieties_____ %
3. Inert Matter_____ %
4. Other crop seeds_____ %
5. Total Weed Seeds_____ No/%
6. Moisture_____ %

Germination_____ %

Hard Seeds_____ %

Fresh ungerminated_____ %

Abnormal seedlings_____ %

Dead Seeds_____ %

Name and number of objectionable weeds per kg:

_____

Remarks_____

_____
Signature Laboratory Incharge

Dated:_____/198

181

FO

REQUEST FOR SAMPLING AND TESTING OF A SEED LOT ON ARRIVAL AT PROCESSING PLANT.

Lot No.

Crop _____

Variety _____

QUANTITY (Tonnes).

No. of bags to be sampled. _____

The above mentioned lot has arrived at the plant. Please arrange to draw the samples.

(PLANT MANAGER)

To

_____

_____

FORM NO. 06

REQUEST FOR FINAL CEPTIFICATION, SAMPLING, LABELLING AND SEALING

Name of applicant _____

Crop _____

Varieties. _____

Seed lot No. _____

Quantity. (M.Tons). _____

No. of bags. _____

No. of labels/seals required. _____

The above mentioned lot has been processed. Please arrange to draw the samples for final testing.

_____
Signature of Plant Manager

183

FORM NO. 07

GOVERNMENT OF PAKISTAN
FEDERAL SEED CERTIFICATION DEPARTMENT

CERTIFICATE:

Pre-basic

Basic

Certified-I

Certified-II

To _____

Reference your No._____dated_____

Lot No._____ Crop_____

Variety_____Weighing_____Tonnes

No. of bags_____is accepted/rejected as per results attached at the time of testing.

_____
INCHARGE LABORATORY

To

_____

_____

184

Annex J

Extension Outreach Programme
Background, Accomplishments and
Future Strategies--Kandiaro Subproject, Sindh

185

ANNEX J

ISM / COMMAND WATER MANAGEMENT

EXTENSION OUTREACH PROGRAMME
BACKGROUND, ACCOMPLISHMENTS AND FUTURE STRATEGIES

KANDIARO SUBPROJECT, SINDH

Prepared by:
Mohammad Asghar Khan, Senoir Agronomist
Aziz Ullah Tunio, Subproject Manager, Kandiaro
for
Command Water Management Project
House 15, Streeet 83, G-6/4, Islamabad - Pakistan

JUNE 21, 1990

COMMAND WATER MANAGEMENT PROJECT IS A MAJOR COMPONENT OF THE IRRIGATION SYSTEMS MANAGEMENT PROJECT BEING IMPLEMENTED UNDER USAID CONTRACT NO. 391 - 0467 - C - 00 - 5076 - 00

BY:

ASSOCIATES IN RURAL DEVELOPMENT, INC.
110 MAIN STREET, 4TH FLOOR
BURLINGTON, VERMONT 05401 USA

FOREWORD

One of the objectives of the Command Water Management Project is to provide an operational framework which allows farmers to combine the water inputs with other inputs - seeds, fertilizer, labor and capital - in a manner in which the potential returns outweigh the high risk associated with input costs including construction, operation and watercourse maintenance costs.

This paper outlines the activities of the Subproject Management Office, Kandiaro, which support the above objective. Emphasis is placed on making the best and most efficient utilization of the farmers' available resources, both capital and managerial. This paper indicates that the use of improved and certified seeds and the judicious and timely application of both water and non-water inputs could bring about a substantial increase in the present yield levels. Encouraged by these findings, the SMO and TA Team are planning to apply this approach on a full watercourse basis so as to test the replicability and economic return on a larger scale.

I feel that this is a step in the right direction. I appreciate the hard work and devotion of the SMO staff, members of the Technical Assistance Team and staff of other line agencies, without whom this objective could not be achieved. I wish them success in their future programs.

(K.B. DODANI)
Director General
Agricultural Engineering and Water Management
Government of Sindh

187

EXTENSION OUTREACH PROGRAMME

BACKGROUND, ACCOMPLISHMENTS AND FUTURE STRATEGIES

The total area under cultivation in the Kandiaro Subproject is 150,000 acres. Wheat is the most important crop and occupies the largest cultivated area. Other major crops, in order of importance, are cotton, fodder, and orchards (mangoes, lemons, guava). Crops grown on a smaller scale include pulses, vegetables, rice, sugarcane and oilseeds. The below table lists the average yields and cropping intensities for the area's two major crops at the beginning of the project and the corresponding values targeted for its completion.

	BEGINNING		COMPLETION	
CROP	CROPPING INTENSITY %	YIELD (MDS/ACRE)	CROPPING INTENSITY %	YIELD (MDS/ACRE)
WHEAT	50.00	22.00	65.00	40.00
COTTON	26.00	11.20	28.00	20.00

To achieve the established targets, the Technical Assistance Team (TAT) and the Subproject Management Office (SMO) launched an extension outreach programme. The cooperating organizations included agricultural extension; research institutes; private sector fertilizer, pesticides and seed companies/dealers; etc. The salient features of this programme are discussed below.

DEMONSTRATION PLOT PROGRAM

The project area has the potential for increasing crop yields, and thus production and farmer incomes, by adopting simple inexpensive, cost effective, improved practices such as listed below.

1. Use of clean certified/improved seed of recommended varieties;
2. Prepare weedfree and properly leveled seedbeds;
3. Timely, crosswise broadcasting of seed to ensure gapfree germination and to secure the required plant population;
4. Timely effective weed control;
5. Judicious, timely and uniform application of irrigation water and fertilizer.

The above general practices are all within a farmer's financial resources and technical abilities. With wheat, for example, the project fertilizer recommendations are only one bag of urea and one bag of diammonium phosphate (DAP); the weeding is by hand.

A demonstration plot programme was developed to show farmers the benefits of using the above practices. The specific practices recommended for wheat and cotton are attached. Results from the 1987-89 programmes were very encouraging; the following table shows the increases in yields and farmers' income.

CROP	NO.OF DEMO PLOTS	AVE. YIELD (MDS/ACRE)		GROSS INCOME (RS/ACRE)		NET INCOME (RS/ACRE)		INCREASED NET INCOME (RS/ACRE)
		DEMO	CONTR.	DEMO	CONTR.	DEMO	CONTR.	
WHEAT	190	40.35	28	3,760	2,632	2,482	1,549	933
COTTON	22	24.00	13	7,200	3,800	5,790	2,830	2,960

As compared to the controls, the average increase in wheat yield was 12.35 mds/acre; for cotton it was 11 mds/acre. The increased net income from wheat was Rs.933/acre (60%); for cotton, it was Rs.2,960/acre (105%). To effect such changes throughout the project area requires a very dynamic extension service program; one which can motivate/educate farmers to adopt these practices.

COTTON

Certified and quality seed of approved varieties of cotton is produced in this country in both the public and private sectors. Farmers have access to the seed of their choice. The average yield of cotton in this Subproject area is much below the potential yield. The main causes are low plant population and poor insect control. The heavy texture of the soils in the Subproject area requires implements like soil-turning ploughs and clod-crushers to prepare levelled, well-pulverized seedbeds for good emergence of seedlings. Most farmers in the project area do not have these implements; as a consequence, poor seed-bed preparation results in low plant population. Cotton plants are also attacked by a variety of insects during their life cycle. If these insect are not controlled, yields will be reduced to a bare minimum. In the cotton demonstration plot program, emphasis was placed on obtaining required plant population and effective plant protection. The results are very encouraging but the rate of adoption of improved practices by farmers is much lower than in the case of wheat crops because of the cost of insect control and the non-availability of implements. During the last three years, much of the cotton was replaced by rice, even though rice is a banned crop in the Subproject area. To cite an example at water-course 2L Abji, cotton which was previously cultivated on 135 acres, this year (1990) occupies only 98 acres; the other 37 acres were planted with rice.

DEMONSTRATION PLOTS (WHEAT)

FARMERS VISITING A DEMONSTRATION PLOT ON A FIELD AT 2-LABJI

A DEMONSTRATION PLOT DEPICTING PROPER LAYOUT AND GAP FREE GERMINATION

THE DIFFERENCE IS OBVIOUS DEMONSTRATION PLOT ON THE RIGHT SIDE AND CONTROL ON THE LEFT

INTRODUCTION OF IMPROVED AND CERTIFIED SEED

Certified wheat seed of improved varieties, Pavan (early) and T-J83 (late), were introduced into the Kandiaro Subproject area in Rabi 1987-88. Most wheat here is sown late, after the harvest of cotton and rice. It was therefore decided to include the late variety T-J83 in the Demonstration Plot Program. This variety can be sown late in the season and still yield as high as the early varieties. In 1988-89, T-J83 was sown in all the wheat demonstration plots.

The wheat seed produced through the demonstration plots in previous years has spread within the project area through exchange/sale among the farmers. In one case, a farmer sold his seed to 16 other nearby farmers. The demand for these new and improved varieties is increasing. To meet farmers' needs, the Sindh Seed Corporation will supply these new varieties of wheat, T-J83 and Sarbsabz, to the project area; in 1989-90, they sold through their sales depots 1200 mds of seed. Additionally, progressive farmers in the area purchased 2000 mds of certified seed directly from the Seed Corporation. A survey was conducted in the project area to assess the adoption rate of improved seed. It showed that in 1989-90, 28 percent of the wheat sown in the project area were improved varieties introduced by the Command Water Management Project. The survey also showed that the average yield of wheat throughout the project area increased from 20 mds/acre in 1986-87 to 32 mds/acre in 1989-90.

The Sindh Seed Corporation is unable to provide all the certified seed needs of the entire province. It would, therefore, be helpful to induce selected farmers to multiply improved seed for exchange or sale to other farmers. For this, farmer training in seed production techniques is required. Encouraged by the demonstration program results, the SMO/TAT is planning a seed multiplication program, on a full watercourse basis, in 1990-91.

TRAINING

Training of SMO/agricultural extension staff and farmers is an integral part of the extension outreach programme. Both formal (structured) and informal (on-the-job) training was provided by TAT and other line agencies' experts.

Staff Training: Training of the SMO/extension staff was linked with the Training and Visitation (T&V) programme of the Agricultural Extension Department. In all, 23 training sessions were held, which included workshops, seminars, and refresher courses. Though a variety of topics were covered in these training sessions, the main emphasis was on:

1. On-farm water management
2. Land leveling and good seedbed preparation
3. Importance of timeliness in the various recommended operations; i.e. sowing, application of irrigation water, fertilizer, insecticides, weeding and harvesting
4. Methods of plant protection
5. Judicious and efficient use of inputs like seed, fertilizer, irrigation water and pesticides

Farmer Training: Farmer training was organized through Water User Associations on various watercourses. Farmers were trained to make the best use of their resources by adopting improved agricultural practices. Most of this training was arranged in the vicinity of demonstration plots where farmers could see the benefits of adopting the improved practices. These gatherings helped farmers to educate themselves. They also provided a forum where farmers exchanged their views with fellow farmers and discussed their problems with representatives of various line and other cooperating agencies, i.e. Agricultural Extension, OFWM, research institutes, credit institutes, and input suppliers. In all, 32 Field Days were organized and 960 farmers received training. The training was given by subject-matter specialists, the TAT Agronomist and extension agents. The field training was supplemented with lectures, charts and audio-visual aids.

DISSEMINATION OF AGRICULTURAL INFORMATION

Improved management practices were developed by the TAT Agronomist for wheat, cotton, and fodder crops. Instructions were printed in the local language and distributed on a large scale to members of Water User Associations. Additionally, agricultural information brochures, bulletins, pamphlets and booklets, developed by both the private and public sector, were collected and placed at the farmers' meeting place (ottaq) on the watercourses to serve as reference material. Video cassettes containing agronomic information on various crops, on water management techniques, pest control, tractor operation and maintenance and other topics were collected and are available for training in the project area.

CONCLUSIONS

Both crop yields and farmer incomes can be substantially increased by motivating/educating farmers to adopt improved agricultural practices which are cost effective and within the financial resources and technical abilities of the farmers. Among the outputs of the Extension Outreach Programme, the following are worth mentioning:

1. Crop yields and farmer incomes increased
2. Improvement in the knowledge of the farmers
3. Improved interagency cooperation and coordination
4. Improved skills of the field personnel
5. Improved communication between the members of WUAs, Agricultural Extension, and Irrigation Department
6. Institutional Development of SMO

FUTURE STRATEGY

Encouraged by the success of the Extension Outreach Programme, the SMO/TAT will include in this programme, in Kharif 1990 and Rabi 1990-91, a full watercourse trial. The objective of this exercise is to

192

STAFF AND FARMER TRAINING

TRAINING WORKSHOP FOR FIELD STAFF AT SAKRAND

SMO AGRONOMIST TRAINING FARMERS AT ONE OF THE INFORMATION CENTRES

A GROUP OF TRAINERS AND TRAINESS:

assess the programme impact on the yields of different crops, farmers income and the possibility of replicating this approach on a large scale. Watercourse 2-L ABJI has been selected for this purpose.

DESCRIPTION OF WATERCOURSE 2-L ABJI AND PLAN OF WORK

The criteria used for selection of watercourse 2L Abji was;

1. Demonstration of interest by members of the WUAs
2. Identification of clear benefits
3. Large number of farmers
4. Long history of cooperation
5. Respected local leadership

2L Abji is located at the head reach of Abji Minor in the Sehra system. The design discharge of the watercourse is 1.34 cusecs. It irrigates a culturable command area of 395 acres. There is no private tubewell on the watercourse. Wheat is grown on 210 acres and cotton on 135 acres. The other crops grown on the watercourse include fodder, sugar cane and vegetables. The following activities will be undertaken by the Command Water Management Project during Kharif 1990- and Rabi 1990-91 on watercourse 2L Abji:

1. Wheat seed of certified/improved varieties, T-J83 and Sarsabz will be sown replacing the outdated/impure varieties on the entire watercourse.

2. Farmers' seed multiplication programme will be initiated; 40 acres of wheat will be allocated for this purpose. The improved seed thus obtained will be sold/exchanged with other farmers in the project area.

3. Hybrid seed of a multicut fodder (a cross of sudan grass and sorghum) which was introduced in the project area through demonstration plots has attracted the farmers. This seed is being introduced on watercourse 2-L ABJI on an area of 1.0 acres. Its performance is being monitored.

4. Hybrid sorghum seed (grain) is being procured and introduced to the farmers on the watercourse.

5. Farmers are being motivated/assisted in using improved and recommended varieties of cotton. Farmers will be assisted in protecting their cotton crop from insects and pests. Assistance from the private sector is being arranged in pest management.

6. Field Days, before and after sowing of each crop, training of field staff and farmers and dissemination of agricultural information will be an ongoing activity.

The general details of the production packages and implementation schedule are attached.

194

FULL WATERCOURSE TRIALS (2L-ABJI) EXTENSION OUTREACH PROGRAMME

PLAN OF WORK

The trials will be conducted in Kharif 1990 and Rabi 1990-91. The crops selected and the areas sown with each crop are:

KHARIF 1990	AREA IN ACRES
1. Cotton	98
2. Sorghum (grain)	20
3. Sorghum (fodder)	10
RABI 1990-91	
1. Wheat	210
2. Lucern (fodder)	10

CROP PRODUCTION PACKAGES

1. WHEAT Location 2L Abji (Kandiaro)
Area 210 Acres

Varieties:	EARLY	LATE
	T-J83	Sarsabz Johar

Source of Seed: SINDH SEED CORPORATION

Seed Rate: 45 kg/acre

Sowing Time: For early variety 1st Nov.-25th Nov.
For late variety 25th Nov.-20th Dec.

Seedbed Preparation: Two dry ploughings with disc plough. Planking the land with Sohaga (leveler). Divide the acre into four equal portions. Irrigate these sub-plots individually.

Sowing Methods: Due to heavy texture of the soils, broadcasting the seed in standing water is recommended. Divide the seed in two halves and broadcast the seed crosswise to avoid any gaps.

Fertilizer Application: One bag of DAP and 1 bag of urea is recommended. DAP should be incorporated into the soil before sowing. Apply 1/2 bag of urea at 1st irrigation and the other half at 2nd irrigation. In order to ensure uniform application, divide the fertilizer into equal halves and broadcast it crosswise.

Weeding: Pull out the weeds from the field two or three days after 1st irrigation.

Irrigation Schedule: Five post-sowing irrigations are recommended. In case of shortage of water, apply four irrigations according to the schedule below:

Five Irrigations	WHEN TO APPLY WATER (Days after Sowing)
1.	20 - 25
2.	40 - 45
3.	60 - 65
4.	80 - 85
5.	100 - 105

Four Irrigations	WHEN TO APPLY WATER (Days after Sowing)
1.	20 - 25
2.	40 - 45
3.	70 - 75
4.	100 - 105

2. COTTON:

Location:	2L Abji (Kandioro)
Area:	135 acre
Varieties:	Qalandri, Shaheen. Niab
Seed Rate:	13 kg/acre
Sowing time:	15th May - 15th June

Seedbed Preparation: Dry ploughing with mould board plough. Leveling with sohaga. Divide acre into four portions. Give an initial three acre - inch soaking dose. Sowing, crosswise ploughing with cultivator or global is recommended followed by planking.

Sowing Method: In order to get a uniform stand, line sowing is recommended with single row cotton drill. Acid delinting of seed is also recommended. It will reduce the chances of seed borne diseases and will not block the drill. The sowing should be done in rows 2-1/2 ft apart.

Thinning: Thinning should be done when the plants are 6"-9" high. Keep a distance of 6" between the plants; leave one plant per hole.

Weeding: Weeding should be done before 1st irrigation.

Fertilizer: One bag of DAP and one bag of urea is recommended. Apply DAP before sowing. Split the nitrogen dose. Apply 1/3 bag of urea with 1st irrigation and 2/3 with 2nd application.

Insect Control: Control of insects according to infestation of the pest. Get the assistance of extension agents to determine the time of spray and type of insecticide to be used.

Irrigation: Apply 1st irrigation after 40-45 days of sowing, then irrigate the crop at 3-week intervals. Last irrigation should be given at the end of October.

Picking: Try to pick twice or thrice. Always start picking at 10-11 p.m. Store in a dry place.

3. SORGHUM (GRAIN)

Area	20 Acre
Varieties	8319
Source of Seed	Pioneer Pak Seed Ltd.
Seed Rate	8 kg/acre
Sowing time	15th July - 15th August

Seedbed Preparation: Two dry ploughings with Desi plough followed by planking. Apply soaking dose and when the land comes into condition, plough with cultivator and plant the seed.

Sowing Method: Sowing in lines at a distance of 2 1/4 ft/ is preferable. Broadcasting is also a common practice. In case of line sowing, the crop should be thinned and a distance of 4 in. between plants should be maintained.

Fertilizer Application: At sowing, one bag of DAP and 1/2 bag of urea. When the crop is 11 1/2-2 ft. high, apply one bag of urea.

Irrigation: A good crop of sorghum can be realized with three to four irrigations. The first irrigation is applied after 15-20 days of sowing. It is followed by 2-3 more irrigations. At the time of earhead formation, water is critical. The crop should not be stressed at this stage.

Weeding: Weeding should be done after both the 1st and 2nd irrigations.

Insect Control: Stem borer is the most common insect that attacks sorghum. It starts right after sowing. Granules should be applied at the following rates to control the insects.

1. Diazanon (Granule) at the rate of 5 kg/acre
2. Furaden (Granule) at the rate of 10 kg/acre

4. SORGHUM (FODDER)

Area:	10 Acres
Varieties:	SSG 988 Sadabahar
Source of Seed:	Cargill Seed Pak Ltd. Pioneer Seed Pak Ltd.
Seed Rate:	SSG998 15 kg/acre Sadabahar 10 kg/acre
Sowing Time:	April - May

Seedbed Preparation: Plough twice with mould board plough followed by levelling with a sohage (planker).

Sowing Method: Broadcast crosswise in standing water.

Fertilizer: One bag of DAP and one bag of urea at sowing followed by a bag of urea after every cutting.

Irrigation: First irrigation after 15-20 days followed by irrigating every 15 days.

Harvest: The first cut will be approximately 2 1/2 months after sowing; subsequent cutting can be at 45-day intervals.

5. LUCERN

Area:	10 Acres
Varieties:	NK Sundor
Source of Seed:	Sandoz Pak Seed Ltd.
Seed Rate:	5 kg/acre
Sowing Time:	Middle of Oct. - middle of Nov.

Seedbed Preparation: Ploughing with mould board plough followed by planking.

Sowing Method: Broadcast in standing water.

Fertilizer Application: One bag of DAP and 1/4 bag of urea as starter. After every cutting, apply a bag of TSP. As it is a nitrogen fixing crop it does not require nitrogen applications.

Irrigation: It is a perrenial crop and should be irrigated according to the season. In general, bi-weekly irrigations in summer and monthly irrigations in winter are recommended.

Harvest: The crop is ready to cut 2 months after sowing. Seven to eight cuttings per year. Every cutting would yield 120 - 160 mds of fodder.

COST OF CULTIVATION OF WHEAT/ACRE

Item	Cost In Rupees	
	Demo Plot	Control Plot
Ploughing (Disc/Goball)	200	200
Levelling (Planking)	100	100
Cultivator	70	70
Cost of Seed	136	136
FERTILIZER		
Nitrogen	198	198
Phosphate	161	161
Postassic	23	-
WEEDING	100	-
Water Rates	50	50
Total	1038	915

THRESHING CHARGES
At the rate of Rs.6/md shall be included

COST OF CULTIVATION OF COTTON/ACRE

	Item	Cost In Rupees Demo Plot	Control Plot
1.	LAND PREPARATION		
	a. Plowing & Planking	80.00	80.00
	b. Levelling	40.00	40.00
	c. Plowing	80.00	80.00
2.	SEEDBED PREPARATION		
	a. Plowing & Planking	120.00	120.00
3.	SEED	65.00	65.00
4.	SOWING	35.00	35.00
5.	THINNING	50.00	-
6.	WATER RATES	50.00	50.00
7.	FERTILIZER		
	a. Phosphate	100.00	100.00
	b. Nitrogen	300.00	300.00
8.	PLANT PROTECTION	490.00	200.00
	TOTAL	1410.00	1070.00

200

Annex K

Report of Extension Outreach Program

ANNEX K

REPORT OF EXTENSION OUTREACH PROGRAM
By
Mohammed Asghar Khan, Senior Agronomist

The Extension Outreach program had the following main components:

1. DEMONSTRATION PLOT PROGRAM
2. SEED MULTIPLICATION PROGRAM
3. DESSIMINATION OF AGRICULTURAL INFORMATION
4. TRAINING OF FARMERS & FIELD STAFF.

DEMONSTRATION PLOT PROGRAMME

The main objective of the program was to increase the per acre yield of crops in the project area by efficient utilization of available resources (both water and non-water) of the farmers. As the majority of the farmers in the project area were illiterate and had limited resources, it was decided that, in order to motivate/educate the farmers, the first step was to demonstrate to the farmers how yields could be increased by adopting simple, non-expensive, cost effective improved agricultural practices. Wheat and cotton, the most important crops in the project area, were selected for demonstrations. The salient features of these demonstration plot programmes are listed below:

1. Use of certified/improved seed of recommended varities of wheat and cotton.
2. Preparation of weedfree and leveled seedbeds.
3. Timely planting of the crop.
4. Crosswise broadcasting of wheatseed to ensure gapfree germination.
5. Line sowing and placement of seed at proper depth to ensure the required number of plants/acre.
6. Timely and effective weed control.
7. Judicious, timely and uniform application of irrigation water and fertilizer.

The above general practices are all within a farmer's financial resources and technical abilities. Due to limitation of funds and staff, the demonstrations were limited to a selected number of water courses. Farmer Days were held regularly on these plots before the planting of a crop and during its different growth stages. Farmers were invited from neighboring watercourses. Water Users Association were very closely associated and involved in these demonstration plots and field days. The field days provided an opportunity to the members of WUAs to learn and see the benefits of using improved agricultural practices. Besides wheat and cotton, many other crops which are more efficient in water use, have high yield potential and can fit into the cropping pattern of the project area, were introduced:

1. SADA BAHAR

This is a hybrid multicut fodder (a cross between Sorgham X and Sudan grass). It can be sown starting March - June). If sown in the month of February, it can give eight cuttings. It was first introduced in Spring 1990 and became so popular with the farmers, that in spring of 1991, 7000 kg. of this crop was planted in the project area and it is expected that 7000 kgs. more will be planted by the month of June. The seed was procured by SMO through Cargill Pak Ltd. and sold to the farmers on cash payment.

2. SORGHAM GRAIN

Sorgham grain (hybrid) was also introduced by SMO in Kharif 1990 as demstration. This is a very high yielding variety which yields from 40-60 mds of grain. This seed is also in big demand by the farmers, and it is expected that about 12000 kg of this seed will be planted in the project area in Kharif 1991. Hybrid Maize, Sunflower, Lucern (Imported), Barseem (Imported) were also introduced in the project area through demonstrations.

3. KALAR GRASS

Kalar grass is known to survive in saline areas and helps in reclaiming saline lands. The SMO brought two truckloads of Kalar grass from the Bio Saline Research Institute, Lahore, and planted it on saline unproductive patches at 2L-Abji. The Kalar grass is growing well and it will be transplanted to other saline areas in the project.

FARMERS SEED MULTIPLICATION PROGRAM

During the demonstration plot program, good-quality seed was identified as one of the major factors in increasing the per acre yield of wheat crops. The Sind Seed Corporation is the only source of supply. There is a big gap between demand and supply. The Sind Seed Corporation is only able to supply 4% of the total demand. Encouraged by the results of the demonstation plots and the demand for certified and pure seed, it was decided to produce certified seed through WUAs. The Department of Federal Seed Certification and Sind Seed Corporation were contacted by the SMO to assist in this program. 400 acres were earmarked for this purpose. Certified seed of varities T-J.83 and Sarbaz were obtained from the Sind Seed Corporation. Members of WUA 2L-Abji and the Federation of WUAs at Kotri Kabir and Sehta Minor were contacted. A number of meetings were arranged with the farmers by the Sociologist & Agronomist of TA Team to motivate them to undertake the programme. Farmers were asked to prepare their lands according to the instructions of the TAT Agronomist, keeping their crop weedfree and rouging out the off-type plants. All other instructrions regarding various operations were strictly followed according to the input management package developed by the TAT Agronomist. 300 acres of certified wheat seed were planted on 2L Abji and 100 acres at Kotri Kabir, Sehta Minor and some other watercourses. Farmers cooperation was exemplary and beyond expectations. The crop at all locations looked distinctly better and more vigorous than the adjacent fields. The CWM/Representative of USAID inspected the crop in its early stages and was impressed by the enthusiasm of the farmers and by the crop itself. He promised to visit again when the crop would be mature. A big Farmers Day was organized at Watercourse 2L-Abji on 13th March, 1991. Invitation were extended to

representatives of different line agencies, USAID, World Bank Mission and farmers. The Deputy Director (Agronomy) Sind Seed Corporation also attended the field day with his teamates. Sahibzada Asif Mahmood of USAID was the chief guest. About 200 farmers from different locations in the project area attended the field day. All the participants visited the entire length of the watercourse and were impressed by the uniform stand, growth and the exoected yield of the crop. It is estimated that 15,000 kg of seed will be obtained from Watercourse 2L-Abji and another 4500 kg from other locations. The Deputy Director Sind Seed Corporation inspected the entire crop with his team members and declared that the crop meets the requirement of certified and pure seed and that SSC would be willing to lift the entire crop and pay a premium of seven rupees/maund to the farmers. He also informed the farmers that he would be willing to list the WUAs as their registered growers for the purpose of producing certified seed.

TRAINING

Training of SMO/Agricultural Extension staff and farmers remained an integral part of the Extension Outreach Program. Both formal (structured) and informal (on-the-job) training was provided by TAT and other line agency experts.

Staff Training

Training of the SMO/Extension staff was linked with the Training & Visitation (T&V) program of the Agricultural Extension Department. In all 30 training sessions were held, which included workshops, seminars and refreshes courses. Though a variety of topics were covered in these training sessions, the main emphasis was on:

1. On-farm-water management
2. Land levelling and good seedbed preparation
3. Importance of timeliness in the various recommended operations; i.e. sowing, application of irrigation water, fertilizer, pesticides, weeding and harvesting.
4. Methods of plant protection
5. Judicious and efficient use of inputs like seed, fertilizer irrigation and pesticides.

FARMER TRAINING

Farmer training was organized through WUAs on various watercourses. Farmers were trained to make the best use of their resources by adopting improved agricultural practices. Most of this training was arranged in the vicinity of the demonstration plots, where farmers could see the benefits of adopting the improved practices. These gatherings helped farmers to educate themselves. They also provided a forum where farmers exchanged their views with fellow farmers and discussed their problems with representatives of various line and cooperating agencies i.e. agricultural extension, OFWM, research institutes, credit institutes and input suppliers. In all, 50 field days were organized and 1500 farmers received training. The training was given by subject matter specialists, TAT Agronomist, WMS, Sociologist and extension agents. The field training was supplemented with lectures, charts and audio-visual aids.

DISSEMINATION OF AGRICULTURAL INFORMATION

Improved management practices were developed by the TAT Agronomist for wheat, cotton, maize, sorgham and lucern. Instructions were printed in the local language and distributed on large scale to members of WUAs. Additionally, agricultural information brochures, pamphlets and booklets developed under both the private and public sector were collected and placed at farmers meeting places (ottaqs) on the water-course to serve as reference material. Video and audio cassettes containing agronomic inforamtion on various crops, water management techniques, pest control, tractor operations and maintenance, and other related topics were collected and made available for training in the project area.

BALOCHISTAN

Demonstration

Demonstration plots were established on similar lines as in the Sindh project for vegetables and fodder crops. Watercourse 24 on Minor 4 was selected for a full watercourse trial. Most of the activities were confined on this watercourse as there were no funds available for demonstration and only limited support staff.

Note from AEW: Apart from the first paragraph, the rest of the text is exactly the same as in the same portions above (Training/Staff Training/ Farmer Training/Dissemination of Agricultural Information). There must be an error in this document - by the way, if you read Asghar's version it is terrible, the worst we ever had.

CONCLUSIONS

Both crop yields and farmers income can be substantially increased by motivating/educating farmers to adopt improved agricultural practices which are cost effective and within the financial resources and technical abilities of the farmers. Among the outputs of the extension outreach programme, the following are worth mentioning:

1. Crop yields and farmers income increased
2. Improvement in the knowledge of the farmers
3. Improved interagency cooperation and coordination
4. Improved skills of the field personnel
5. Improved communication between members of the WUAs, Agricultural Extension and Irrigation Departments
6. Institutional development of SMO
7. Emergence of a replicable model (full water coursetrial) to increase agricultural productivity on a much large scale.

Annex L

Organization of Private Tubewell Groups

ANNEX L

ORGANIZATION OF PRIVATE TUBEWELL GROUPS

M. Afzaal Khan - Sociologist

Organizing farmers at the watercourse level in the CWM Project was a mechanism for enhanced farmer participation in the watercourse improvement program and better maintenance of these watercourses. Efforts were also made to improve farmers' access to resources, agricultural information, and market through the WUAS. In the Full Trial Watercourses, where watercourse improvement has been completed, farmers' organizational programs included seed multiplication, conjunctive water use, marketing, and farmer training.

The report on tubewell organization for two types of groups - sole ownership and joint ownership - is presented below. The reports on other activities, such as seed multiplication, have been given separately.

1. SOLE OWNERSHIP AND SELLING WATER

In Shahkot Subproject area, Chak No. 18/RB at the Coordinated Watercourse, conjunctive water use was studied; a simple and short questionnaire was prepared and implemented. Information about private tubewell water use and purchasing/selling practices was obtained. There are seven private tubewells at CWC Shahkot, from which most of the farmers purchase water. The prevalent rate was Rs. 25/- per hour. Those farmers who had less than 200 percent cropping intensity were of the view that they did not have sufficient water supply. When asked why they did not purchase water to increase their cropping intensity, most of them replied that they were unable to pay cash for tubewell water because they did not have sufficient money at hand.

Based on the information collected, 19 farmers at the tail and middle of the watercourse were identified, who had often purchased water from private tubewells installed on the middle and the tail end of the watercourse. These farmers own a total of 96 acres of land, ranging in size from .5 acres to 9.5 acres. The fallow land constituted 31.5 acres during the 1989 Kharif season. The TA Team Sociologist visited these farmers and motivated them to find a solution to this problem. Ultimately three groups of 5, 6 and 8 members were formed to purchase water in order to cultivate their land during this Kharif season. These groups were formed with the mutual understanding of the farmers and tubewell owners. In the group formation process, the main considerations were: i) easy access and less conveyance losses of tubewell water, and ii) credit worthiness of a farmer in the eyes of the tubewell owner. Each group met twice or thrice to finalize the agreement and openly discussed every point they considered necessary. Finally, they agreed on the following arrangements:

i) Tubewell owners would supply water to each member of the group purchasing water from him as and when required during this Kharif season.

2) Tubewell owners agreed to receive water charges after the harvest of the rice crop. Correspondingly, group members/farmers promised to pay for water @ Rs. 25/- after the harvest of the rice crop in cash or kind (at the prevailing market prices) as requested by the tubewell owners.

3) Farmers agreed to cultivate their whole area during Kharif as the water supply would be ensured.

4) Tubewell owners would keep a record of the water supplied and if any dispute arose, the group would resolve it hemselves.

Arrangements for two groups were alright; the third group disintegrated at the time of sowing rice. Out of 5 members, 3 joined the other group of 8, raising its number to 11. Two members did not join any group. The matter was discussed with the farmers concerned and the tubewell owner separately in order to discover the factors responsible for the group's disintegration.

Discussions revealed that there was no dispute regarding arrangements. The tubewell owner had left farming and had given his land out on rent. The farmers thought that the tubewell owner might not be able to fulfill his agreement, as his financial condition was deteriorating in their opinion. Though the owner never showed any inability to supply water and was ready to keep his word, the farmers did not want to take the risk of discontinuation of water supply after sowing their crops.

The tubewell owner selling water to the group of 6 farmers did not show any constraint in meeting operational costs. The other tubewell owner providing water to the group of 11 farmers was in financial difficulties. The owner managed to obtain a loan form a village businessman in order to meet the operating cost of the tubewell.

The record of water purchases was maintained by the owner of the tubewell and the payments to be made by individual members were determined. There was no dispute between the tubewell owners and individual members of the group on the accounts maintained. The payments for the water purchased were made promptly in cash or in kind after the harvest of the rice crop.

An analysis of the data on the tubewell members' cropping pattern and intensity indicated a major improvement. For the first group, which consisted of five farmers, the cropping intensity was 95% in Kharif 1990 as compared to 44% the previous season. For the second group, the cropping intensity increased from 74% in Kharif 1989 to 87% in 1990 as a result of access to groundwater. Data also indicated that this certainty of irrigation water increased the acreage under high income vegetable crops.

2. JOINT OWNERSHIP

A joint tubewell group was organized with 6 farmers having 7 shares. The group installed the tubewell and during the previous Kharif they started pumping water. The study regarding the maintenance and operation could not be completed.

It was planned to study three more existing private tubewell organizations for analysis of organizational models and economics of these organizations. It would only be possible to recommend a replicable model after the completion of this programme. Unfortunately, we could not complete this program, but the lessons learned during the implementation of this program are given here under:

a) The joint tubewell groups should be organized in areas where tubewell water is greatly needed in order to maintain farmers' interest in sustaining them.

b) Encourage individual farmers to manage tubewells as private business to ensure their proper maintenance and adequate, timely supply to their subscribers.

Annex M

WUA Federation at Pacca Dalla Minor

ANNEX M

WUA FEDERATION AT PACCA DALLA MINOR

By
M. Afzaal Khan
Sociologist

It is generally conceived that Federation of WUAS is necessary to deal with issues and problems at the minor or distributary level. Farmers participation through Federation could be ensured in the improvement, maintenance and operation of minor/distributary with the Irrigation Department. It could also serve as a channel of communication between the irrigation Department and the water users.

It was planned to organize a WUA Federation at Pacca Dalla minor for systematic pilot testing of this programme. The Pacca Dalla minor was selected because there are five water courses. Considering this size more appropriate for pilot testing and easy to manage activities. It was decided to start work at this minor.

To develop the functions and structure of the federation, many farmers were contacted at the head and tail watercourses. Briefly, the main problems which came into light were:

1. Equitable water distribution.

2. Unawareness of farmers towards their water shares in terms of sanction/designed discharge at the watercourse and minor level. They generally perceive that they are getting less water.

3. Maintenance of the minor. Farmers of tail watercourses cleaned the minor with the permission of the Irrigation Department. The farmers of the head two watercourses were apposed to the cleaning of the minor as this would reduce the flow into their watercourses.

   In the light of information the objectives of the Federation and its structure and functions were proposed.

OBJECTIVES OF THE FEDERATION

1. Assist PID in the equitable distribution of available water among the watercourses along the Pacca ella Minor; (Training: Water Management)

2. Assist PID in the proper maintenance of the minor; (Training: System of proper maintenance)

3. Help resolve irrigation-related conflict among federation members at the minor level; (Mechanism for conflict resolution)

211

4. Help monitor water discharge in the watercourse along the minor to adjust water supply in according with water requirement; (Training: Water Measurement and recording)

5. Bring to PID's notice whatever problems are obtaining on the minor level regarding water distribution and allocation; tampering of the moghas and other concrete structures; and whatever repairs are necessary in order to put the minor at optimum level of operation;

6. To engage in collective purchase of non-water inputs like seeds, fertilizers, pesticides, etc. (Provide farmers information on sources of non-water inputs)

7. To liaison and establish linkages with line agencies of the government like the Agriculture Extension; OFWM; Cooperative Banks ad other non-government resource institutions were established to render assistance to the farmers;

8. Improve the communication process between and among the farmers at the head, middle, and tail portions of the watercourse.

STRUCTURE OF THE FEDERATION

The following is the proposed structure of the Federation:

i) The General Body: It will comprise all the members of the WUAs on this minor.

ii) The General Committee: The general committee will consist of the 4 executive body members of each WUAs. These 20 members will represent WUAs in federation.

iii) Executive Committee: The executive committee will be elected/selected from the general committee.

iv) Functional Committees: To perform different tasks the functional committee can be organized if the situation so required. The member of the committee can be taken from the general committee and from general body os that at different level more people can get a chance to participate and to distribute the responsibilities to many persons.

FUNCTIONS OF THE FEDERATION

i) Planning: The federation can make planning with the assistance, coordination of the WUAs for preparing its work plan, keeping in view the needs of the area.

ii) Coordination: The federation will be able to establish its links with the line agencies, and will discuss the matters of common concern on behalf of all the WUAs in the

212

federation area.

iii) Communication Channel: The federation will act as communication channel between the Irrigation Department and Water Users.

iv) Assistance to Line Department: The federation will assist the line departments for the implementation of their program like demonstration and to arrange field days.

The following steps has been taken so far in the organization process.

a) Discussion Of The Federation Program With The Farmers

The members of the five WUAs were contacted individually and the federation program discussed in light of the problems and potential for their specific watercourses. In addition, a structure for the federation and the process for making it operational was explained to the farmers and their input noted.

In these meetings the role of the WUA and the WUA Act was reviewed with the farmers. The need for an active organization to address their problems was discussed.

b) Replacement Of Inactive Executive Members Of WUAs

While holding a WUA meeting, it was noticed that some of the executive body members did not attend due to lack of interest; therefore the farmers decided to replace them with new members. In this regard general meetings were arranged and these members were changed with consent of the majority of the shareholders.

c) Joint Meeting of WUAs For Watercourses Situated At Head Of The Minor

A joint meeting of WUAs for the two watercourses situated at the head of the Minor was held to discuss the problems common to them and their conflict with the tail-enders, i.e., the cleaning of the Minor. Consent of these farmers in maintaining an equitable water distribution for all five watercourses on this Minor and a joint federation program for better interaction with the Irrigation Department was attained in this meeting.

d) A Joint Meeting Of WUAs For Watercourses Situated At Tail Of The Minor

Another joint meeting for the three tail watercourses was held in Bhoro village. The structure and purpose of this meeting was similar to the one held for the two head

213

First Meeting Of The Executive Committee Of Federation At 18/RB Shahkot SubProject

watercourses. The problem of the tail watercourses and how their problems with the farmers at the head watercourses can be resolved through the minor level federation was emphasized. High level support for the federation program was given by these farmers.

e) Joint Meeting Of Five WUAs And Organization Of Federation

Following a clear commitment by the representatives of the five watercourses in the federation, a joint meeting was organized at Chak-18RB. In this meeting, the Executive Body of the Federation was selected by mutual consensus.

For the first activity of the Federation, the problems of equitable distribution among the five watercourses and the overall low supply into the Minor were selected for investigation and correction.

The Technical Administrative Officer of the TA Team and Mr. Shabbir of the SMO carried out the water measurements requested by the Federation. These measurements indicated that the Minor was drawing 1.26 cusecs less than the authorized discharge of 6 cusecs. Among the five watercourses, three were receiving less than their sanctioned supply of water and the other two somewhat higher than the sanctioned level.

f) Meeting With The SDO And Executive Engineer Of PID

A meeting was then held with the Executive Engineer and the SAO of the Irrigation Department to explain the program of the Federation of water users and the need for cooperation form the PID. The farmers' request for adjusting the flow rate into the Minor and the individual watercourses was communicated. In response, the SAO indicated the need for repeating the measurements and identifying the causes for inequitable distribution.

A date for measurements was set with the SAO. However, this SAO was replaced with another during this period and the measurements were not made.

g) Organization Of Discharge Measurement Committee

It was decided that to perform different tasks under the Federation, functional committees would be organized. Therefore, one functional committee, the Discharge Measurement Committee consisting of 10 members, 2 from each WC, has been organized.

It was planned that members will be given training regarding water discharge measurements and they will work with the Project staff at the time of water measurements. A program

245

has been outlined to train the members of this Committee. After that, unfortunately we could not continue this programme.

216

Annex N

End of Project Report

ANNEX N

END OF PROJECT REPORT

by

BASHIR AHMAD
Project Engineer

for the period
March 02, 1988 to March 28, 1991

CWM-ARDINC
6-D, Upper Mall, Lahore
PAKISTAN

218

CONTENTS

S.NO.	TOPIC	PAGE
I.	Installation and Operation of Water Level Recorders and Weather Stations. Processing, Interpretation and Use of Their Data	03
	Justification Program Design and Implementation Strategy for Water Level Recorders Results from Water Level Recorders Recommendations on Water level Recorders Program Design and Implementation Strategy for Weather Stations Request for Instruments and Accessories Results from Weather Stations Recommendations for Weather Stations	
II.	Study of Conveyance Losses in Warsak Lift Canal	11
III.	Coordination with TAT and TDY	13
IV.	Equipment Requirements of Provinces	13
V.	Administration and Technical Duties	14

219

BASHIR AHMAD
Project Engineer

March 02, 1988 to March 28, 1991

I. INSTALLATION AND OPERATION OF WATER LEVEL RECORDERS AND WEATHER STATIONS. PROCESSING, INTERPRETATION AND USE OF THEIR DATA

JUSTIFICATION:

Canal irrigation system is designed to meet water requirements of crops. How the system in the four provinces stands at present in regard to its reliability, adequacy, distribution pattern and mode of operation needs to be investigated. It is also essential to know the water requirements of different crops under local climatic environment and to determine the frequency, amount and time of irrigation during different stages of crop growth.

The main purpose of GOP, through the Command Water Management Project, was to increase agricultural production by employing all means which help achieve this goal, including the water factor.

The program of observing time series of water distribution in the irrigation system and the climatic characteristics of each project area was to determine the existing pattern of water distribution and to suggest suitable measures for equity in the distribution of water and provide climatic data to calculate crop water requirements and develop calendars for irrigation scheduling.

PROGRAM DESIGN AND IMPLEMENTATION STRATEGY FOR WATER LEVEL RECORDERS:

In order to understand the problems associated with water and to suggest their solutions it is necessary to have a continuous record of flow at strategic points. For this purpose USAID procured 48 water level recorders and allocated them to the four provinces as follows:

Balochistan:	Lasbela Canal	6 No.
NWFP:	Warsak Lift Canal	6 No.
Punjab:	Pakpattan	6 No.
	6R-Hakra	6 No.
	Niazbeg	6 No.
	Shahkot	6 No.
Sindh:	Naulakhi	6 No.
	Sehra	6 No.

I visited all the areas and in consultation with the officials of CWMP and PID selected suitable sites for the installation of these recorders. For proper working of the recorder, a stilling well has to be provided. For Punjab and Sindh, a steel pipe housing was designed to serve as stilling well to keep the recorder in safe custody under lock and key for its undisturbed operation. For Balochistan and NWFP,

220

masonry recorder houses were designed in view of their special security risks. A staff gauge is an integral part of the water level recorder. For the steel casing, an inclined staff gauge was designed for installation on channels with sloping sides.

Design of steel casing was first submitted to USAID which approved a sum of $ 15,000 in PIL No. 183 dated 02-06-89. Later, when the design of masonry structure for the recorder house was submitted for Balochistan and NWFP subprojects, USAID approved an additional amount of $10,000 in PIL No. 183A dated 09-13-1989 to cover the additional cost involved in the construction of masonary recorder houses.

In Balochistan, six water level recorder houses were constructed at the following sites:

Lasbela Canal Head
Minor No. 1 Head
Minor No. 2 Head
Minor No. 3 Head
Minor No. 4 Head
Minor No. 5 Head

Water level recorders and staff gauges were installed and put into operation at all the above locations except Minor No. 4 head which was planned to be lined.

In NWFP the following six sites were selected on Warsak Lift Canal. However, it was not possible to construct recorder houses in masonry at any of these sites because of numerous problems.

Head of Feeder Channel at Warsak Gravity Canal RD 20130
RD 260 Head of Warsak Lift Canal
RD 40000 Start of Settled Area
RD 77700
RD 101000 start of Tail Section
RD 142800 (For future use)

In Punjab, eighteen recorder housings in steel casing were installed at the following sites, where water level recorders and staff gauges have been installed and put in operation.

NIAZBEG Sub-Project
RD 76000
RD 134000
RD 166000
Jalleyki Head
Thatti Head
Tail
PAKPATTAN Sub-Project
3R Head
1R/3R Head
1R/3R Tail

221

SHAHKOT Sub-Project
- Head
- RD 43500
- RD 117315
- RD 131800
- RD 142435

6R-HAKRA Sub-Project
- 6R Head
- 6R (2R)
- 6R RD 128000
- 6R Tail

In Sindh, twelve recorder houses in steel casing were installed at the following sites:

Naulakhi Sub-Project
- Naulakhi Branch Head
- Kotri Minor Head
- Khanwahan Minor Head
- Gul Minor Head
- Jatoi Minor Head
- Sial Distributary Tail

Sehra Sub-Project
- Sehra Branch Head
- Budika Minor Head
- Darbello Minor Head
- Detha Minor Head
- Dalipota Minor Head
- Mithiani Distributary Tail

So far four water level recorders have been installed and put into operation.

In order to train on how to install, operate and maintain a water level recorder, how to process its data and how to present the end results, a series of training courses were held in (1) Hub Chowki, Balochistan (2) Lahore, Punjab and (3) Kandiaro, Sindh and personnel selected by CWMP and PID were trained on the subject with practical demonstrations. Presently the recorders are being operated by CWMP personnel and in Punjab data processing has also started. When CWMP finally closes, this work of operating recorders and processing their data will be performed by PID.

In the processing of water level recorder data, it is necessary to have a rating table which gives discharge corresponding to depth of water in the channel. For this purpose a series of accurate discharge readings corresponding to various depths of flow are taken and, by regression analysis of this data, a discharge equation is established for each site and this is used to work out a rating table.

In Punjab and Sindh, work on establishing rating tables has just started.

222

RESULTS FROM WATER LEVEL RECORDERS:

Water level recorder housing can be installed or constructed when there is little or no flow in the channel. This work can therefore be carried out properly during the canal closure period, which generally falls in January. This constraint, alongwith other financial and miscellaneous problems, has directly affected the program. The installation has taken much longer than expected. Unfortunately no installations could be carried out in NWFP due to various reasons.

In Punjab, a rating table has been established for one site, while other sites will be taken care of in future. In Balochistan and Sindh, no measurements have so far been made to establish rating tables.

In the absence of flow data no study could be made of the irrigation system.

RECOMMENDATIONS ON WATER LEVEL RECORDERS:

Steps should be taken to install the six water level recorders in NWFP. CWMP and PID should join hands in making flow measurements and establish rating tables. All recorders should be operated properly and the data should be analysed to understand the existing flow distribution. Keeping in view the water requirements of crops, recommendations should be made to ensure the reliability, adequacy and equity of water distribution, especially in view of the recently concluded historic agreement on the distribution of Indus River Water among the four provinces of Pakistan which allocated substantial increases in water supplies for each province.

PROGRAM DESIGN AND IMPLEMENTATION STRATEGY FOR WEATHER STATIONS:

Prior to my joining ARDINC it had already been decided that, in all, eight weather stations would be established in the project areas as shown below:

Balochistan	1
NWFP	1
Punjab	4
Sindh	2

SITES:

I visited all the sub-project areas and, keeping all requirements for a suitable location in view, selected the following sites.

Balochistan:

(1) Hub Chowki, Open space within PID Colony, housing SDO office also

223

NWFP:

(1) Warsak Lift Canal, RD 68800, Right Bank
Near Sulaiman Khail Village

PUNJAB:

(1) Niazbeg Sub-Project
Jalleyki Canal Rest House, Field adjoining compound

(2) Pakpattan Sub-Project
Pipli Adda, Open Land in front of and belonging to the Agriculture Office

(3) 6R-Hakra Sub-Project
Faqir Wali Canal Office/Rest House
Open Land

(4) Shahkot Sub-Proejct
Lakar Mandi Canal Rest House,
Open Land

SINDH:

(1) Naulakhi Area
Kotri Minor Head, Adjoining Open Land

(2) Sehra Area
Tharushah Canal Office/Rest House,
Open field.

I discussed the suitability of these sites with the respective Sub-Project Managers and they all gave their concurrence.

EQUIPMENT:

During my visits to the Subproject offices, I found out that USAID had already supplied eight sets of instruments to these offices for the establishment of eight weather stations. Each set of instruments consisted of the following items:

1. Evaporation Pan, Class A
   with Stilling Well and Hook Gauge
2. Maximum Minimum Thermometer Set for water
3. Standard 8-inch Raingauge with stand

Since this did not meet the minimum requirement of a weather station, I made a survey of the local market at Lahore and Karachi and noted down the instruments available and their prices. I wrote a separate report for each province and sent it to the respective Subproject Manager. My report dealt with the following topics:

1. Site of weather station.
2. Instrument supplied already.
3. Complementary instruments in order of necessity alongwith their prices.
4. Accessories for installation like fence, instrument stands and their concrete bases.
5. Layout of instruments in the station with all necessary dimensions.

224

6. All installation details including directional positioning of fence and instruments; instrument stand, base and foundation; preparation and maintenance of plot.
7. Data Books and other miscellaneous items required for the operation and maintenance of station.
8. Selection of Observers and their training.

The reaction of each province on my report and the steps taken are as follows:

BALOCHISTAN:

The SPM purchased the following instruments and provided necessary funding for other installation accessories.

Maximum and Minimum Thermometer Set for air temperature
Hygrothermograph
Psychrometer
Anemometer

The station was therefore installed and a permanent observer was appointed who is still taking observations at the station in a satisfactory manner.

NWFP:

The station could not be established for lack of funds. The minimum requirement of instruments, fence and instrument stands could not be purchased. USAID later approved installation expenditure for the preparation of the plot, making concrete bases, some miscellaneous supplies and painting fence and stands, but this could not be utilized because complementary equipment and accessories had not been purchased.

PUNJAB:

The SPM showed sufficient interest and purchased the following instruments in addition to fence, instrument stands and other necessary supplies.

1. Maximum & Minimum Thermometer Set for air temperature
2. Psychrometer
3. Anemometer

Consequently all the four weather stations were installed one after the other. Observers were trained and all the stations are now working.

SINDH:

Lack of funds hindered the establishment of the two weather stations.

225

REQUEST FOR INSTRUMENTS AND ACCESSORIES:

At one stage when I was approached by USAID to write specifications for equipment and supplies requested by the provinces, I included in this list all weather station instruments and accessories which were necessary but could not be purchased by the SPMs due to lack of fund. This supply is still awaited.

RESULTS FROM WEATHER STATIONS:

For Balochistan, the station in Hub Chowki is working satisfactorily. Part of the processing was done by the Sub-Engineer of PID in Hub Chowki. Checking and rest of the processing was done by me. The following data is available since the installation in May 1989.

Rainfall
Evaporation
Wind Speed
Maximum, Minimum and Average Air Temperature
Maximum, Minimum and Average Relative Humidity
Psychrometric Readings and Relative Humidity

For Punjab, four weather stations are under operation in the four sub project areas. Data has been processed for the following three stations for the periods shown against each.

1.	Jalleyki	August 1988 to September 1990
2.	Pipli Adda	January 1988 to December 1990
3.	Laker Mandi	August 1988 to December 1990

For these stations the following daily information is available:

Rainfall
Evaporation
Wind Speed
Maximum, Minimum and Average Air Temperature
Psychrometric Readings and Relative Humidity
(with some gaps)

Although the observed data does give some idea of the climatic conditions of the area, it is insufficient to calculate crop water requirements which need data on solar radiation energy and sunshine hours in addition to air temperature, relative humidity and wind speed. If the complementary equipment which I have requested from USAID is installed at all the stations, observations then obtained will be sufficient to calculate crop water requirements. A calendar can then be developed for irrigation scheduling.

226

RECOMMENDATIONS FOR WEATHER STATIONS:

(1) The major outcome of the program is the establishment of five weather stations in Balochistan and Punjab. The SPMs of Sindh and NWFP also wish to install weather stations. Once the complementary equipment and accessories become available, the three weather stations in Sindh and NWFP should be installed and the five stations in Balochistan and Punjab should be completed.

(2) Data from completed stations should be used to calculate crop water requirement on monthly basis for right use of water at the right time.

II. STUDY OF CONVEYANCE LOSSES IN WARSAK LIFT CANAL:

An irrigation channel loses some of its water while conveying it from one place to another through either evaporation from open surfaces or by seepage through the wetted perimeter. The seepage loss amounts to about 92% of the total loss while the remaining 8% loss is due to evaporation. If a channel is lined properly, its conveyance loss can be reduced to a minimum and the water so saved can be utilized to augment the present supply.

Warsak Lift Canal is no exception. It presents a rather peculiar situation. Four pumps are supplied to lift water from the feeder channel to its head. Generally only three of the pumps are working. Actually the head reach is probably not spacious enough to take in the flow of the fourth pump, if at all it works. The first 40000 feet length of canal pass through the tribal area where control on the use of water is not easy. If water is used for other purposes than irrigation. it is at the cost of downstream agriculture farms.

Whatever water is left after RD 40000, is generally insufficient and too precious to be lost through seepage. To reduce this loss to a minimum, more and more canal lining is being done every year at Warsak Lift Canal. The first 40000 feet of the canal were lined right from the beginning. Lining of the reaches from RD 39100 to 72400 and from RD 86000 to 153000 were completed during the period from 1985 to 1990. Lining of the reach from RD 72400 to 86000 is planned to be completed this year.

In order to ensure that an outlet draws only its sanctioned discharge and to reduce losses in a watercourse, a phased program has been going on whereby outlets are being remodelled, naccas being provided at diversion points and watercourses are being improved by lining them. Records show that from 1986 to end 1990, 25 outlets were remodelled and 52 watercourses were lined on a total length of 16043 meters. Plans are that this year 75 outlets will be remodelled and six water courses will be lined on a total length of 2501 meters.

227

A diagnostic study of the Warsak Lift Canal was conducted during November and December of 1985 by a team from Colorado State University. It was found that the conveyance loss in the lined reach from RD 100 to RD 39700 was 0.16% per 1000 feet and in the unlined reach from RD 39700 to RD 101000 the conveyance loss was 0.23% per 1000 feet. The study made measurements on four watercourses and found out that their conveyance loss varied from 2.2% to 6.0% over a length of 1000 feet.

Conveyance losses in Warsak Lift Canal and some of its watercourses were again measured firstly in December 1989 and then in December 1990. Both times I participated in the measurements and subsequent calculations. December 1989 measurements showed that the conveyance loss in the lined portion of the main channel was almost negligible. In December 1990, one reach was selected in the unlined earthen section of canal and its conveyance loss was 0.54% per 1000 feet (ranging from 6-9% in a length of 1000 ft). In the reach selected from the lined portion of the canal, the conveyance loss turned out to be 0.19% per 1000 feet.

It is needless to say that lining of canals improves the hydraulic efficiency of the channels and reduces the conveyance loss. It results in net saving of precious water and affords easy maintenance of canal channels. In the same way, lining of watercourses in proper dimensions is beneficial in reducing the loss of precious water and allowing the saved quantity to be used for irrigation.

III. COORDINATION WITH TAT & TDY:

Throughout my service with ARDINC I constantly gave a helping hand to all TAT members and TDYs in fulfilling their jobs. Below is a summary of some of the extended help.

1. Contacted concerned offices and collected complete daily weather data for stations situated in or around our sub project areas.

2. Collected flow turn (WARABANDI) data for some water courses in Punjab.

3. Translated some reports from English to Urdu for distribution among non-English speaking groups.

4. Attended meetings and provided simultaneous translation from Urdu to English to expatriates.

5. Corrected some technical reports.

6. Supervised measurement of discharge in minors and watercourses on behalf of Water Management Specialists.

228

7. Explained and demonstrated to Water Management Specialists the selection of sites for weather stations and water level recorders; the assembly, operation and maintenance of water level recorders.

8. Helped Sociologist in determining the existing flow pattern in a minor and its water courses in order to take suitable measures for equitable distribution of water.

IV. EQUIPMENT REQUIREMENTS OF PROVINCES:

CWMP SPMs have been sending their requirements for different types of equipment to USAID for procurement. There was a need to consolidate these demands, to know what they wanted exactly and then to write technical specifications for this equipment for different fields. USAID gave me this job. I visited all SMOs and noted down the exact requirement of each SPM. I surveyed the market and looked through catalogues to identify possible suppliers, examine their products and to know the prices.

I divided the equipment into the following three categories:

A. Farm/Irrigation Equipment/Implements
B. Water Management/Data Collection/Survey Equipment
C. Office Furniture & Equipment

I prepared a report consisting of three sections. In the first section I gave for each of the three categories names of items, quantity required by each province and their total, estimated unit and total cost in Rupees and Dollars. In this list I included all instruments and accessories for weather stations which were essential but could not be purchased by SPMs. In the second section of the report I gave technical specifications for all items listed in the first section. In the third section of the report I gave addresses of possible suppliers for the listed items.

Based on this report USAID invited tenders for the supply of this equipment. Some bidders sent queries about some items; these were passed on to me and I answered them all.. When offers arrived I was called to Islamabad where I analysed all of them and identified each item, the most suitable choice fitting the specifications. At the request of USAID Karachi I advised them on the choice of some items. I gave my opinion about the choice for these items.

The latest news about this procurement is that some items have been purchased and delivered to SPMs while other items are in various stages of processing.

229

V. ADMINISTRATION AND TECHNICAL DUTIES:

Initially I was hired as Technical Administrative Officer and performed the following duties in accordance with my scope of work.

1. Coordination with CWM Project GOP personnel (both federal and provincial level), USAID personnel and with CWM-ARDINC staff on all project activities under the responsibility of ARDINC's Chief of Party.

2. Provide liaison and technical advice on GOP and line departments policies and practices to CWM-ARDINC staff.

3. Assist ARDINC's Chief of Party in the operation of all segments of the CWM Project activities including the technical control of designated local personnel.

4. Assist Chief of Party and Technical Assistance Team in the reporting and data collection activities of the Project.

5. Assist in the supervision, overview, and control of the accounting and financial activities of both the Lahore and Karachi Offices of ARDINC.

6. Provide technical and administrative assistance to the entire CWM-ARDINC staff.

7. Assist in inventory control and maintenance scheduling of all project related materials and equipment to include all office furniture, etc. issued to ARDINC.

8. Assist in the supervision of all vehicles and drivers, to include record keeping and filing, use and maintenance. Develop for the drivers a safety program for review and approval by the Chief of Party;

9. Liaison with the two Expatriate Office Coordinators and Office Secretaries in Lahore and Karachi Offices.

10. Travel within the Provinces as authorized by Chief of Party and as necessary in order to fulfil main function of liaison with various organizations.

11. Assist with the passport renewals, revalidation of visas, and police registration.

230

12. Assist the Chief of Party in all activities including, but not limited to the following:

    i) aid in the implementation of the Command Water Management Master Plan;

    ii) aid in the implementation of the individual staff work plans;

    iii) aid in the procurement of office supplies and materials, and assist in the custom clearance of equipment and goods.

Under CWM project, weather station equipment and water level recorders were to be purchased and installed at suitable sites. Since I had vast experience in this type of activity while none of the TAT members had any such experience I took up this job and was solely responsible for the following:

1. Purchase of complementary weather station equipment and accessories.

2. Planning, design and establishment of weather stations and water level recording stations at all the sub projects in the four provinces.

3. Training of observers for weather stations and water level recorders regarding assembly, installation, operation and maintenance of equipment and analysis of their data.

When new ARDINC offices started functioning at Islamabad and Peshawar and Dr. M.I. Haider was appointed as Expatriate Administrative Coordinator for Lahore Office my administrative duties were reduced and I started giving 50% to 75% of my time to technical work. In January 1991 when Expatriates were evacuated to USA due to the imminent war between allied forces and Iraq over Kuwait occupation I was relieved of all administrative duties except the preparation of inventory of office furniture and equipment present in all the four ARDINC Offices at Islamabad, Karachi, Lahore and Peshawar. This status continued until all the ARDINC Offices in Pakistan were officially closed on March 28, 1991.

Annex O

Extension Specialist's End-of-Tour Report

232

Annex O

Extension Specialist's End-of-Tour Report

1.0 Review of the Scope of Work for the Extension Specialist--Lahore

In the third year of the contract period, the title of the Extension Specialist was changed to Farmer Organization Specialist-Peshawar.

In the USAID Project Paper, it was assumed that the advisor would perform the following tasks during his tenure:

- Assume principal responsibility for assisting in the development of Water User Associations.
- Examine and become familiar with the current legislation at the provincial and federal Levels dealing with WUAs and similar rural associations.
- Train CWM, OFWM, and extension staff in rural organization techniques.
- Ensure that extension personnel are able to understand and relate to farmers and assist them in understanding the procedures for obtaining loans, getting inputs for the farm, farm management concepts, and how to participate in the decision-making process.
- Develop models for working with WUAs in each subproject area, oversee implementation of the models, and refine them as needed.
- Supervise, in close collaboration with Subproject Managers and the USAID/Pakistan Social Scientist, the local WUA Development Specialists.
- In collaboration with the WMS II Team, assist with the development/implementation of the SMOs' monitoring and evaluation systems and train SMO staff in methods of data-gathering, analysis, and in interpretation for planning purposes.
- Assist in defining research, analysis, and planning tasks for the special impact evaluations.
- Assist SMOs in evaluating socially oriented data in order to guide program operations and evaluate operation plans, groups, and associations as well as individuals.

233

- As required, develop special studies of individual attitudes, group dynamics, and community participation as these pertain to the planning and implementation of the SMOs' operation plans and train staff in their execution.

The advisor undertook all of the activities indicated above during the ract period. As indicated in each of the sections below highlighting specific program areas, the intervention of the Farmer Organization Specialist was paramount. As most of the program areas of CWM were interdisciplinary by nature, most of the work was implemented through a team effort approach. Therefore, it is difficult to separate out specific tasks which individual team members were responsible for, as decisions and fieldwork were TAT/SMO staff-generated.

It would be useful at this stage to point out some of the assumptions that were made in the Project Paper (PP), and how this determined or affected the development of the project. The PP assumes that the Water User Association Development Specialists (WUADS) will have a major role in technical assistance and will be recruited directly by the TAT Contractor. Along with the extension specialists, they were to form the basis of a strong and effective WUA development network. However, prior to the arrival of the TAT, this idea was changed to have the WUADS direct employees of USAID under secondment to the SMOs.

An assumption in the Project Paper was that the government counterpart capabilities were adequate to undertake project implementation. Many of the counterparts lacked basic knowledge of their field. Allowances should have been made for the TAT to re-train their counterparts within the project time framework.

In addition to shortcomings in overall design, there were many hurdles to routine implementation, particularly problems related to the ability of the SMO to coordinate line agencies. Despite the expectations of the SAR and the PP, the SMO entity, as such, was unable to develop a method of administering the project's line agency components. By the second year of the project, line agencies were asked by the Federal Cell to implement their own programs directly; line agencies likewise were asked to work directly with TAT members in developing and implementing specific field activities.

2.0 Accomplishments and Findings

2.1 *Training to WUADS and WUA Officers*

The project in NWFP placed major emphasis on imparting technical information and skills to farmers in the command area. Both the SAR and the USAID PP require the TAT and the SMO staff to coordinate the farmers' training component, and report on the experience. This was done via individual training reports issued from the TAT Peshawar Office and through Quarterly Progress Reports.

As part of an overall strategy to impart technical skills to government officers responsible for forming WUAs and strengthening their capability to carry out watercourse improvement and joint agricultural activities, the TAT Farmer Organization Specialist regularly conducted training seminars, together with and for the WUADS. The training focused on rural leadership identification and strengthening, and skills to motivate shareholders to take part and sustain their active participation in the program. Over 3,000 farmer/shareholders in Punjab and NWFP received up to one to three days of training during the TAT contract period. In general, the farmers were receptive to the idea of WUA strengthening training, although the interest waned whenever there were problems with water supply regularity and/or government services.

2.2 *OFWM Field Advisory Service*

One of the truly innovative aspects of the program in NWFP was the development of the OFWM Field Advisory Service, which enabled the OFWM staff to offer technical assistance to farmers outside the purview of watercourse improvement and land leveling. This pilot effort had been tried no where else in the country prior to CWM. This advisory service had as its primary goal the dissemination of information to farmers through the OFWM linkages on water management, watercourse maintenance, and non-water inputs. In all other provinces, and prior to this in NWFP as well, OFWM activities concentrated on watercourse construction and physical rehabilitation, with little field-level focus on water management practices. This OFWM Advisory Team consisted of two field assistants (FAs), who were assigned 20 watercourses. They visited 10 watercourses a week and met with WUA chairmen. Each watercourse was visited twice a month. Each Thursday, their progress was checked by the WUADS, at which time they were given direction and guidance.

The initial method the field team used was to approach each WUA through its respective chairman to call the members-at-large to a general meeting, following which a plan would be outlined for watercourse maintenance. However, the turnout was relatively unencouraging as these WUAs had by and large become defunct. As an alternative to this situation, the field assistants were instructed to contact individual key members of the WUAs. Each farmer was given a careful explanation regarding the long-term and short-term benefits of regular watercourse maintenance. The FAs realized that the most cogent argument for the shareholders was the prospect of water-saving as a result of routine and effective maintenance. This direct approach was relatively successful as many of these shareholders undertook physical maintenance of the watercourse adjacent to their lands, and encouraged their fellow shareholders to do likewise. The advisory team FAs provided the shareholders with technical guidance regarding how the actual physical work should be done. On several occasions, the FAs were summoned back by the WUA chairmen to the watercourses to check the quality of the work which had been performed. A significant advantage of contacting the members in their field was that, when they met a farmer, he was more than likely engaged in fieldwork--irrigating, preparing the land, or sowing--and the FAs were able to provide relevant advice to him regarding improved cropping practices (e.g., benefits of and procedures

235

for land leveling, new high-yielding varieties, efficient fertilizer application appropriate to their capability, and efficacious and judicious use of pesticides and weedicides).

As a result of this direct farmer approach, efforts of the FAs resulted in quality maintenance performed on the following watercourses. It should be noted that most of the work mentioned here was achieved just prior to project termination, as during the earlier period of the experimental strategy, the FAs underwent technical training and had to develop procedures in the field:

1.	Watercourse RD # 62000	300 meters
2.	Watercourse RD # 62900	200 meters
3.	Watercourse RD # 63100	600 meters
4.	Watercourse RD # 63110	800 meters
5.	Watercourse RD # 63150	400 meters
6.	Watercourse RD # 63300	2,600 meters
7.	Watercourse RD # 65720	110 meters
8.	Watercourse RD # 73485	250 meters
9.	Watercourse RD # 74900	260 meters
10.	Watercourse RD # 70800	100 meters
11.	Watercourse RD # 72340	3,000 meters
12.	Watercourse RD # 78980	980 meters
13.	Watercourse RD # 79860	2,310 meters

As the advisory team is still operating in a pilot phase, and is likely to continue to through the end of the project, careful monitoring by the WUADS and TAT Farmer Organization Specialist was critical for analyzing the impact and recommending further expansion of the program to a wider area, and eventually including a broader range of expertise which they could impart to the WUAs. It is still too early at this stage to predict what configuration might eventually be recommended; however, even at this relatively early juncture, it is possible to conclude that the WUA shareholders appreciate the fact that government staff regularly call on them with technical advice.

An important issue related to implementation of this program was that the field assistants were hampered by transportation limitations. Although they were temporarily using a borrowed motorcycle, USAID provided two motorcycles specifically for their use in the field. Just prior to the termination of the TA contract, two motorcycles procured by USAID for the Advisory Team were received; however, the SPM maintained that there was no operating budget available within his financial capability.

By the end of the TAT's contract period (January 1991), the OFWM Advisory Service had permanently appointed the two staff members, indicating an acceptance on the part of the higher authorities of the approach and its perceived benefits not only to the farmers in the command area, but to other departmental field officers whose work load has been considerably alleviated through this intervention. It is our understanding that, during the next

236

OFWM Department annual fiscal budget preparation, the Advisory Service is earmarked to receive its own line budget for salaries, field equipment, and motorcycle maintenance.

2.3 *Participatory Watercourse Strategy: Lasting Impact on OFWM WUA Organizing Strategy*

This program, which was first initiated in the CWM project in NWFP, is one of the most significant successful endeavors. We can point to concrete examples of how this pilot program has had a sustained long-term effect on the field methodologies used by the OFWM, SMO, and Agricultural Extension staff for organizing WUAs, and strengthening their resolve. The TAT Farmer Organization Specialist developed a successful program in NWFP, which received adequate coverage through routine quarterly reports and special process documentation publications.

In the CWM project, this activity was successfully initiated at Pakpattan subproject in 1989 under the overall coordination of the WUADS, but with the regular participation of the OFWM-WMS and WMO and the TAT EXT, and the SMO liaison officer. After the watercourse was identified by the OFWM-WMS, several weeks of farmer contact followed, during which the WUADS met with every farmer on the watercourse. A WUA members' Survey Committee was formed and the survey was conducted with nearly 100 percent of the WUA shareholders in attendance and the design prepared by OFWM. The Farmer Organization Specialist and the WUADS carried out the "process documentation" of this effort so that significant lessons learned were recorded and used to develop similar programs on a wider scale.

PPWCs in Shahkot and 6R/Hakra were started by the Farmer Organization specialist and the WUADS. The design was completed with farmer participation and was submitted to the SPM for consideration by USAID for PIL issuance. The farmers were ready to start *kaccha* work once approval had been given. The PPWC at Niazbeg Subproject also was successfully instituted. The first Process Documentation Report on Punjab PPWCs was drafted by the TAT Farmer Organization Specialist and was distributed to project personnel at a special seminar held to discuss and analyze the findings. One-day workshops discussing the implications of the experience to date with USAID, the Punjab government, and TAT staff had been held in three of the four command areas.

The TAT had developed several region-specific participatory methodologies to focus on motivating farmers solely on unimproved watercourses. However, totally unimproved watercourses represented only a minor fraction of the existing watercourses in the project area. In order to be truly effective, the participatory methodologies had to be adapted to accommodate watercourses on which OFWM has already undertaken some initial work. In addition, undertaking four additional areas in Punjab, where unimproved watercourses were in great number, afforded a good opportunity to test participatory strategies on a larger scale. To do this, OFWM had agreed to adopt a modified version of the present strategy used on the

251

PPWCs in Punjab as its normal operating procedure. However, coordination problems prevented this program from going forward.

The Farmer Organization Specialist presented a modified flow-chart of proposed organizing strategies, based on experience to date with the participatory approach in Punjab and NWFP. In the future, OFWM would print a new register for WUAs that would contain all information as well as terms and conditions, with full details of civil work specification. This register would be handed over to WUAs from the first day of their registration, and WUAs thereby would be in a position to monitor progress and problems from the outset.

Subcommittees (i.e., functional committees) would be formed by WUAs to perform specific assignments in an effective way and encourage greater farmer participation in the watercourse improvement:

- a WUA Membership Subcommittee, consisting of two or three educated and respected persons, that would explain the CWM program to shareholders at large;

- a Survey and Design Subcommittee for topographical survey and design would be formed following WUA registration, and consist of three or four educated persons--the watercourse design would be taken to this subcommittee after its preparation before submitting it for PIL approval;

- a Subcommittee for Labor and Funds Mobilization, which would serve to mobilize farmers for *kaccha* improvement as well as *pacca* lining, and generate funds for masonry work. The size and composition of this committee would be determined by the number of shareholders and *biradris* at the watercourse;

- a Subcommittee for Quality Control, which would assist and supervise in the actual construction and maintain quality of the delivered material;

- a Watercourse Maintenance Subcommittee which would, in fact, be the same as the Subcommittee for Labor and Funds Mobilization after completion of the watercourse improvement. Watercourse maintenance criteria should be made clear to these committee members from the outset, and this committee should have training in organizing farmers for maintenance and water flow measurement techniques.

All of the above WUA subcommittees should reflect representation from the head, middle, and tail of the watercourse.

A significant turning point in the process was OFWM agreeing to restructure itself institutionally along the following lines: each OFWM field team would have one Water Management Officer devoted solely to organizing farmers for WUA formation; together, with

238

the WUADS, they would form the WUA Organizing Task Force in each subproject command area. The Farmer Organization Specialist and the WUADS would provide training and orientation to the WMO, who would have no other responsibilities except for organizing. With effective implementation of this new setup, there would be considerable institutional growth in OFWM capability as envisaged in the SAR and the USAID Project Paper. Unfortunately, the TA component was terminated before a determination of any long-lasting effect could be made.

2.4 *Development of TAT/SMO Task Force Strategy and Federations in the Punjab*

Two Task Forces were formed (in Pakpattan and 6R/Hakra subprojects) and were comprised of field-level officers from line agencies and the SMO. The Task Forces concentrated efforts toward formation of Water User Association Federations (Canal Committees). At Pakpattan, a pioneering Canal Committee federating 19 WUAs, was organized along 4R distributary. The WUADS and the TAT Farmer Organization Specialist followed the guidelines specified by the latter. Each WUA named one member to the General Committee. The General Committee elected a four-person executive committee from among its 19 members. This Canal Committee named a subcommittee for water discharge measurement/control and a subcommittee for maintenance. The subcommittee on water discharge received technical training from the SMO staff and regularly recorded flow measurements, which they reported to the SMO. The other activities focused on assisting WUAs in arranging production credit, and training a subcommittee of farmers in *mogha* discharge measurement. The project was unable to establish Task Forces in the Niazbeg and Shahkot subprojects; however, efforts were made to work on this following appointment of the two additional WUADS. Having Canal Committees as an integral part of the Task Force Strategy is an extremely useful approach; it is doubtful, in fact, that the Canal Committees in these two subproject areas could have been initiated without the logistic support from the Task Forces, as Federations have no legitimacy or legal basis under the Punjab WUA Act.

In principle, Federations can be a way of strengthening the WUAs. However, efforts at organizing Federations were not appropriate to every subproject command area at this point in time. In the Warsak system, for example, with one exception, the watercourses were not deployed along minors. There was no evident natural unit to serve as the basis for the Federation. Determination of the appropriate basis for the Federation took considerable reflection and consultation with the PID and SMO.

The TAT was reluctant to anticipate only one systematic approach to organizing Federations. SMO and project staff needed to experiment with different approaches on a small scale before undertaking development of a standardized methodology. It was agreed by

239

the participants in a WUADS meeting in Quetta in May 1989 that the following would be the general functional goals of Water User Federations in the CWM project:

- **Secondary planning functions**: The Canal Committee should be responsible for the second stage of planning from below (i.e., the collation, coordination, and consolidation of WUA plans), and the preparation of its own plans based on information from the groups.

- **Intermediary channel functions**: When WUAs have developed internal needs identifications and plans, the Canal Committee could act as a stronger link between WUAs and credit agencies, input suppliers, and cooperatives.

- **Negotiating functions**: On behalf of WUAs, the Canal Committee should be in a position to negotiate with outside bodies and authorities on matters of common concern to all the WUAs or on specific individual or WUA problems (e.g., water discharge fluctuation along a single minor).

- **Economy-of-scale functions**: WUAs may occasionally require the Canal Committee to arrange bulk purchases of machinery and organize marketing, transport, supply, storage, processing, and similar functions in which non-collective action for single WUA entities is uneconomical and inefficient.

- **Miscellaneous functions**: The Canal Committee should be able to help extension agencies and WUAs organize training, demonstrations, and other educational functions. The Canal Committee may be required to undertake other jobs which are in the common interest of all the member WUAs.

The listing of these functions does not mean that they must all be done by each and every Canal Committee. On the contrary, and from the perspective of the WUA shareholder, the most important were the secondary planning and negotiating functions.

2.5 *Program Interventions in Agricultural Credit*

The area of production credit remained one of the least successful aspects of this project. First of all, the project had no control over lending policies, and lending agencies were not predisposed to providing credit to small farmers or farmers' groups. As a last resort, the SMO asked USAID to intervene on its behalf to determine if a seed money "revolving fund" might be feasible and acceptable to the Cooperatives Department. In other words, USAID would provide the seed capital for loans to be given to WUAs in the CWM area, and the repaid amounts would be used to satisfy successive loan demands.

240

In order for this to occur, four changes in the present credit configuration would be necessary:

- the banks at the federal/provincial level would have to recognize WUAs as channels for both production and capital investment loans;

- the credit would have to be "total" in the sense that the various needs of small farmers would be taken into account as part of a total farm budget, instead of calculating separate loans for each different productive activity or input (e.g., fertilizer, pesticide, equipment);

- a practical arrangement would have to be made for introducing an institutional system of loaning in the form of required inputs with recovery in the form of produce, since this is commonly done by the village moneylenders and commission agents.

- the banks and Cooperatives Department, while keeping a vigilant eye on probable defaulters, would have to simplify procedures and forms for processing group loans to WUAs which would be treated as special clients.

This activity was supported in the last year of the project with structured training to WUA shareholders in farm-business and marketing techniques.

2.6 *Interventions in Extension Information for WUAs*

The SMO, Department of Agricultural Extension, and the TAT developed an extensive information networking system for transferring knowledge and information to farmers. Dissemination of information occurred largely during several farmer field days, establishment of WUA libraries, and intensive shareholder training. The WUADS started WUA information centers at the coordinated watercourses and on the PPWCs. These libraries were not, as is commonly thought, just repositories for agricultural extension bulletins, but stores of documents (e.g., *warabandi* and blueprints) and technical information relating to the watercourse improvement program, watercourse maintenance, and water scheduling. Along with this effort, the WUA officers were provided guidance on how to maintain the information center archives and how to read and use the material therein. Over 26 WUA libraries were established in NWFP, of which 18 were still functioning at the time of TAT contract termination.

2.7 *Coordinated Watercourse Development Program*

The purpose of this program was to revitalize selected WUAs with a menu of possible interventions from which they could select specific target activities. In all but a few cases, the WUAs identified availability of production credit as their primary constraint. Therefore, for the first part of the trial, the TAT and the SMO concentrated efforts on these lines. On the

241

coordinated watercourses, meetings were held by the shareholders regarding seed exchange, joint procurement of fertilizer, and tree removal. Many meetings were held with the concerned WUAs and field programs were developed in concert with the project's participating line agencies.

As a WUA-sponsored activity, the WUADS and the Farmer Organization Specialist have promoted cultivation and marketing of sunflower seed on the coordinated and virgin watercourses. A field officer from the Ghee Corporation in Nowshera attended repeated meetings with these WUAs and explained the procedure for procurement, sowing, and crop care. Germination tests were conducted in the command area showing higher than 90 percent rates. He will continue to advise the project and the cooperating farmers during the cropping season. However, the premature and unanticipated closure of the TAT component of the project prevented any effective monitoring of the trial or reporting on the results and impact.

By the end of the program, the major emphasis was being placed on improved seed procurement through the WUA mechanism. During the last year of the project in NWFP, farmers on the coordinated watercourse purchased 3,750 kgs of certified wheat seed for post-harvest exchange. The WUADS, and the Farmer Organization Specialist were now assisting the shareholders in planning for post-harvest seed exchange. At one of the farmer field days organized by the project the attending farmers were significantly impressed by the visual difference between the certified seed and traditional seed fields, and indicated willingness to cultivate certified seed during the next *rabi.*

2.8 *Additional Lining for Coordinated Watercourses*

Many watercourses in the command area submitted requests for additional lining; however, none of the watercourses met the minimum technical criteria for eligibility, particularly with reference to critical reach and WUA performance. There was no improvement in the situation regarding removal of trees and completion of the coordinated watercourse. As the coordinated watercourses now stand, they do not even meet the revised physical criteria which USAID approved with TAT guidance in April 1989. It is clear to project authorities that the WUAs established to date are not ready to meet the qualifying criteria. It is anticipated that a few WUAs might be eligible for this additional activity next year.

2.9 *Water Supply Problems on the Warsak Lift Canal and Recommendations to Correct the Situation*

This project implementation period has reportedly seen perhaps the most difficult period in water supply since the Warsak Lift Canal was created, and certainly since the present pump/motor configuration was installed over 25 years ago. The pumps and motors have not functioned at even half-capacity, and the electricity supply has been erratic. In the TAT's effort to promote a package of skills, and improved techniques and inputs, the absence of water managed to undermine nearly every effort, as the farmers could not see beyond the

242

implications of the empty irrigation canal. Vigilante committees of organized farmers (what amounts to an ad-hoc WUA Federation) converged on the SMO field office during SCC meetings and made it clear that they would not tolerate any further debilitating disruptions in the water supply.

New motors were ordered and delivered by USAID; however, pumps for the new motors now need replacement. With shortage of electricity supply in NWFP likely to increase in future years, we strongly recommend that either one of the following actions be taken to rectify the crisis:

- a separate electrical power supply could be arranged for the Warsak Pump Station, which would not be affected by load-shedding; or

- small, earth-filled dams could be created as catchment basins for river flooding; water could then be discharged into the lower-middle and tail sections of the Warsak Lift Canal for use by farmers who are not getting any of the canal water supply, even under the best of circumstances.

2.10 *Full Watercourse Trial Strategy*

As a result of a request made by the Additional Secretary, Water and Power, the TAT developed a full watercourse trial strategy. The TAT and the SMO staff in NWFP developed an ambitious program of activities for these full watercourse trials. The purpose of this program was to introduce a total package of inputs, improved techniques, and physical improvements, which in combination would result in sustained greater agricultural yields and overall farmer income. The trials were implemented on two watercourses, and focused on farmer participation at all stages and levels of the program. The two watercourses were located respectively in the middle and tail reaches of the Warsak Lift Canal system. Due to the overall water supply problem, particular attention was given to the tail watercourse, which was supplemented by water from a public tubewell.

The trials were conducted during two consecutive cropping seasons (i.e., *kharif* 1990--extending from May to September), and *rabi* 1990/1991--extending from September to April), and stressed a package of practices and inputs which were **within the average farmer's means and capability**, and which he could sustain within his own resources after the program inputs ceased. Therefore, package components differed from what the adaptive research institutions recommend, as they often exceed those inputs and practices which the average farmer is capable.

The field and organizational approach was modeled after that of an integrated rural development project, wherein multidisciplinary activities all leading to one common goal are carried out, under the coordinating umbrella of the SMO. The SPM had overall responsibility for the coordination function, and called regular fortnightly meetings of the concerned WUA shareholders, the participating line agencies, and advisory personnel to plan and review

243

progress and problems. The following line agencies were the primary participants: the On-Farm Water Management Department, the Agriculture Extension Department, and the Irrigation Department. Secondary-level line agencies have, in the past, played only a peripheral role in CWM project implementation--this program had a special goal to actively engage the participation of the following agencies on a wider and more sustained basis: the Cooperatives Department, the Agricultural Development Authority (ADA), the National Fertilizer Marketing Ltd. (NFML), the Fauji Fertilizer Corp., the Agricultural Development Bank/Pakistan, the Allied Bank Limited (serving the CWM project area), and Pir Sabaq Research Station.

Together with the SPM, the TAT assumed the lead role in monitoring and reporting on the participation of these secondary agencies. As the fundamental focus of the project's full watercourse trials in NWFP, the NWFP SMO/TAT implemented completely integrated improved production packages, including cropping pattern adaptations, varietal seed, improved water management, fertilizer, herbicide, insecticide, weed management. The trials were conducted on selected fields, to represent the various soil conditions and water supply situation facing the farmers on the particular watercourse.

Field trials conducted for the 1990 *kharif* cropping season, are listed below:

Crop: Maize

Demonstration:
1. Furrow sowing
2. Varietal demonstration of improved seed
3. Use of balanced fertilizer

Key activities:

1. Selection of farmer with assured irrigation water supply.
2. Selection of leveled field.
3. Introduction of *sardheri* plow (bullock-driven) for the preparation of ridges (**Furrow Demo**).
4. Procurement of improved varieties basic seed, seed treatment, germination testing, and proper seedbed preparation.
5. Procurement of required fertilizer before sowing.
6. Use of land planter for line sowing (on ridges).
7. Timely application of fertilizer and incorporation in the soil.
8. Provision of a side channel for better distribution of irrigation water.
9. Use of improved varieties, certified seed, and balanced fertilizer.

Agencies Involved: WUAs, On-Farm Water Management Department, Agricultural Extension, Agricultural Development Authority, private fertilizer dealers, and Fauji/NFC companies.

244

Crop: Sorghum

Key activities:

1. Selection of cooperative farmers.
2. Obtaining improved high-yielding variety seed.
3. Use of balanced fertilizer and supplementary nitrogen after additional cutting.
4. Supplementary irrigation after each cutting.

Line Agencies Involved: Agriculture Extension, Livestock Departments and Seed Corporation (ADA)

2.11 *Training*

During the project implementation period, a very ambitious shareholder training program was implemented in the NWFP and the Punjab with the full participation and cooperation of the SMO and related line agency staff. A vitally important element of this total watercourse trial centered on training farmers to undertake many of the key field-level activities. The TAT Farmer Organization Specialist was responsible for coordinating the training and drawing on the technical expertise from other TAT members, the SMO, and other staff. Experience has shown that, in order to be effective, farmer training must be succinct and to the point as all farmers regard their time as valuable. The intensive, structured training to the farmers was coordinated in three phases: on the two watercourses where the project attempted the full watercourse trials, and a separate series of training sessions for shareholders from the command area at-large.

The following are the training topics which were covered in detail during the Full Watercourse Trial (a similar agenda of topics had been scheduled for *rabi*-crop-specific training, but could not be actualized due to the early termination of the project by USAID and the GOP.

(maize)
Use of *sardheri* plough for preparing ridges
Farmers/FAs training for field layout for irrigation
Irrigation Scheduling
FAs and farmer training for seed treatment
FAs and farmer training for germination tests
Need for phosphate fertilizer
Timely fertilizer application and incorporation in the soil

(sorghum)
Training in optimum cuttings
Use and application of fertilizer
Supplementation with irrigation

245

In addition to the above crop-specific topics, the following general subjects had also been imparted to the farmers:

- techniques of water application on agricultural lands;
- various techniques of water measurement and comparative advantages;
- methods and ways of soil moisture determination;
- procedures of watercourse maintenance;
- WUA organizing and strengthening techniques (aimed toward elected WUA officers); and
- simple farm business techniques related to non-water inputs, cultivation, and marketing.

A total number of 1,180 farmers (2,341 in the Punjab) both from the two full trial watercourses and the command area at-large were trained in the above-mentioned fields. After the training was over, one set of *sardheri* plow and ridger, both driven by a pair of bullocks, were distributed among the farmers of the virgin watercourse at RD-76450. One set each was handed over to the WUA committee of the full watercourse at RD-103000, and eight sets for the command area at-large.

2.12 *Training Farmers and FAs in Farm Business and Marketing Techniques*

As part of an overall project objective to enhance farmers' technical capability to undertake improved agriculture, 11 training sessions were arranged for the farmers of the full trial watercourses and the FAs of the SMO office in simplified farm business techniques. As per the planned training program, the farmers of the two full trial watercourses also were included in the marketing training. A Marketing Specialist from Peshawar Agricultural University was recruited to coordinate the workshop, and staff from the Agricultural Marketing Department of the GONWFP and SMO participated in the program. Several two-day training sessions were arranged for the farmers of the two full trial watercourses at the SMO Field Office at Zangali area. The training was imparted by the TAT Economist and Subject Matter Specialist. The following topics were covered in detail: **marketing practices and problems**, transportation facilities, prevention of losses (storage, packing, packaging methods), transportation charges: how to minimize costs and maximize limited resources. A second round of topics were included in the sessions: market structure--inter-village, local, central; market system--regulated, unregulated.

In addition, training was imparted to more than 100 office-bearing WUA shareholders of the project-organized and registered Badaber Minor Federation, focusing on WUA strengthening strategies, and the functions and role of a Federation. The staff of the OFWM

246

and SMO participated in the training to be fully apprised of the purpose and potential of this new Badaber Minor Federation. Training on agricultural marketing problems was conducted, with participation from over 350 Federation shareholders.

The TAT and SMO developed and produced model materials, primarily handouts, simple guides in Urdu, for activities related specifically to the full WUA trials. (Some of the required handouts previously had been prepared by the TAT Farmer Organization Specialist and Agronomist). During the course of this proposed program the TAT and SMO prepared a videotape scenario of all activities for preparation of a film to educate other WUAs in the project command area, and to inform the public at-large regarding project findings and developments. However, due to the early closure of the TAT component, the videofilm could not be completed.

Although one of the major outputs of the farmer training was enhanced SMO capability to undertake such training efforts on its own, the SPM made it clear to USAID and the team members that, with no budget and limited staff, it would be impossible for the SMO to do so. While some of the technical field training, particularly pertaining to cultivation practices, will most likely continue as a result of this effort by the TAT, it is unlikely that the extraordinary training (e.g., marketing and farm budgeting) will continue.

2.13 *Involvement of the Private Sector in CWM Activities*

The NWFP was one province that successfully maintained private sector involvement in CWM for more than three cropping seasons. Private sector agencies were encouraged to participate in all CWM activities. Specifically, the Fauji Fertilizer Company and Sarhad Farms (seed dealers) had agreed to provide requisite inputs for demonstration trials on the two full trial watercourses in NWFP. They provided technical monitoring expertise to assist the SMO staff in monitoring and recording the progress of these demonstration trials.

Additional participation was provided during *kharif* season from several grain and input dealers to provide inputs to the WUA on an advance basis. The WUA (not individual farmers) entered into agreements to sell the crops to the dealers at prevailing rates. The dealers had guaranteed <u>not</u> to assess additional charges or reduce the purchase price. This represented a major modification in the normal way in which private dealers enter into agreement with individual farmers, who normally are required to sell their crops to the dealers at a reduced rate.

Discussions were held for possible project assistance and cooperation with private sector agencies to take on extension responsibilities heretofore assumed by the government extension agents. Progress in this direction is not known at the time of this report.

247

2.14 *IIMI/CWM Project Collaborative Study: Review of CWM Institutional Framework in NWFP*

The purpose of the interrupted study was to analyze the institutional framework and management setup of CWM, and provide recommendations to USAID for a second stage of a CWM-type project. Data collection in the field was completed just prior to evacuation of the team members from Pakistan. The areas explored include:

- the functioning role of SMO and its ongoing relationship with line agencies;
- the relationship and linkages between WUAs and government agencies (i.e., the farmer-bureaucracy interface);
- the functioning role and sustainability of the WUAs as agricultural development support bodies and alternatives;
- the possibilities for enhanced private sector responsibility in project implementation including farmer advisory and project monitoring roles.

This study would also have contributed to a plan for developing the SMO work plan which is currently underway to replicate the CWM principles. This workplan would have focused on continuing activities which were deemed successful, while replicating those non-civil works activities on a wider scale, with particular interest on areas adjacent to the present command area (e.g., the Warsak Gravity Canal command area) where water supply is constant and reliable and farmer interest in investing time and money in improved agriculture is very high. The initial results from this study were promising and would have been a valuable contribution to the systemic analysis of CWM concepts.

2.15 *Program in the NWFP WUA Federation Development*

The NWFP Water Users Association Ordinance, ratified by the provincial assembly in 1981, specifically calls for the formation and development of Water Users Federations at the minor or main system levels. However, given the water supply problem, the Irrigation Department, which has ultimate coordinating control over this project in the NWFP, had asked the SMO and TAT not to follow through at this time.

A plan for federating a trial minor of the Warsak system had been developed by the TAT Farmer Organization Specialist, the WUADS, the Deputy SPM, and OFWM. The SPM and the TAT agreed that the time was appropriate for initiating a Federation on Badaber Minor, as the project operating environment had improved with installation of the new pumps. Following the Provincial WUAs Act, the Badaber Minor having 19 watercourses would be formed into a Federation. (On this minor, eight WUAs were formed and watercourses partially improved; the remaining WUAs near the tail had not been formed as water supply at the tail was minimal.) It was anticipated that with formation of a Federation, this issue could

248

be addressed and an alternative source of water possibly could be developed. To establish a WUA Federation in the command area, meetings were held with the OFWM staff; Badaber Minor was selected as the appropriate area for this purpose. Basic information regarding the land and population of the 19 watercourses on this minor was collected. The remainder could not be organized as, under the present circumstances, water does not reach their outlets. The participatory approach, as implemented with the virgin watercourse trial, was used in organizing the Federation. The function and purpose of the Federation was discussed openly and the WUA chairmen were clearly enthused about the prospect of having a formalized forum for negotiating with the PID. A discussion of priority issues the newly formed Badaber Federation would initially address ensued, and the group indicated that the most obvious concern was the unreliable water supply, followed by the need to improve non-water inputs procurement, and farm machinery to be jointly managed and utilized. The Federation members were also interested in increasing tubewell efficiency and expanding the number of tubewells on this minor. They made it clear their concern was not to look for government subsidized installation of new tubewells; rather their interest was to curtail the red-tape resulting from new tubewell installations.

2.16 *Seed Multiplication Program in NWFP*

In addition to the official functions of the Federation, the quorum of member WUAs expressed specific interest in a project seed multiplication program. Over the years, a large number of high-yielding seed varieties of all major crops have been developed in Pakistan. However, the rate of multiplication of these was slow. A shortage of high quality seed was noted by the farmers as a continuing major constraint to their production efforts. Only the Agricultural Development Authority (ADA) is a source of certified seed for the farmers in NWFP. According to the ADA representatives, they could only meet up to 10 percent to 15 percent of the NWFP's need for certified seed of improved varieties of wheat. This meant that approximately 85 percent to 90 percent of the area has to be sown with seed either kept by the farmers themselves from their previous crop or non-certified seed purchased from the open market. This seed is generally found to be of poor quality and farmers are uncertain about their yield potential. They considered poor quality seed as one of the major constraints for low yields, as described below.

One of the indicators stated in the SAR and Project Paper for measuring the success of the CWM project is increasing the use of certified seed among WUA shareholders. The certified wheat seed of Pir Sabaq 85 and Pak 81 was procured from the Agricultural Development Authority and distributed to 16 farmers. Sixteen acres were under cultivation by these farmers on the two full trial watercourses at the time of project termination. These farmers were given assistance in seedbed preparation, method of sowing, and use of balanced plant nutrients (within their economic capability). It had been the intention of the TAT during the next quarter to assist these farmers in weed control, rouging, and irrigation. The produce from these fields would have been examined by the Federal Seed Certification Department to certify the purity and germination rate. It was hoped that from 16 acres, seed growers would produce quality seed sufficient for 650 acres next *rabi*.

249

In the weekly SMO/TAT meetings, it had been decided that, due to the water supply problem in the canal, the farmers should be supplied with improved seed of less water-consuming crops that can be substituted for wheat. In this connection, the TAT Economist, together with his SMO counterpart and the SMO AO, made several visits to Pir Sabaq Research Station at Nowshera, the Pioneer Seed Industry at Peshawar, as well as to the Agriculture Development Authority (ADA).

The TAT Economist was assigned the task of distributing the improved seed of improved barley and dwarf-variety pea to farmers in the project area for cultivation of demonstration plots. Approximately 200 kgs of barley (Frontier 87), 50 kgs of improved pea seed, and 20 kgs of improved gram seed (variety C 44) were delivered. The project was successful in distributing all of the seed in time to the interested farmers, and securing their signed affidavits to return either the seed or money to the project at harvest time. Some farmers were hesitant to substitute barley for the wheat for a number of reasons, possibly as a result of the massive campaign by the federal government to increase wheat production in the national interest. While some farmers were doubtful about the new pea variety, they were most convinced by photographs of similar trials in the Punjab showing bumper crops and low investment requirement (e.g., elimination of expensive staking). Particular emphasis was placed on the two full trial watercourses; as a result, there were five barley demonstration plots and two pea demonstration plots on the virgin watercourse (i.e., RD-76450), and on RD-103000, known as the tubewell watercourse, there were three well-established barley and three pea demonstration plots. The project had a total of 47 demonstration plots set up by the SMO and the TAT, including the 16 wheat demonstration plots. Gram plots were laid out in the tail area of the canal, where water was largely limited to rainfall and where the soil was sandy relative to other areas in the command area. The potential for gram is high in the tail area as land presently left fallow due to absence of canal or tubewell water can be brought under cultivation, with only one irrigation or one heavy rainfall. It was understood that the purposes of this demonstration program included the following:

- to create an awareness regarding new varieties of seed among the farmers of project area and especially the farmers of the full trial watercourses in particular;

- to demonstrate the appropriateness to this command area of barley as a substitute crop for wheat in areas constrained by the availability of irrigation water;

- to help the farmers sow crops which are less expensive and yield greater returns; and

- to encourage WUAs and the Federations to develop their own internal self-replicating seed multiplication network.

250

The project was terminated early in the *rabi* season, and all field activity was terminated on January 15, at the time of the onset of the Gulf War. Therefore, it was impossible to monitor the performance of this program, or glean the results for analysis and development of proven demonstration modules, as envisaged by the TAT and the SMO. We can only say, therefore, that at the time of termination, the plots looked healthy and that the cooperating farmers were extremely encouraged by the prospects. Nothing more conclusive than that can be surmised from the available data without risking controversy or conjecture. Photographs taken by the TAT members confirm the healthy germination of the field crops.

3.0 General Recommendations Pertaining to Systemic Structuring

Below are a number of suggestions for replication of this project and for the improvement in farmers' participation in general in irrigation management projects in Pakistan. The aim is to raise productivity and farmer assurance through generating their participation in the entire process. If farmers oppose any measure suggested or refuse to support it, an effort should be made to understand the reason.

- The initial focus in irrigation water management projects should be on creating and then implementing a *warabandi* schedule that most effectively meets the farmers' needs with the available water. The CWM project worked within the environment of the existing *warabandi* schedule as developed by the Irrigation Departments of the provinces. Running days will be largely determined by engineering considerations, but farmers should decide opening and closing times. The primary conflicts which have continued to erupt involving farmers tend to deal with issues related to gate opening, closing, and timing. Farmers and PID staff should conjointly decide the number and length of turns. Maintenance and allocation will follow as a natural incentive. (One of the intentions of the CWM project was to focus on maintenance and allocation as the incentive for WUA strengthening--the primary focus/incentive should have been on *warabandi*/scheduling).

- Communication with WUAs should be regular and continuous, to develop a dialogue with the WUAs and the PID/OFWM/Agricultural Department officials. Meeting agendas should be developed by numerous advance meetings with WUAs.

- WUAs must be truly representative of the socioeconomic structure of the community. Until such time as an effective system of elections can be established, this means that those called upon to help develop the irrigation schedule must accurately represent the farming households in the command area in terms of constraints they face re agricultural production. If most of the shareholders in a command area use the canal water to grow wheat for subsistence, and perhaps to market a small surplus, it is of no use to have the irrigation schedule set by a group of "progressive" farmers using the water to

251

grow sugarcane or cotton, and meeting their subsistence needs on land serviced by groundwater.

- The WUA groups should be multitiered. Implementing water schedules and effective trading of water turns and volumes can only be done by WUA shareholders in close proximity to one another, in the same or neighboring chaks. Such low-level groups are too numerous for canal officers to meet with separately, and too small to be able to reach any useful consensus on setting the overall canal schedule. Ideally, the farmer organization should extend up to whatever level in the canal system has water flowing constantly or nearly constantly, since this is the level that will give the maximum possible.

- The canal federation rules should allow WUA shareholders to trade turns or sell water, and should allow groundwater facilities to provide water to the same fields and watercourses that receive canal water. This flexibility adds greatly to the value of canal water, and the efficacy of the canal and watercourse associations. Nevertheless, where WUA Federations remain informal, as in the Punjab, canal authorities should have the ability to cut off water or penalize farmers in cases of abuse of agreed-upon methods of allocation, turns, or other forms of water theft, including free-riding. Procedures for establishing and implementing fines should be prompt and should be agreed upon in advance in conjunction with the WUA shareholders. If current laws do not allow such procedures, as in the case of the Punjab, or if the mandated procedures are ineffective, as in the case of NWFP, permission should be sought to experiment with new procedures on a trial basis, with due regard for safeguards against abuses. Such safeguards might consist of establishing a grievance board with a senior PID officer and representatives of the WUA organization.

- Major responsibility for dealing with WUAs should be assigned to permanent officers of the OFWM Department and the PID. This is not the case under the present configuration, and the absence of permanency is a root cause of lack of continuity in the CWM implementation scheme. There should be a clear plan of operation, developed with the WUAs and Federations, that delineates which level officer is primarily responsible for which type of farmers' group, and at which level in the hierarchy. Under most circumstances in the Punjab and NWFP, such liaison would naturally follow hydraulic divisions.

- WUAs and Federations with legal charters should be allowed to assist in investment fee recovery, and should be able to retain a portion of the fees for the O & M activity they wish to undertake. Moreover, if such organizations wish to charge more than the mandated fees to engage in public works, they should not be prevented from doing so. Nor should they be prevented from changing the terms of payment. If they wish to charge their members in advance, or collect deposits and charge against them, this too should be

252

allowed. WUAs and, principally Federations, that do not have legal charters should be allowed to use their officers to recover fees, provided that the limitations of the PID's liabilities are clearly understood. If such Federations wish to collect fees and engage in modifications of the canal works or maintenance in ways that improve service, they should be provided prompt and appropriate technical advice and support for doing so.

4.0 Closeout Plans and Procedures

The early closeout of the project resulted in a complete loss of the last and final season, where it was expected that all elements of the project would come into play and coalesce into viable and significant results. Despite the problems associated with the early closeout of the project and the inability to complete the activities initiated during the *rabi* season, the project in NWFP was able to make significant strides toward accomplishing its planned activities, principally the full watercourse trial.