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INSTITUTIONAL FRAMEWORK

FOR IMPROVED ON-FARM WATER MANAGEMENT

IN PAKISTAN

Special Technical Report

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U.S.AID Mission to Pakistan

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All reported opinions, conclusions or recommendations are those of the authors and not those of the funding agency or the United States Government.

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January 1976

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This report discusses the problems of an institutional framework for implementing a water management program; the impetus being a loan program between the U. S. Agency for International Development and the Government of Pakistan. The collective thinking of many of the CSU Water Management Research Project staff located in Pakistan and on campus, is contained in this report. Unfortunately, no individual can really be sure as to the most appropriate implementation process--considerable "judgement" is all that can be applied to many of the serious questions. However, as water management improvement programs progress, feedback from actual field operations will provide valuable insight for improving the implementation process. Provision for assuring this feedback and evaluation and continued program refinement are an essential part of the implementation process.

TABLE OF CONTENTS

		Page
PART I	INSTITUTIONAL APPROACH	1
Section		
1	INTRODUCTION	2
	Problem	2
	Water Management Research	2
	Improving Water Management	6
	Purpose of Report	7
2	CONCEPTUAL APPROACH	9
	Organizing Farmers	9
	Governmental Organization	10
	Flexibility in Field Program	11
	Training	13
	Evaluation	14
	Summary	14
PART II	WATER MANAGEMENT PROGRAM	15
Section		
3	PROGRAM OBJECTIVES	16
	General Objectives	16
	Water Use Efficiency	16
	Institutional Development	18
4	PROGRAM COMPONENTS	19
	The Physical Program	19
	Integration of Components	19
	Sequencing of Technical Components	21
	Institutional Component	23
	Institutional Arrangements in the Agricultural Sector	24
	Water User Associations	24
	Level of Formation	29
	Nature and Structure of an Association	29
	Functions and Powers	30
	Membership	32
	Voting	32
	Election of Representatives	34
	Assessments	34
	Registration Requirements	34
	Hierarchy of Associations	34
	Government Related and Support Agencies	35
	Irrigation and Power Departments	35
	Agricultural Departments	36
	Organizational Scheme	36
	Laws and Regulations	36

Section		Page
4	Organization and Training of On-Farm Advisory Service	38
	Organization of Farm Level Water Management Advisory Service	39
	Linkages With Other Institutions	39
	Position Descriptions for Water Management Advisory Personnel	42
	Estimated Manpower Requirements for 500 Watercourses	42
	Institutional Arrangements for Training Water Management Advisors	50
	Concept and Methods of Training	50
	The Training Content	51
	Selection and Evaluation	51
	In-Service Training	51
	Supervision	51
	Incentives for Water Management Advisors	53
	Training of Other Personnel	53
	Land Leveling Engineers	53
	Watercourse Construction Engineers	53
	Water Management Coordination	53
	Summary	54
5	PROGRAM IMPLEMENTATION	55
	Criteria for Selecting Watercourses	55
	Criteria for Selecting Critical Areas	56
	Criteria for Selecting Specific Watercourses	56
	Summary	59
	Phasing of Program Activities	59
	Organizational Linkages	64
6	PROGRAM EVALUATION	70
	Watercourse Improvements	71
	Land Leveling	71
	Water Users Associations	72
	On-Farm Water Management Advisors	73
	Training Programs	74
	Evaluation of Total Impact of Improvement Activities	75
PART III	PROGRAM EXECUTION	76
Section		
7	U.S.AID/PAKISTAN	77

Section		Page
8	A NOTE ON ALTERNATIVE ORGANIZATIONAL APPROACHES	80
	General Comments	80
	Program Structure	82
	Planning and Development Department	82
	The Implementing Field Team	83
	Water and Power Development Authority	83
	Irrigation Department	84
	Agriculture Department	84
	Financial Channels	85
	Summary	85
	Summary	85
REFERENCES		88

LIST OF FIGURES

Figure 1.	Water User Organizations for Pakistan: Development Scheme	25
Figure 2.	Water User Organization for Pakistan: Organization Scheme	26
Figure 3.	Internal Structure of Water User Associations for Pakistan	31
Figure 4.	Linkages between Water User Associations and Government of Pakistan Policies and Personnel	37
Figure 5.	Linkages with Water Management Advisory Service	40
Figure 6.	Functional Linkages for Water Management Field Program	66
Figure 7.	Proposed Administrative Structure for Implementing an On-Farm Water Management Program in Pakistan	87

FOREWORD

During the summer of 1975, the U.S. AID Mission to Pakistan requested that Colorado State University prepare a report giving their "best thoughts" regarding an institutional framework for implementing the proposed Water Management Loan Program between AID and the Government of Pakistan. This request was made to Dr. W. Doral Kemper, Chief-of-Party of the CSU Field Party in Pakistan, who in turn requested that the on-campus staff of the CSU Water Management Research Project prepare a draft of such a report by December 1, 1975 which could be reviewed by the CSU Field Party and then forwarded to the AID Mission for review.

The draft of this report was completed on December 12, 1975 and reached Pakistan approximately December 20, 1975. Additions to the report were prepared by the CSU Field Party and then forwarded to the AID Mission. The authors wish to thank Dr. Dilawar Ali Khan and Mr. Stanley R. Remington of the Mission staff for their review comments on this report. The reviews were completed during January, 1976.

Every effort has been made to incorporate the "combined" thinking of all involved individuals in the final draft of this report. Hopefully, this report can serve as a guide in the development of a successful water management program for Pakistan.

The staff of the CSU Water Management Research Project pledge their support to AID and the Government of Pakistan in undertaking this important effort.

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Jerry B. Eckert
David M. Freeman
W. Doral Kemper
Max K. Lowdermilk
George E. Radosevich
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Part I

INSTITUTIONAL APPROACH

Section 1

INTRODUCTION

Problem

The Indus Basin irrigation system is the largest in the world, containing more than 30 million acres under an integrated water delivery network. This large system is also favored with a climate for growing crops year round, as well as soils that will provide good crop yields if properly managed. Unfortunately, Pakistan is not able to grow sufficient food from this irrigation enterprise to feed its rapidly growing population and must import some food each year. A major constraint to increasing food production is poor water management.

Water Management Research

Colorado State University first began water management research efforts in Pakistan during the summer of 1970 with the arrival of Dr. Gilbert L. Corey. Two years later, a more concerted research effort was launched with the arrival of Drs. Wayne Clyma, Jerry Eckert and C. J. deMooy. Now, under the direction of Dr. W. Doral Kemper and with the addition of Drs. Alan Early, John Reuss, Sam Johnson and Sidney Bowers, considerable headway is being made in defining appropriate technologies for improving irrigation water management in Pakistan, as well as defining the processes for implementing such technologies.

Some of the early work by Clyma and Corey (2) and Clyma et al. (1) was highly significant in pointing out the large water losses in the watercourses and the inefficient use of water on the farm fields. Earlier studies, mostly by consultants, had reported low losses (usually 10 percent) in the watercourses and high irrigation application efficiencies (usually 75 percent). Field research has clearly shown that these earlier studies made inaccurate assumptions, and instead, major attention should be focused upon that portion of the irrigation system below the mogha, which includes the watercourse and the croplands served (commanded) by the watercourse.

Studies have been completed on campus, and are underway in Pakistan, under the direction of David McWhorter, regarding the design of skimming wells. Based upon technological considerations (5,8,11), as well as studies by social scientists (9), small tubewells (less than 1 c.f.s. discharge) are now being recommended. In addition to providing irrigation water supplies which are less saline (particularly near the center of the doabs), the smaller tubewells will induce

more private development and facilitate participation by the small farmer.

More recent efforts, particularly by Max Lowdermilk, David Freeman, Wayne Clyma, and Alan Early (6,7), have focused upon both the technical and social aspects of the watercourse environment. In addition to taking numerous field measurements at sixteen watercourses of water delivery losses and irrigation application efficiencies, many farmers along each watercourse were interviewed in order to establish economic and sociological factors which can be linked to differences in irrigation efficiency, to provide criteria for selecting watercourses for improvement, to provide a data base for subsequent development of guidelines for organizing farmers, and to evaluate farmers' cultural practices, irrigation behaviors and levels of farm management knowledge.

A recent report, "Water Management Alternatives for Pakistan: A Tentative Appraisal" by Jerry Eckert, Niel Dimick and Wayne Clyma has summarized the research findings as of early 1975 and developed a proposed water management program for Pakistan (4), which consists of:

1. watercourse improvement;
2. precision land leveling; and
3. irrigation and irrigated cropping extension.

The authors emphasize that if farmers continue their present irrigation and cropping practices, then the potential benefits from either watercourse improvement or precision land leveling are limited. Therefore, while extension and information transfer programs may be much more difficult to implement and their benefits harder to quantify than other components, it is essential that they receive just as much or more emphasis and full coordination within the overall program. In fact, all three components are interdependent and a coordinated balanced program is essential in order to realize the full potential of increased food production that can result from improved water management practices.

Another recent report, "Organizational Alternatives to Improve On-Farm Water Management in Pakistan," by George Radosevich and Craig Kirkwood is highly pertinent to the implementation of an improved water management program for Pakistan (10). The authors conclude that the water laws of Pakistan have remained in a static state for a number of years. Law, like the society for which it is adopted to guide social conduct, should be dynamic and unconstraining. Unfortunately, there is no process in Pakistan nor in most other nations for a systematic review on the adequacy of the law. This report (10) is an attempt to take one particular aspect of the law and examine it against the existing conditions and changing times. The legal analyses of the status of local

water user organizations in Pakistan and selected countries has led the authors to the following conclusions.

1. Pakistan has no formalized pattern of local association or organization concentrating upon water use and conservation.

2. The laws and regulations for water use as well as the design and operation of the water delivery system do not encourage creation of cooperative efforts among water users at the farm level. Three major reasons exist that compel the majority of water users to merely function in the system: a) the rigidity in rotation of canal water delivery, yet unpredictability in water delivery to the farmer; b) noninvolvement of the farmer in the decision-making process of canal delivery, subsequently leading to an inability to influence control over one of the most vital elements in agricultural production, or to adopt a planting and harvesting schedule in which the plant water requirements are timed to coincide with predicted water availability; and c) legal sanctions against water trading and selling inhibit the users from freely maximizing the supply within the watercourse area.

3. The Government of Pakistan has accorded high priority to the development of some structural type of local water user organization.

4. No insurmountable constraints are detectable in either legislative or customary water laws of Pakistan. In fact, research into old irrigation systems of other Islamic nations, and in particular the Moslem influence upon the irrigation communities of the once Moorish controlled portions of Spain, clearly indicate an established pattern of water user collaboration to control and manage the resource.

5. Several general laws of Pakistan can serve as the legal foundation for implementing the concept of water user associations; however, it is recommended that specific legislation be adopted to sanction their formation and provide adequate legal authority.

6. The formation of local water users associations would provide the institutional framework for improving irrigation efficiency and increasing agricultural production by:

   a. getting farmers directly involved in the local decision-making process;
   b. managing water delivered to the watercourse, thus improving timing and conveyance throughout the chak;

c. solving some problems of small farmers and resolving disputes between users;
d. serving as a vehicle and forum for disseminating information and assistance on improved water use and agricultural practices and technologies;
e. constituting a legal contact point between the government and water users; and
f. offering opportunities for increased labor intensive agriculture.

7. A range of organizational schemes exist that serve to illustrate users involvement and programs in local water control and management and from which basic models can be developed acceptable to the needs of the Pakistani farmers and consistent with the policies and programs of the government.

8. The scheme of water user associations:

a. must be an endogenous entity structured and tailored to coincide with the religious, social, political, economic and legal systems of Pakistan;
b. should commence with a simple, nonsophisticated organizational arrangement having the attributes of flexibility and completeness to allow evolution and maturation as intra-watercourse demands and development take place; and
c. can be designed for hierarchical evolution to achieve interwatercourse collaboration in water management, and undertake development on improvement programs of a greater magnitude or complexity than the "first level" entities.

9. Based upon an examination of local water organizations in five countries, it is concluded that effective water control and management is facilitated by having an expeditious institution for equitably resolving disputes (e.g. the Tribunal of Waters, Valencia, Spain).

10. The success of any agrarian program with objectives of enhancing the quality of rural life and meeting national food production requirements depends upon a strong water policy to increase delivery and application efficiency, encourage conjunctive use of surface and groundwaters and activate structured collaboration of local water users in improved water management. Such objectives and policies require an awareness of policy-makers and government officials of the conditions and constraints to change of the water users. Conversely, the image of government officials and personnel in relation to the water users must be improved by their demonstrating an appreciation and understanding of the problem.

The U.S. Soil Conservation Service has a field party located in Pakistan for the Precision Land Leveling Project. Land leveling will be a very important segment of a water management program. The Project Leader is Murray Cox, who recently completed a document, "A Discussion Paper on Developing a Service Organization for On-Farm Water Management in Pakistan." This document tackles many of the same problems reported herein; thus, many of the ideas reported by Cox have been utilized in this report (3).

Improving Water Management

The primary purpose for improving irrigation water management in Pakistan is to grow more food. The "heart" of this food growth process is the plant environment, particularly the plant root zone. Here, most of the agricultural inputs such as seeds, fertilizers, cropping cultural practices, and water come together, along with climatic conditions and pests, to determine crop yields.

The role of improved water management is to provide the proper quantities of water to the root zone at the proper times in order to maximize crop production. The first step, then, becomes defining the proper quantities and timing of water for the various combinations of crops and soils. The next step is to effectively apply the water delivered to each field to maximize crop production and avoid over-irrigation. Precision land leveling is an essential prerequisite to achieving high irrigation application efficiencies.

Reducing water losses in the watercourses is important for two reasons: (a) provides more water for on-farm application; and (b) alleviates waterlogging and salinity problems. Another important aspect of watercourse rehabilitation, often overlooked, is the amount of water control provided, thereby allowing higher potential irrigation efficiencies (delivery x application) to be achieved on the croplands.

Even with land leveling and watercourse rehabilitation, many watercourses in Pakistan will still experience water shortages during peak crop water demand periods. The employment of small discharge tubewells along a watercourse can frequently remedy this situation. An important consideration, here, is that land leveling and watercourse rehabilitation coordinated with tubewell construction will allow a much higher percentage of the tubewell discharge to reach the root zone and be utilized by the plants.

The construction of physical improvements will provide the "hardware" for improving water management and consequently food production. However, the proper utilization of the physical facilities is required in order to actually realize the benefits that can result from improved water management.

Appropriate extension efforts are required in order to achieve the intended benefits of a water management program. Also, extension efforts are critical in advising farmers on the proper utilization of all agricultural inputs in order to maximize crop production. Therefore, technical assistance and extension become the most important ingredients in a water management program.

Organizations have been established at the national and provincial levels of government in Pakistan for the construction of hydraulic facilities and the diversion and conveyance of water through the world's largest irrigation canal system. However, that portion of the conveyance system below the mogha has been left to the farmers for construction, operation and maintenance. In some manner, farmers under a watercourse need to be more effectively organized, either formally or informally, in order to implement improved on-farm water management practices.

In summary, the most important components of a water management program for Pakistan are: (a) watercourse rehabilitation; (b) precision land leveling; (c) small tubewells; (d) effective agricultural and water management technical assistance and extension and (e) development of local institutions to insure the effectiveness of the program.

Purpose of Report

Sufficient data has been collected and analyzed to define some aspects of some of the major irrigation water management problems in Pakistan, as well as the technologies that could be employed to correct many of these problems. Thus, there is a strong basis for undertaking a program of improved on-farm water management in Pakistan, even though there is still a need for additional field data to further identify and define problems. The more difficult problems, though, are not in defining the appropriate technologies, but rather, to define the appropriate processes for implementing such technologies in Pakistan. Consequently, the CSU Water Management Research Project is concerned both with developing technologies (physical sciences) and developing the processes by which such technologies can be implemented (social sciences).

This report discusses the problems of an institutional framework for implementing a water management program. The impetus being a loan program between U.S. AID and the Government of Pakistan. The collective thinking of many of the CSU Water Management Research Project staff located in Pakistan and on campus, is contained in this report. Unfortunately, no individual can really be sure as to the most appropriate implementation process--considerable "judgement" is all that can be applied to many of the serious questions. However, as water management improvement programs progress,

such as the current pilot watercourse improvement projects, feedback from actual field operations are providing valuable insight for improving the implementation process. Provision for assuring this feedback and evaluation and continued program refinement are an essential part of the implementation process.

Section 2

CONCEPTUAL APPROACH

There is a need to delineate some of the guiding principles which have been used in developing the institutional alternatives for improved on-farm water management in Pakistan. In describing the conceptual approach for this report, four basic elements are considered necessary for an effective water management program: (1) water management improvements will be facilitated by having farmers organized; (2) there must be effective linkages developed between farmer organizations and Government of Pakistan agencies; (3) a competent training and extension network is necessary that will effectively serve these organizations; and (4) a successful water management program will require strong evaluation techniques.

Organizing Farmers

Efforts are underway to improve on-farm water management in Pakistan in order to increase food production and rural incomes via improved water delivery and application efficiencies, which will result in higher cropping intensities and better yields per acre. Unlike the divisible technologies of improved seeds, fertilizers, pesticides, and in some respects land leveling, the sound aspects of the technologies for improving watercourses and gaining control over water quantity and timing at the field outlet require farmers to be organized into effective units facilitating joint cooperation. If any one farmer is to realize significant benefits with such technologies, all farmers under a watercourse or in a village must be organized. The experience of all nations, regardless of cultural pattern, is that irrigation systems have been constructed, maintained, and improved only through the building of administrative organizations capable of undertaking activities in behalf of participating farmers. To forego organization building, is to forego irrigation system building and improvement.

In Pakistan, certain necessary organizations have been established at the national and provincial levels to divert river and ground water into the world's largest network of canals. However, once the water passes through the mogha outlet, it flows through locally constructed watercourses for which there is no adequate organization to mobilize farmers for the purposes of improving and maintaining the structures. Without effective farmer organizations to construct and maintain improved watercourses much potential benefit of improved seed, fertilizers, pesticides, and agricultural credit is lost. Furthermore, the smaller the farm operations, the greater the need for organization.

The following statements represent key facts and principles which must be recognized and used in developing a program by which farmers--especially smaller farmers--can be successfully organized for the purpose of increasing food production via improved on-farm water management.

1. Small farmers, owning 25 acres or less, constitute approximately 89 percent of Pakistani owner cultivators and must be the primary focus of programs to improve on-farm water management.

2. Farmers must be involved in their own organizations. A long history of governmental failures has revealed the inadequacy of any program which purports to undertake "development for" farmers without their meaningful program participation. The underlying approach is that of building up from a base of farmer watercourse organizations which are federated into higher level units at the level of canal, etc., which will serve as linkages to appropriate governmental bureaucracies.

3. Farmer participation in organization building to improve on-farm water management practices must be guided by regulations from authorities in the Government of Pakistan. The organizational system must work within national and provincial policies and constraints.

4. Farmer organization must help achieve: (a) increased agricultural production; (b) equity of welfare distribution; (c) equity of farmer participation in organization policy; and (d) mobilization of rural manpower to undertake local developmental work in water management in lieu of already overloaded governmental bureaucracies attempting to undertake this mammoth effort.

These facts and principles are used as a basic guide in developing the concepts regarding farmer organization later in this report.

Governmental Organization

To provide farmers the necessary agricultural inputs and services for increasing food production, a set of complementary institutional arrangements are necessary within the Government of Pakistan. One of the more serious questions in implementing a water management program is the organizational arrangements within the Government of Pakistan for accomplishing the myriad of necessary tasks. Consideration has been given to these basic types of organizational setups. The guiding principles used in this report are:

1. Numerous inputs and services are required for increasing crop production including such agricultural inputs as seeds and fertilizers, improved codes and regulations for water distribution, engineering services, advisory services, credit arrangements, etc.;

2. Any single organization would have considerable difficulty in providing all of the required complex and diverse agricultural inputs and services over an area as large as the Indus Basin;

3. Setting up a new semi-government agency modeled after WAPDA would have many advantages, with the primary disadvantage being the time required before such an organization became functional;

4. A new semi-government agency could be organized which would be capable of providing the necessary technical and economic assistance, but there would still be a strong requirement for many existing organizations to play a role in the water management program;

5. The Integrated Rural Development Program (IRDP) has some desirable features, but to date has not achieved many of its objectives, but its successes and failures provide insights into the requirements for a successful program;

6. Working within the framework of existing Government of Pakistan organizations has the advantage of improving the capabilities of existing institutions, but this will require considerable effort and patience in order to strengthen the present bureaucracies;

7. Although difficult to accomplish, strong linkages should be developed between Government of Pakistan agencies and the water users associations (either formal or informal) to be initiated with the water management program; and

8. Emphasis should be placed upon Government of Pakistan organization from the "bottom-up", beginning with field personnel, much in the same manner as organizing the farmers.

Flexibility in Field Program

With over 80,000 watercourses in Pakistan, considerable variability in the physical and social characteristics of watercourses is to be expected. This aspect alone would dictate considerable flexibility in the program to be implemented

on selected watercourses. Following are numerous principles which are considered important in guiding the field program:

1. Even though a sufficient research data base exists for implementing an "action" water management program in which benefits substantially exceed costs, the first phases of this program should be strongly oriented towards providing feedback that can optimize the benefit/cost ratio of the program with time;

2. In selecting watercourses, a variety of watercourse conditions should be sought, which can then be combined with a variety of technological components, as well as some variability in the methods of organizing farmers, to maximize the degree of feedback in the shortest period of time;

3. The water management program will be a "field training grounds" for farmers and water management professionals--a significant by-product should be the development of communication between professionals and farmers which is presently nonexistent (and is certainly a problem in almost any country);

4. The use of "administrative edicts", even if only implied, regarding acreages, crop production, irrigation efficiency, etc., are normally counterproductive to actual field achievement and tend to result in lower morale of field personnel (including farmers), although they produce satisfying (but artificial and misleading) administrative reports;

5. The emphasis in field programs should be upon "quality" rather than "quantity", because failure to do a good job will create a credibility problem with the farmers on a watercourse, thereby compounding the difficulties in achieving improved on-farm water management (in other words, when a poor job has been done, it would have been better to have never started);

6. A sufficient number of well-trained field personnel should be available on each watercourse to achieve improvements on a "timely" basis, including extension components, since experience shows that the time to bring about major changes in irrigation practices is when physical changes are being made;

7. The field program should maximize rural labor requirements on a long-term basis; and

8. The field program should encourage private entrepreneurship.

Training

Assistance for the farmer-irrigator, particularly the small farmer, is the major purpose for implementing an on-farm water management program. In order to organize and train farmers in agricultural skills and improved water management practices, some type of extension service staffed with adequately trained personnel is required on a continuous basis. Experience with irrigation projects shows that where adequate agricultural inputs and services are not made available, physical improvements often have a short life, and the intended project benefits are never fully realized. Some of the guiding principles in setting up a water management training program in Pakistan are listed below:

1. Rather than being agricultural generalists, field professional personnel are required with in-depth water management skills in order to effectively implement a water management improvement program on a watercourse;

2. In order to improve the "image" of extension in Pakistan, new titles combined with in-depth training are required in order to develop farmer confidence;

3. A farm level Water Management Advisory Service is proposed that will have a very strong linkage with the water user associations;

4. The "institutional building" should include increasing the capability of the agricultural universities at Peshawar, Lyallpur and Hyderabad for providing training in irrigation water management including soil-plant-water relationships;

5. Special consideration should be given to developing more effective linkages and feedback between the farmer-water management advisor-research institute;

6. Training programs should also be initiated for administrative personnel in order to develop a "water management awareness" among all agencies and personnel having any type of role for increasing food production in Pakistan;

7. The training program should have a "continuing education" component; and

8. Rewards, awards and incentives should be utilized to recognize outstanding field personnel.

Evaluation

A vital element for a successful water management program is a strong program of evaluation. Without good evaluative procedures, it is easy to visualize the water management program falling into disrepute with the farmers, as well as the morale of trained field personnel deteriorating. Some of the anticipated requirements are: Each program component such as land leveling, watercourse construction, farm advisory service, farmers' organizations, and training should design and conduct continuous evaluation to provide feedback for program improvement; a separate external evaluation unit should conduct a formal evaluation of all program activities and impact of the total program in creating desired outcomes. Such efforts are necessary to assure quality work and to provide Government and sponsoring agencies with data for policy measures.

Summary

In summary, the program to be described in Part II, which follows, is based upon the following premises: one, farmers--and especially small farmers--must be organized to undertake water management improvements; two, that these farmer organizations must be effectively linked to appropriate Government of Pakistan agencies; three, these organizations must be served by a competent training and extension network; and four, the program must be designed with objectives specific enough for valid and reliable evaluations.

Part II

WATER MANAGEMENT PROGRAM

Section 3

PROGRAM OBJECTIVES

General Objectives

The general objective of the proposed water management program is to increase food production and farm incomes by increasing the efficiency of water management on farms and in the watercourse delivery systems of Pakistan.

In order to develop meaningful specific objectives, it is necessary to isolate separate means of achieving the general objective. At the first level of disaggregation, food production and farm income increases can be obtained by increasing cropping intensity or yields per acre. Ideally, both will occur. Since yields are only about 20 percent of potential yields and cropping intensity is about 60 percent of potential intensity, more production increase can be obtained by increasing yields than by increasing intensity. However, cropping intensity increases tend to be employment generating in a developing country while yield increase, after a time lag, may induce mechanization and labor displacement. Tendencies in this latter direction should be monitored and if they are adversely affecting the national interest alternative opportunities for using rural labor on the farms should be developed.

Setting numeric targets for increasing yield and intensity is difficult in Pakistan. Reported yields and intensities are unreliable. Crop cutting for yield estimates is laborious on a large scale.

Water Use Efficiency

Disaggregating again, cropping intensity and the crop mix is a function of water supply. Crop mix affects income as farmers change to high value crops with increased quantity and dependability of water. Effective water supplies can be increased by the following physical modifications:

1. Reducing delivery losses by watercourse improvement;

2. Increasing irrigation application efficiencies by precision land leveling (and irrigation scheduling); and

3. Increasing irrigation water supplies by constructing small discharge tubewells.

The amount of improvement possible depends, inter alia, on the status of present efficiencies. These will vary widely, particularly between SCARP and non-SCARP environments.

Selecting a target expressed as an arbitrary percentage improvement would be unduly restrictive in that it would have different meanings in different cases. Setting a target of a minimum acceptable irrigation efficiency level for watercouses that have completed their program is also fraught with danger, since the construction of physical improvements only provides the potential for increased water use efficiency; the operation of the watercourse and irrigation practices largely dictate the watercourse irrigation efficiencies that will be achieved, which again indicates the importance of a well-trained water management extension staff for properly advising farmers on improved irrigation practices in order to more nearly achieve full benefits from the physical improvements. Then, after gaining experience, we can set potential targets. We can propose potential delivery efficiencies and application efficiencies as well as cropping intensities based on these values.

This discussion implies that general objective of increasing yields can be attacked by the following two derived objectives:

1. To transmit to farmers knowledge of plant-soil-water relationships necessary to plan and manage an efficient irrigated cropping system to improve yields and cropping intensity; and

2. To transmit to farmers the techniques and knowledge necessary for efficient water control in watercourses and improved irrigation practices on farm fields.

In fact, the pursuit of these objectives in combination with the physical modifications listed above results in an optimum water management program.

The setting of target irrigation efficiency levels implies a predictive capability based upon physical improvements, when in fact we only have a capability for predicting the potential irrigation efficiency levels. This potential excludes any measure of the effectiveness of three important institutions; namely, the individual farmer, the water users association, and the water management advisory service (described in a later section).

Instead, water use efficiencies should be measured before any improvements are undertaken and some time after the physical improvements are completed. (Also, there should be an increasing irrigation efficiency each year as more and more farmers adopt improved irrigation practices.) The "before" and "after" measurements are a measure of the overall effectiveness of physical improvements and improved irrigation practices. Analysis of such data for a large number of

watercourses will provide insight as to the most effective combinations of physical modifications and institutional arrangements for placing more of the water supply in the root zone where it is available for plant growth.

Institutional Development

Several institutional objectives are necessary to ensure that physical changes will lead into an era of modern irrigation water management. These institutional objectives, if met, provide for a continuing stream of irrigation information research, its transfer to farmers, the development of a water management support industry, and the organization of farmers into units that can exert collective action on water affairs.

The institutional objectives are:

1. To develop a core of water management advisory (extension) personnel trained in modern irrigation techniques whose services would then be concentrated on the improved project watercourses.

2. To develop a cadre of well-trained engineers for the precision land leveling program capable of performing design, layout, construction and evaluation.

3. To develop a cadre of water management engineers trained in watercourse improvement and able to design and implement such a program.

4. To develop a research program on crop irrigation and water management that will continue as a permanent part of the national agricultural research effort.

5. To strengthen the linkages between research and extension and farmer.

6. To develop a network of water users associations enabling farmers to act collectively on their water management problems and to aggregate and transmit a concensus regarding specific problems to levels of decision-making authority. This will be achieved at the local level since formation of a water users association will be mandatory for participation in the program. Also, federations of water users associations would be organized around hydrologic units to deal with water management issues of a more aggregate nature.

7. To encourage private entrepreneurs throughout Pakistan to manufacture and market the several types of water management equipment that might be profitably used by farmers. Similar encouragement should be provided to those who would provide services to farmers such as land leveling services, irrigation scheduling advice, farm planning and others.

Section 4

PROGRAM COMPONENTS

The Physical Program

Integration of Components

The necessary physical program is seen as a set of watercourses in which the three physical components of watercourse improvement, land leveling and tubewells are integrated with irrigation extension. It is this type of program--a combination of watercourse improvement, land leveling, tubewells and extension in appropriate proportions--that is the subject of this report.

Previously, the U.S. AID water management loan program (4) has discussed the employment of watercourse improvement and land leveling in conjunction with extension. However, some institutional mechanism (whether foreign assistance, Government assistance, or private initiative) must be devised so that small discharge tubewells are included as needed. The field program must have a capability for incorporating all appropriate technological and institutional components in a water management improvement plan for each watercourse.

Watercourse improvement and land leveling are seen as synergistic in most watercourses. Saving water in delivery is a much more profitable investment if leveled fields permit efficient application to fields. Neither physical modification can achieve maximum potential food production if farmers remain ignorant of modern water handling and irrigated cropping techniques. Hence, irrigation extension is critical for the success of improvements in water delivery or field levelness.

There will be watercourses in which only watercourse improvement or land leveling can be justified. In other areas, the primary program that should be considered is augmenting water flows by small discharge tubewells located at the head and perhaps the middle of the watercourse after completion of watercourse improvements in order to allow more of the tubewell discharge to reach the farmers' fields.

Finally, village organization for the purpose of better maintaining earthen watercourses is essential all across the country, whether or not the watercourses are involved in the primary water management program.

Pakistan should not restrict its water management program to those watercourses qualifying for the full program. Instead, Pakistan has the resources to implement several programs simultaneously, thereby achieving a broader and more

rapid impact on conserving the nation's water resources. Indeed the magnitude of water losses throughout the country should mandate as widespread a program as possible.

The paper "Water Management Alternatives for Pakistan" (4) recommends a three-way attack on water wastage, which includes watercourse improvement, precision land leveling, and extension of improved agronomic and irrigation practices. We wish to reiterate that recommendation with emphasis since the three suggested programs do not compete for physical or administrative resources and would, in fact, reinforce each other in achieving the main objective.

In addition to the primary water management program that has been discussed in the previous section, the Government of Pakistan should implement the following general water management program thrusts:

1. Induce as many watercourses (or villages) as possible to organize and implement a permanent program of routine maintenance. This program should probably be implemented by the existing Irrigation Department itself, supported by national emphasis through several media and an appropriate incentive. The program is very inexpensive, the benefits very large, and without it millions of acre-feet are being lost needlessly.

2. In sweet groundwater areas, a program of support should be mounted for installation of community tubewells pumping directly into the watercourse, as in SCARP areas. In general, these tubewells should be the small size (100 to 150 feet deep and 0.2 to 1.2 cusecs capacity) which are efficiently dug by local drilling contractors using rural labor, and generally produce water with lower salt content than deeper wells. These tubewells would be situated where they can most effectively meet the water and drainage needs of the area. In some cases, they could supply water to high areas where jalars are presently required. These wells can also be used during monsoon seasons to reduce waterlogging and salinity by lowering water tables in the lower portions of the commanded area and allowing more leaching and removal of salt. Where necessary to minimize capital outlay, these low cost wells can be driven by versatile farm power units such as tractors. Peak water use is commonly during periods when demand for these power units for other purposes is low. Costs of small tubewells, without power units, can be as low as Rs.5000. Benefit:cost ratios have been estimated to exceed 8:1. This program could be implemented mainly by selective credit programs for

tubewell components provided that the constructed tubewells meet the operational requirements mentioned above. Either a water users association could own and operate tubewells, or a group of farmers could own and operate a tubewell(s) on an informal and cooperative basis.

Sequencing of Technical Components

The core program is seen as one which brings to the project watercourses a package of watercourse renovation, land leveling and irrigation extension. It is important that the three components arrive together for several reasons. First, the disruption to cropping that will result from either watercourse reconstruction or leveling can be confined to a single time period. Second, rebuilding earth watercourses will frequently require fresh soil which can most efficiently be obtained from surrounding fields during the leveling process. It should be noted that the Irrigation Department has the legal right to utilize as much as the top foot from 100 feet on either side of the sanctioned watercourse for this purpose. Also, a determination must be made as to whether or not tubewell(s) are necessary in order to determine the total capacity of the watercourse and consequent sizing for lining or rebuilding. Third, implementing several program components simultaneously minimizes the motivational and educational efforts needed to elicit village cooperation. Fourth, changes in farmer irrigation practices can most easily be brought about at the same time that physical changes to the irrigation system are made.

For maximum efficiency and best utilization of scarce manpower, the program should be implemented as described below. After an appropriate screening process, five (possibly four or six) watercourses would be selected as a cluster. The cluster becomes the unit at which the program is implemented. Consequently, the watercourses forming a cluster should be geographically close enough to each other that key personnel can reach any single one for a day's work from a central location.

Clustering is recommended for several reasons. First of all, clustering allows the engineers involved to interact closely, pool their talents and develop a sense of team association with, and hopefully a commitment to, the project. When necessary, two or more personnel could visit a watercourse for a combined assessment of a problem. Land leveling will be done on a demand basis and as such it will probably require five watercourses to keep a five unit land leveling contractor fully occupied. Again, geographical proximity is required to permit shifting equipment back and forth as the cropping systems of individual farmers come up with idle land.

At average sizes, a cluster would contain 1500-2500 acres and about 200 farmers. These five watercourses could be a part of one, two, or up to five villages. Where more than one watercourse in a village is participating, the possibility arises of organizing the local water users association at the village, rather than the watercourse, level. Consequently, one cannot predict the number of associations involved in a custer.

The personnel involved include the following:

1. One Water Management Coordinator--the senior individual who is the coordinator of the field team.

2. Two water management engineers (preferably agricultural engineers, but civil engineers could also be used) who would specialize in watercourse improvement.

3. Two agricultural engineers who would specialize in land leveling.

4. One On-Farm Water Management Advisor, the equivalent of an AA, yet specialized in irrigation extension.

5. One Assistant On-Farm Water Management Advisor, equivalent of a specially trained FA.

After a series of watercourse studies and farmer meetings have established the specific types of improvement needed and which farmers will support, the water management engineers proceed to implement the watercourse program. While they will often work together, they should be expected to each take primary charge of one watercourse. Two watercourses can thus be renovated concurrently.

The engineers will rely primarily on locally available labor and artisans for unskilled and skilled labor. As much as possible of the labor and materials should be locally obtained so that additional local employment results. The local water users association should do the necessary hiring and purchasing. The engineers then concentrate on design, quality control and specification achievement. Association officials, after certification by the water management engineers, would be reimbursed by the government.

Most improvements can be completed in 4-5 months, hence the five watercourses should be completed in 12 months.

At the same time, the two land leveling engineers begin work. They will provide engineering services primarily and rely on local contractors for the actual earth moving. They will also survey and stake fields for farmers who wish to do the work themselves. Two such engineers can handle the before

and after surveying, organize and manage the program, and ensure compliance with specifications of finished work.

Realistically, not more than half of the fields in a given watercourse can be made available for leveling in any one year. Consequently, a year's work could amount to 1000 acres leveled. One tractor and scraper unit can handle 200 acres annually or one-half of an average watercourse. At most, a cluster will require one private contractor with five units full time. The same equipment with the addition of a sheep's foot roller can be used for building the bed for new ditch channels.

Extension personnel arrive with the Water Management Coordinator in the early stages to assist in the various studies and interviews necessary. As construction work begins, the extension personnel begin selecting their demonstration farmers. As soon as water is available after the construction phase, they set out demonstration plots for land leveling and efficient irrigation practices. Even during the construction phase when water supplies will be temporarily interrupted, they will be educating farmers on various crop-soil-water interactions that they will need for modern irrigated farming. In particular, determination and use of soil moisture status as an irrigation guide should be taught immediately since it is an important technique under any situation.

After completion of the construction phase (approximately one year) the team of engineers move on to a second cluster. The Assistant On-Farm Water Management Advisor remains with the watercourse cluster on a permanent basis. This would provide one man trained in irrigation extension for every 200 farmers, five times the current density, and he would have a modernized watercourse and many leveled fields upon which to work. The senior extension man, the on-farm water management advisor, would continue supervision of the assistant advisor and accept supervision of the assistant assigned to the next cluster. After five clusters he, too, will remain behind when the team moves on.

Institutional Component

The second major component in the water management program consists of the institutional framework that will be necessary to implement the technological propositions and to carry out the necessary training and extension functions designed to ensure a long term success in achieving the project objectives. Pakistan already has a structured institutional framework upon which to build in terms of the existing legislation in the field of water law, land regulations, revenue, etc., and with respect to implementing government entities such as Irrigation and Power Departments, the Agriculture

Departments and the Revenue Departments in the various provinces, WAPDA, Agricultural Universities and the several governmental research institutions. The philosophy behind the recommendations contained in the institutional component is to utilize all existing institutions to the extent possible. But, where constraints or impediments to implementation of improved water management practices exist, it is proposed the institutions be restructured or redeveloped consistent with the goals and objectives of the program.

There are three levels to the institutional component which require attention, modification or adoption. These three levels are:

1. The agricultural sector level. Primary focus is upon the creation of a system of water user associations at the watercourse or village with the potential to develop a hierarchy as the associations mature into effective organs for improving on-farm water management. This hierarchy would consist of a federation of associations and an executive council that would pursue the interests of the water user associations in a dynamic spatial and temporal effort (see Figures 1 and 2).

2. The government related and support organizations level. Primary emphasis will be placed upon the Irrigation Department, Agriculture Department, and such entities as WAPDA, Agricultural Universities, and agricultural research institutes. The thrust at this level is to identify and discuss the role of these agencies to on-farm water management and their participation in the implementation of this program.

3. The laws and regulations level. Key features include formation of water use policies, authorization for creation of water users associations, possibility of expanding the powers and functions under the Soil Reclamation Act, and the need to develop ground water legislation which would include management of the conjunctive use of the ground and surface waters and integration of water quantity and quality.

Institutional Arrangements in the Agricultural Sector

Water User Associations:

Within the agricultural sector of Pakistan there is a definite need to introduce the concept of water users associations in conjunction with improved water management. It is important at this point to emphasize that the proposition is not rigid with respect to the type of structure to be adopted, but initially is to promote the acceptance of the

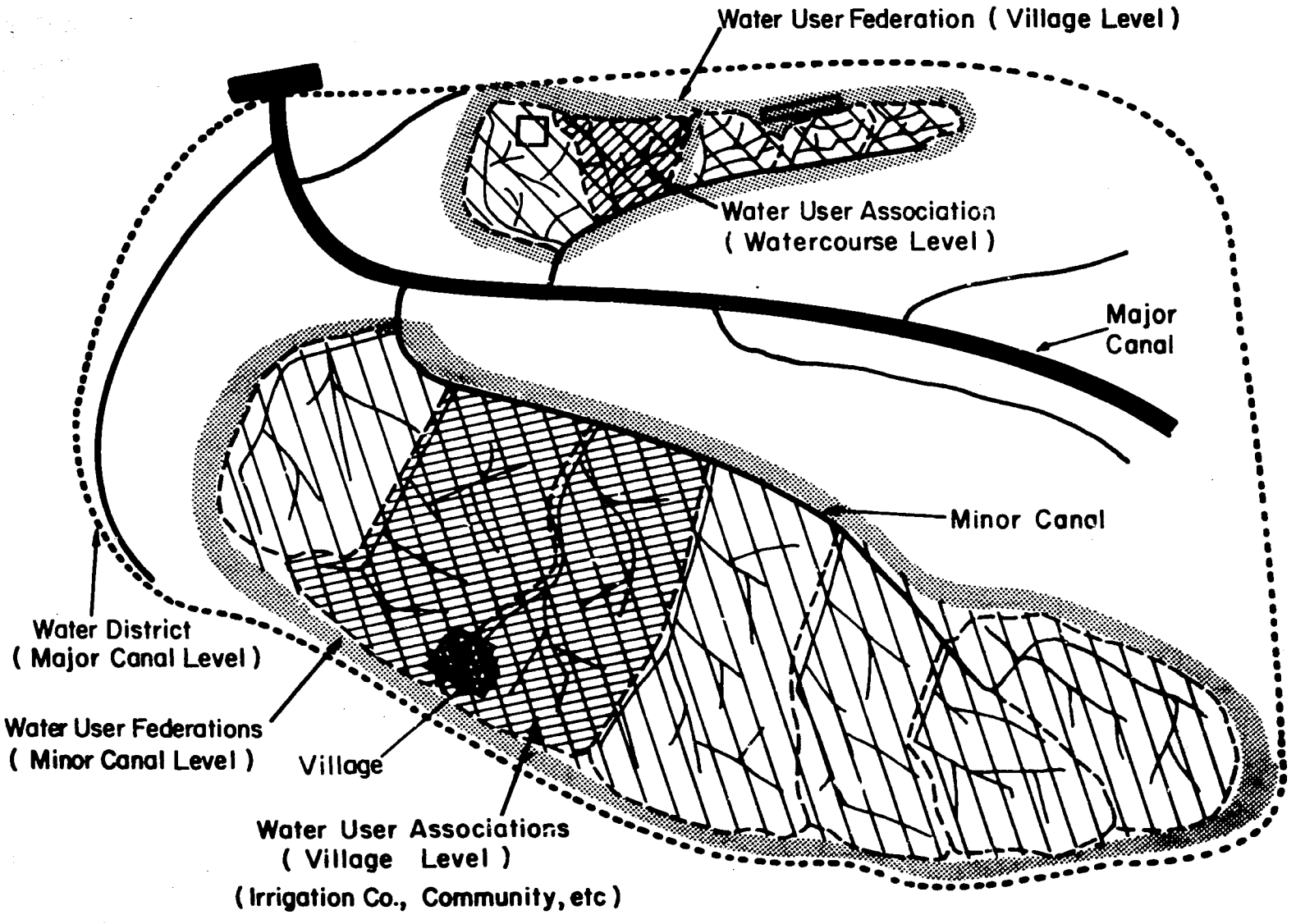


Figure 1. Water User Organizations for Pakistan: Development Scheme.

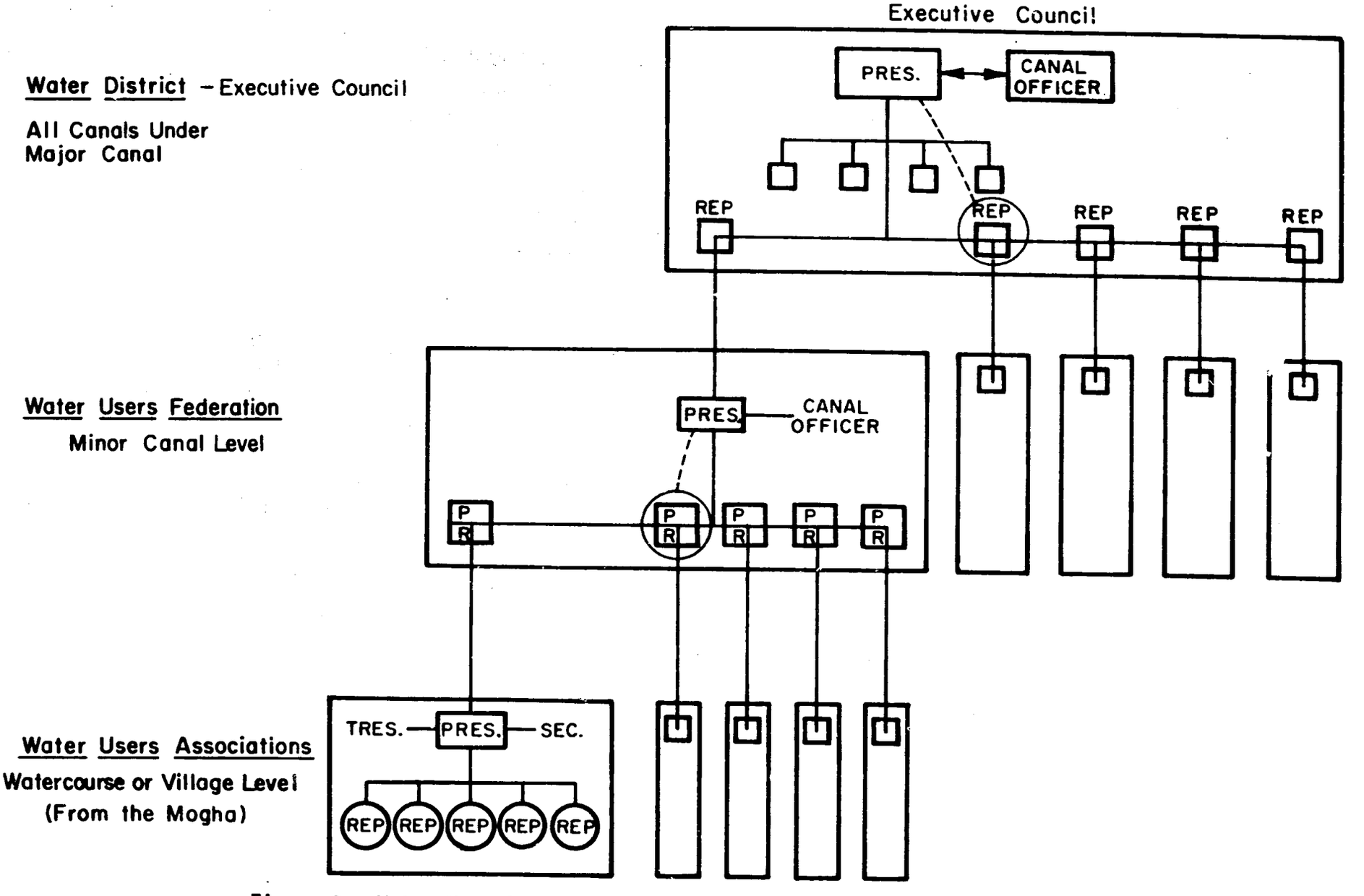


Figure 2. Water User Organization for Pakistan: Organization Scheme

concept of organizing farmers to jointly pursue goals of common interest. The physical boundaries of the association should be along hydrologic units since this is the one feature in common with all farmers. This is distinct from the formation of agricultural cooperatives where common boundaries are the economic and social dimensions of agrarian life.

The introduction of the concept of water users associations in Pakistan should most appropriately consist of a bottom-up approach, that is, to organize the farmers along logical, physical and social dimensions that will enable them to participate in such programs as that being presently proposed by USAID. The bottom-up approach is recommended as opposed to the top-down approach, for example, that was adopted by Mexico with the creation of irrigation districts. It is felt that in Pakistan there is already a well-defined agricultural system of traditional and historical importance upon which to build and, therefore, it is a matter of starting at the lower units in an effort to improve the use of water by the agriculturalists. In contrast, Mexico adopted the top-down approach primarily because there was limited acreage under cultivation in the country prior to the introduction of a management scheme through irrigation districts. Their objective was to reclaim and settle people in as large areas as possible, therefore requiring a highly centralized and well defined program. To ensure this would be carried out, the Mexican Government elected to establish irrigation districts in the reclamation area, and within the districts create sub-units, called water boards. The area under jurisdiction of a board is somewhat equivalent to an area served by a large watercourse or a small minor canal in Pakistan.

The Irrigation and Agricultural Departments in Pakistan are well established and, therefore, to attempt to implement a top-down approach at this time would simply add another layer of organizations to what already exists and perhaps most importantly, take away the initiative of the water users to improve their own system by having a program imposed upon them. Starting from the bottom-up requires the water users to take the initiative. The report by Murray Cox (3) also describes the importance of the grass-roots approach.

It is necessary to provide the water users with the incentive to improve their water use and the mechanism by which they can implement new technologies, practices and programs. Material support (e.g. equipment, loans, construction materials) and obvious benefits would form the incentive. The mechanism at the grass-roots level is the water users association.

The role of the association is as follows:

1. To serve as the legal device for the water user contracting with the government in order to undertake watercourse and land leveling improvements.

2. To provide assurance that the watercourse will be properly operated, maintained and improved after construction of the physical components.

3. To provide a vehicle for farmers to gain an important identity in the country and an opportunity for them to develop and assume individual and collective responsibilities in the use of the nation's natural resources. This latter point is extremely important. In an observation of the operation of water users associations in several countries, it was found that where a sense of duty and responsibility existed in the use of the public resource, a high degree of efficiency was sought (10). The association provides the agricultural water users an opportunity to develop a social consciousness in the use of the resource and the identity of an importance consistent with the role of agriculture in the total economy of the country.

4. It enables the water users in a village or at the watercourse level to gain economies of scale in the use of all resources available to them.

5. It reduces the risk of all users by simultaneously spreading the responsibility in a more equitable fashion.

6. It gives the water users an opportunity to have an important feedback to the purveyor of water and inform the purveyor of constraints and limitations to which the user is subjected and which they may wish taken into account.

7. The institutionalization of water user associations will enable large and small farmers, landlords and tenants to play a vital role in the increase of food and fiber production and stimulate a more enthusiastic work force in one of the more important sectors of the nation's economy.

8. They could provide the water users of the association a right of recourse directly to the courts where otherwise a conflict of interest may exist should an administrative decision be made.

9. As a legal entity representing the collective goals and duties of farmers within a watercourse at the village level.

10. The water users association at the village or watercourse level will serve as the first link in the channel of communication between the water users and the water managers (i.e., the Irrigation Department).

Level of Formation:

Based upon an evaluation of the most efficient means for organizing water users and a preliminary evaluation of village surveys, it is recommended that the associations be formed at the lowest possible unit which would be the watercourse level or, where feasible, at the village level if there is only one watercourse serving the village or where farmers on more than one watercourse are roughly of equal size. The purpose behind recommending formation at the watercourse level is that all users receiving water from a particular mogha have a common interest in the quantity, quality and distribution of the water from that mogha. This commonality is one of the most important links to successful cooperation. In the case where there are two or three watercourses serving a village, it is still suggested that the basic unit be at the watercourse level where it is found that inequities would arise from organizing at the village level. The most significant inequity that could occur is the situation in which a large land holder owns lands in one or two of the watercourses and if the association is formed at the village level, his influence may prevent small farmers on the third watercourse from freely and fully exercising or expressing their desires. Therefore, in order to maintain the highest degree of equity, in the truest Islamic sense, and encourage the greatest incentive, the watercourse would be the most likely unit to form around.

Sufficient legislation in Pakistan exists to create trial associations in an effort to experiment with the most ideal form. The Companies Act provides the best mechanism for formal organization. It is suggested that the associations not be formed under the Cooperative Societies Act in light of the adverse reaction by Pakistani farmers to cooperatives. The most desirable situation would be to have an executive order or notification authorizing the formation of water users associations and specifying the criteria for their formation.

Nature and Structure of an Association:

There are in existence in Pakistan many de facto organizations for distribution of water among local users. The de facto organization which exists by virtue of customary practice in agreement among the users should always remain a viable possibility to the water users. However, it is suggested that a formal de jure entity be formed in order to give it legal status. This status would enable the entity to sue and be sued, seek loans for improvements, undertake programs offered by the government such as the water management loan program, and in general, give the organization a legal characteristic equivalent to the rights and obligations of an individual.

The structure of the water users association should consist of two bodies performing three functions. (See Figure 3). The first body would be the assembly consisting of all of the water users in the association. These water users would be shareholders and members of the association. The primary functions are the election of officers to the second body, which would be the board, and raising and deciding issues of common importance to the association.

The assembly would act as a general directive body. All the members would elect a board, approve organizational policies, approve the method of assessment collections, and approve the selection of the assessment collectors and ditch walkers.

The second body would be the board of directors or watercourse committee. The board would have two functions. The first, to manage the association according to the creating documents and bylaws enacted by the assembly, to carry out other decisions by the assembly, and supervise construction and maintenance of the physical structures, which would also include hiring the necessary personnel to undertake this work.

The second function of the board would be quasi-judicial. This function is to resolve disputes within the watercourse among the water users. In this sense, they perform similar functions to the Community of Irrigators in Spain.

The board of directors would manage and operate the water users association, exercise normal powers to carry out the purposes of the association and have emergency powers for water regulations. The board would be responsible for contracting with the government on the programs, disseminate information on water availabilities, and other types of information pertinent to the farmers, and carry the issues raised by the farmers back to government officials in the promotion of the association's interest.

The board would be organized into the offices of the chairman, the secretary and treasurer--the chairmanship should be rotating. Regardless of the office held by any representative, the representative would have no additional power or authority by virtue of holding that office over other representatives.

Functions and Powers:

As a general proposition in the formation of the association, the following functions and powers should be granted:

1. Main watercourse rehabilitation;

2. Operation and maintenance of the main watercourse;

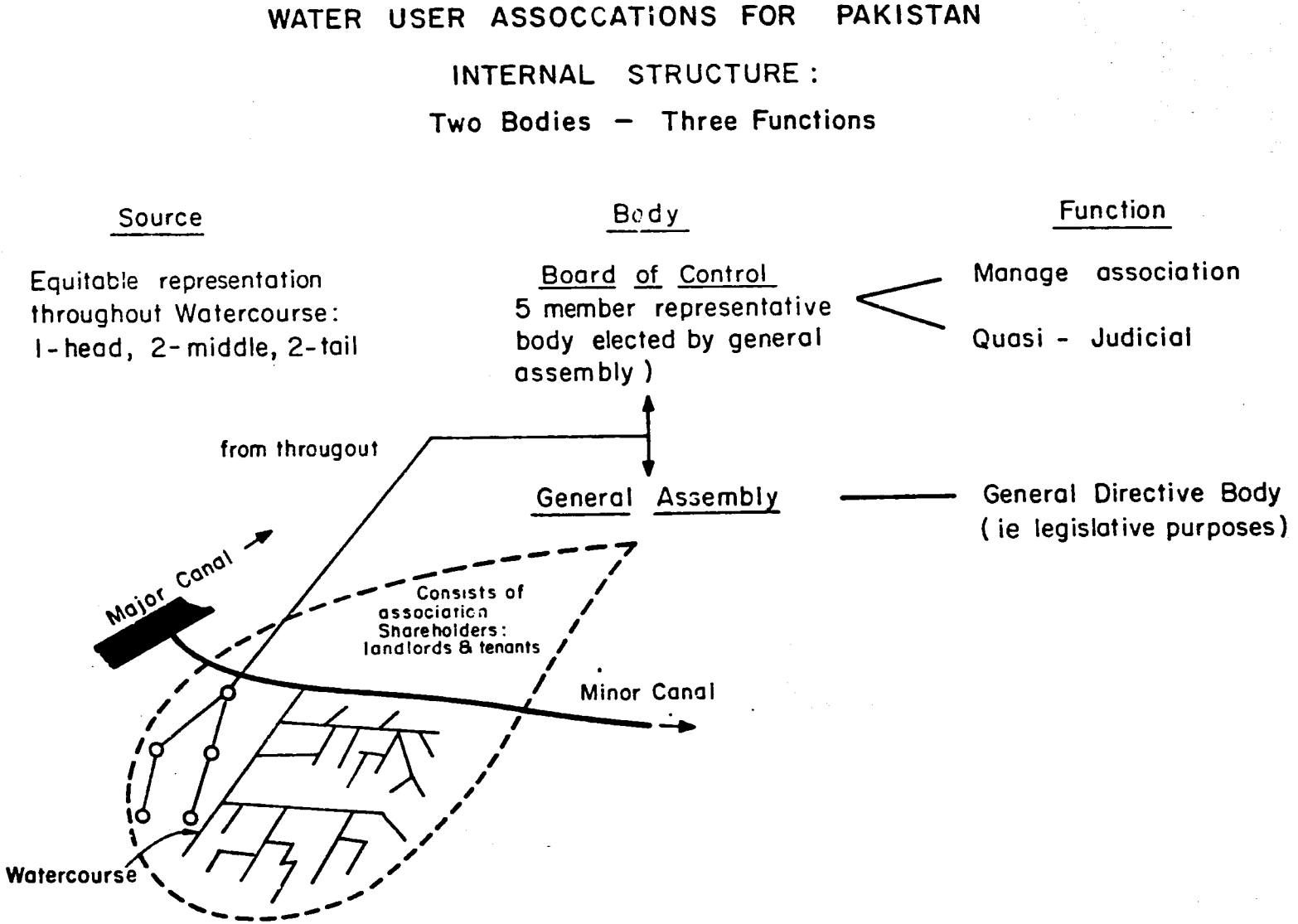


Figure 3. Internal Structure of Water User Associations for Pakistan

3. Sanctions for upgrading and maintaining farm field ditches and outlets;

4. Improving on-farm water management practices to include land leveling;

5. Establishing water delivery schedules and supervising water allocation within the watercourse;

6. Consideration of tubewell placement in order to optimize the water resources from both surface and ground sources in a conjunctive manner;

7. Set assessment methods and rates, and then collect assessments;

8. The association must be granted the power to conscript membership and make assessments in order to undertake emergency repair work; and

9. In general, promote improved water control and management by water users in an effort to reduce the unnecessary losses and increase agricultural output.

Membership:

The formation of the association should be voluntary in order to leave the ultimate decision in the hands of the water users and to psychologically stimulate their reaction to improving their water use. However, once formed, membership in the association should be mandatory for all farmers cultivating lands commanded by the watercourse. Membership should include not only the absentee and operating landlords, but also the tenants in such a manner that through their membership they can voice their opinion on issues concerning water delivery, use and removal.

Voting:

The manner in which the voting rights are granted the members of the association is a delicate one that should balance the power of the large landholder over the masses of the small farmers and balance the interest of the landlord with the efforts of the tenant. It is recommended that a graduated system be adopted that would have both a minimum and a maximum number of votes for any landholder. Through the right to vote, it gives all members a participation in the management of the association.

Graduated voting will protect the interest of the small landholder or tenant by ensuring that he has a minimum number of votes. A minimum acreage should be set to qualify for a vote in order to discourage further fractionization of land holdings. For example, there would be no voting for an

individual holding less than one or two acres, but rather if there were three or four members in the family who held collectively the minimum amount there would be the minimum vote for that family or joint holding. This would prevent either tenants or landlord from granting small acreages to the members of their family or relatives in order to gain more votes in the assembly. A scheme of graduated votes is presented in the report by Radosevich and Kirkwood entitled, "Water User Organizations for Pakistan." This graduated voting system is patterned after the practices followed in Mendoza, Argentina, and Chile.

The other concern is that the voting should be shared between the tenant and the landlord. What must be taken into account is the protection of the landlord's interest in order to encourage investment, while at the same time giving the tenant the feeling of his true value by having him involved in the decision-making. This will stimulate his interest and pride in the work.

One scheme for allocating votes between the landlord and the tenant is to assign the votes according to acreage in the watercourse, and assign those votes initially to the landholders whether working or absentee. This would be the basis for determining the number of votes in the watercourse. Where a landowner operates his farm he would vote his right. In the case where there is a landlord with a tenant, the landlord could vote 51 percent of the total votes to be cast and the tenant would vote the other 49 percent. This still enables the landlord to override his specific tenant. It protects the landowner's investment in the property while stimulating active progress and investment (labor, skill) of the tenant and inducing further cooperation between the two.

Basically, no approaches can be employed for determining voting outcomes: (a) The plurality or simple majority approach wherein the past with the most votes "wins"; or (b) the proportional representation approach wherein all parties divide the "spoils" according to the proportions of support obtained. For purposes of setting association policy and for purposes of electing association leaders, it is suggested that the plurality rule be followed on the premise that, by giving victory to the party with the most votes, parties will be stimulated to formulate policy options in a manner representing the widest possible concerns. There is incentive for leaders to seek the "middle" ground, rather than holding to extreme positions--a posture too often rewarded by proportional voting systems. Obviously, varying voting systems need to be tried and evaluated under different watercourse conditions, such as disparity between large/small operators, single/multiple castes, centralized/decentralized influence patterns, etc.

Election of Representatives:

Representatives who will serve as officials on the board should be elected by members of the association and have a geographic distribution throughout the watercourse. It is recommended that one representative be elected from the head, two from the middle and two from the tail end of the watercourse. In the case of larger watercourses, the number may increase in proportion to this scheme.

Another consideration is the minority group, or the system of baradri (brotherhood). In this case, it may be decided that a representative would be elected by a baradri holding a certain percent (e.g., 20 percent) interest in the watercourse, or the baradris may be given additional votes in a graduated system of voting.

Assessments:

The authority to levy assessments must be granted to the association. The assessments should be based upon the construction, operation and maintenance costs for improving the system and allocated among the water users either according to the water they used or the acreage under their control. The latter would coincide with the voting rights of the members. Payment of the assessment should be made either in cash or in kind (i.e., some product that the farmer is producing).

Registration Requirements:

It is recommended that all associations be registered with the Provincial Irrigation and Power Departments. If the association is formed under the Companies Act it would also be registered with the Registrar of the Companies. A roster or registry of associations will greatly facilitate communications between government and users.

Hierarchy of Associations:

The next level in the hierarchy of the agriculture sector of water users association is the federation of associations. (See Figures 1 and 2.) It is suggested that the water users federation should be formed either at the village level where the watercourses are organized into associations, or the association could be organized at the minor canal level.

The chairmen of the water users associations within the federation area would serve as the federation board.

The primary purpose of the federation would be to gain greater economies of scale for improvements in the larger area where this is necessary; therefore, it is not presumed

that all minor canals would initially be associated into federations. The federation would deal with the SDO on the Irrigation Department side and with the assistant director on the Agricultural Department side. (See Figure 4.) The federation would be in a better position to accumulate the necessary information on water supplies and deliveries and pass this information down to the water users association for further dissemination to the irrigators.

The highest formal level in the hierarchy of the water users associations would consist of the executive council. The executive council would consist of the chairman of the federations under a major canal. Thus, the executive council would deal with the executive engineer of the Irrigation Department and with the deputy director of the Agriculture Department, as well as dealing directly with other officials in the Irrigation and Agriculture Departments, WAPDA, and other agencies related to national water matters.

The ultimate level is an informal body at the provincial level consisting of a representative from each executive council. The functions of this council would be to coordinate the programs and activities in improving water use within the major canal's command area. However, it would maintain only ad hoc powers granted by the executive council representatives.

Water users would consequently be provided a channel of communication of their own membership from the point of mutual interest (e.g., diversion from major canal to their cropping area, or provincial assistance in agricultural development). The development of this hierarchy should take place over a 10-15 year time span, and only to the extent that each level provides a function.

Government Related and Support Agencies

In order to undertake the improved water management program, attention must not only be paid to water users, but also agencies of the government concerned with allocation and management of the provincial waters. It is necessary to identify their role in the on-farm water management program and their degree of participation. It is also considered necessary to include officials of many of these departments in training programs to make them more aware of the on-farm water improvement program and to emphasize how the carrying out of their duties affects the water user.

Irrigation and Power Departments:

The two key organizations at the provincial level are the Irrigation Department and Agriculture Department. In the Punjab, the Irrigation Department has since 1972 acquired the powers under the Soil and Reclamation Act. This act provides

the most feasible legistlative authorization for carrying out schemes to improve the use of water within the watercourses. Although it is primarily directed to soil and waterlogging schemes, the nature of the Soil and Reclamation Act is broad enough to include the scope of the proposed water management loan program. It has not been determined whether the other provinces have likewise assigned the powers under the Soil and Reclamation Act to the Irrigation Department, or whether they have retained the Land and Water Development Board.

In any case, the Irrigation Department is initially the department of most concern, since it is responsible for diverting the delivering water supplies to the users up to the mogha. The quantity and timing of delivery may be critical to the farmer in terms of his planting date and type of crop sown. Although the Irrigation Department is only concerned with the delivery of water to the watercourse, the expertise of the department is also very relevant to the on-farm water deliveries and use of the resources.

Agricultural Departments:

The Agriculture Department, although not the purveyor of water, is very important in terms of extension personnel functions and in working with the farmers in activities related to their water use.

Organizational Scheme:

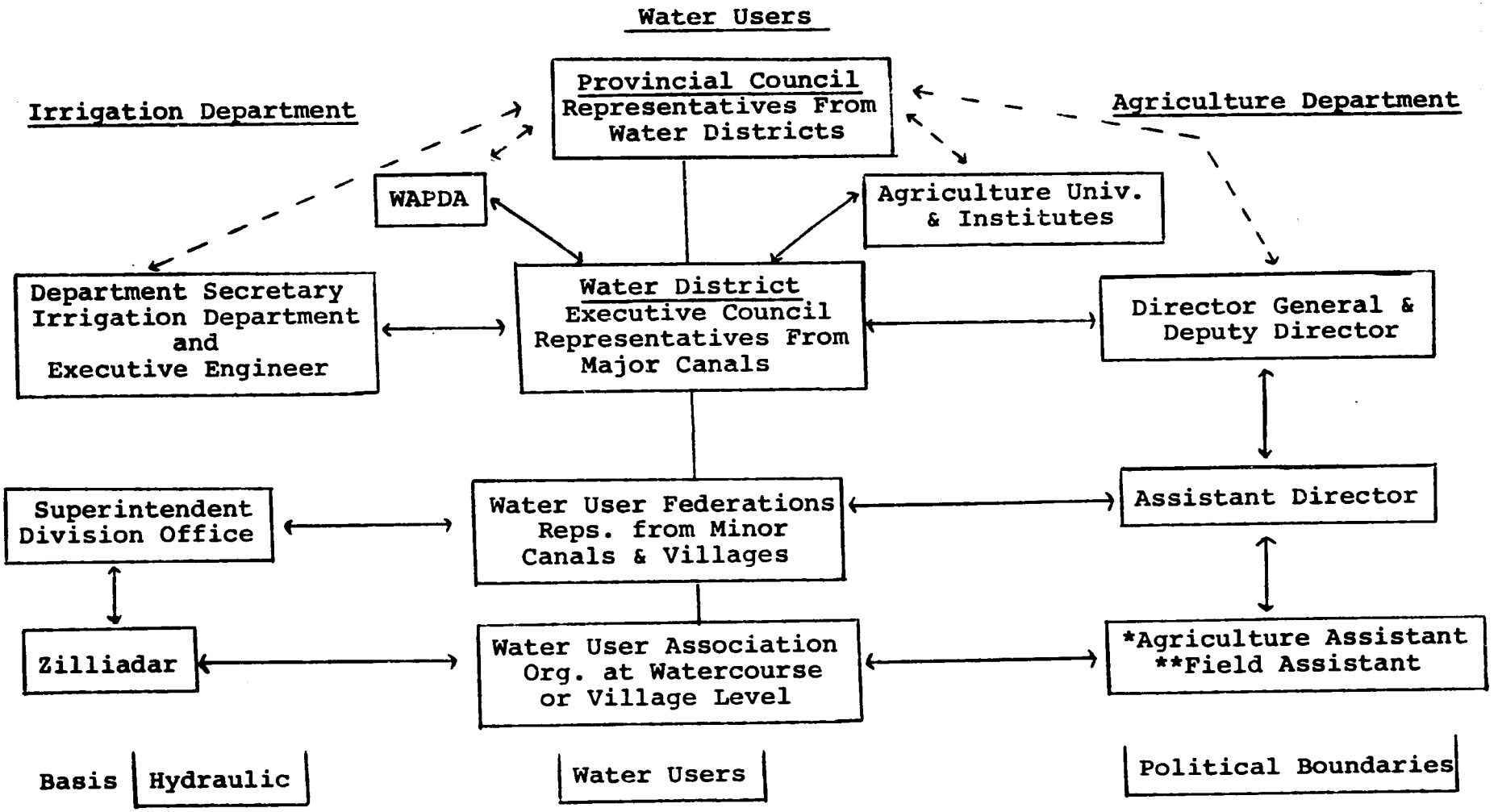
The creation of a system of water users association is recommended for Pakistan, wherein a hierarchy is developed in order to develop lines of communication with the various levels of these two key government agencies (Irrigation and Agriculture) and other entities such as WAPDA, the Agriculture Universities and the Institutes. The proposed organizational scheme is shown in Figure 4.

Laws and Regulations

In order to implement the proposed water management program, it will be necessary to change or enact certain laws to ensure success. The most important addition will be the authorization of the formation of water users associations, i.e., the adoption of the concept of the associations and hierarchy in order to develop the channels of communication so badly needed in Pakistan.

The second recommended change is to expand the Soil and Reclamation Act to include the improved water management program. It is thought that this may be more politically feasible than to enact new legislation.

The third change is that the provinces explicate water policies for the use of the provincial waters and that the



*-To become Water Management Advisor
**-To become Assistant Water Management Advisor
---- Refers to granted ad hoc functions.

Figure 4. Linkages between water user associations and Government of Pakistan policies and personnel.

policies set up the priorities for development; the government responsibilities to allocate, distribute and regulate water use for the people of the province; that conjunctive use of ground and surface water will be sought in order to better utilize the resources; and water quality will be integrated in recognition of the interdependence of the consumptive uses to diverted supplies and the quality deterioration in the nonconsumed return flows. The final element of the policy would call for cooperation of government agencies in the undertaking of the water management program in Pakistan.

The fourth major change is to enact ground water legislation which would create a permit system in ground water use, licensing for well drilling, provide well spacing requirements, and a recording of the location, discharge, and water quality from the wells. In addition, the ground water act should set up a criteria for conjunctive use of ground and surface waters in an effort to improve not only the quantity of these resources, but also the resulting quality.

Finally, it is suggested that the present laws be evaluated and that the laws, rules and regulations of the agencies be evaluated and that they be made consistent with new techniques and technologies to enable the implementation of a dynamic program for improved water management.

Organization and Training of On-Farm Advisory Service

The farmer-irrigator is a major component in any program for watercourse improvements and changes in irrigation practices for increased crop production. In order to organize farmers for improvement activities and help them develop management practices, some type of farm level advisory service staffed with adequately trained personnel is required on a continuous basis. Experience in irrigation improvement projects teaches two major lessons: One, where adequate inputs and services are not made available, physical improvements either have short lives or the intended benefits are not realized; two, where new technologies and production possibilities are made available, farm level advisory services become more important and profitable for farmers.

The focus of this section of the paper relates to the organization of a new type of advisory service in Pakistan, which is a major component of the water management development project. Suggestions are also given as to manpower training requirements. Given the critical need for water management improvements in Pakistan for many years to come, the program also provides an opportunity to begin procedures and activities to strengthen the present weak extension system.

The designation "on-farm water management advisor" is used instead of "extension worker" because both the training

and functions of the former will be different from that of the traditional agricultural assistant and the field assistant.

It is proposed that the manpower for this position be carefully selected from current Agriculture Department field staff and given intensive training with a definite focus on skills required in helping farmers organize for collective activities to promote implementation of improved water management technologies. Recent graduates of the Agricultural Universities with special training in water management also provide a source of additional personnel.

Organization of Farm Level Water Management Advisory Service

There are several alternatives as to how such a program can be organized and under which department. Though it is possible to consider designing a new institution with responsibilities for farm level advisory services, the risks are great and the time factor plus political considerations constraints, our best recommendation is an improved program under the Agriculture Department with enabling linkages with several support institutions.

In light of our recommendation that the water user association composed of watercourse members is an essential part of the total program, the advisory services organization is designed with close linkages to these associations both at the lower and higher organizational levels. The idealized organizational chart (Figure 4) shows the advisory service parallel to the proposed structure of watercourse associations only to the regional level.

Though the water users associations should be organized primarily on hydrological units, the Agricultural Department District and Regional Directors in Figure 5 are related to all the canal and regional associations in their respective areas.

At the watercourse level, a specially trained Assistant Water Management Advisor (field assistant with special training) would service five watercourses under the supervision of a mobile Water Management Advisor responsible for twenty-five watercourses. At the distributary level, a Water Management Specialist would provide technical support and supervision of all advisors in his area.

Linkages With Other Institutions

Unlike the present extension system and other farm level programs in Pakistan, the proposed advisory service should have both functional and enabling linkages with research and other support institutions. Figure 5 shows some of the more important linkages. Descriptions of these follow:

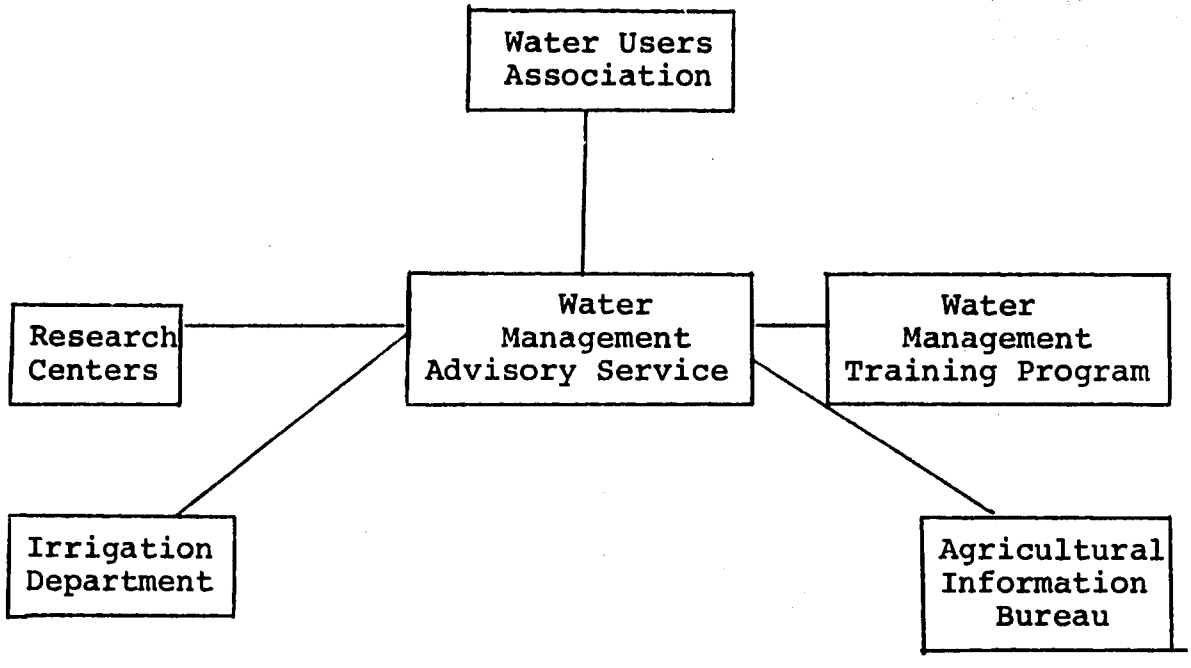


Figure 5. Linkages with Water Management Advisory Service.

1. The farm level advisors must identify closely with the water users associations. Many activities will be directly related to these associations which can become effective educational cells for teaching and assisting farmers in collective activities, as well as influencing the behavior of individual farmers. Some mechanism should be designed whereby the watercourse federations have some control over the work of the water management advisors.

2. The linkage with the Water Management Training Institute or Program is essential for several reasons. After the Water Management Advisor and his Assistant have completed six months of formal intensive training, they can be assigned to watercourses under the Water Management Specialist for an additional six months of on-the-job training. The Training Institute, along with the Water Management Specialist, could be made responsible for the evaluation of the field work of each trainee. Also, the Training Institute should conduct annual short refresher courses (perhaps one or two weeks) for field advisors each year. These two functional linkages will provide feedback for improvement of the training program and will be a means of keeping advisors up-dated in their skills and knowledge.

3. As a support to the advisory service, a continuous flow of agricultural information especially related to water management must be institutionalized. This should not be a one-shot effort because both research findings and farmers' problems will continue to change rapidly. There will be a need for extension materials prepared in Urdu. The Agricultural Information Bureau was designed to fulfill such a function. It has ready access to mass media such as newspapers, radio, television, and has its own fortnightly paper and a journal. However, its capabilities need to be improved and, as a specialized agency under the Agriculture Department, it can function to support the water management development program.

4. Another necessary linkage is with the Irrigation Department which has responsibilities for the delivery system. In order to bring the Irrigation Department more into the picture of on-farm water management, it is proposed that the watercourse construction engineers and assistants be provided by this department. Special training would be required for these engineers. Vital information about delivery schedules, as well as rules, are essential for helping farmers plan rationally and reduce risks. At some level, there should be coordination between the Irrigation and Agriculture Departments and with the water users associations.

5. No farm level extension or advisory service can be effective without strong functioning linkages with research institutes which are directly involved in developing improved production possibilities. A linkage could be developed with

major research institutions through a water management research specialist assigned to selected research centers. This research specialist could provide research findings to the Water Management Specialists who make the same available to the advisory service workers in formats that can be used with farmers. A strong attempt to institutionalize water management research should be made at research institutes if irrigation improvements are to be successful over time. Definite feedback systems are also important between the advisory service and research centers.

6. Though not shown as a linkage, it may be important to assure a credit program operated through the banks especially for small farmers in the development areas. As development activities are initiated, the demands for fertilizer, land leveling services, farm implements, etc., should be expected to increase. Development programs for improved water management seldom reach their potential for farmers unless necessary inputs and services are made available with adequate credit arrangements.

Position Descriptions for Water Management Advisory Personnel

The position descriptions for the Assistant On-Farm Water Management Advisor, On-Farm Water Management Advisor, and On-Farm Water Management Specialist are listed below in Tables 1, 2 and 3.

Estimated Manpower Requirements for 500 Watercourses

With the assumption that one water management advisor can adequately service five watercourse clusters of five watercourses each with one assistant at each cluster, 20 advisors and 100 assistant advisors would be required. In addition, an estimated 20 water management specialists would also be required. However, this estimate will depend on the number of districts in which the development program is implemented. A conservative estimate of total manpower requirements for the advisory service would probably range between 140-150 trained men.

Given adequate training facilities and staff, 25-30 men could be trained every six months. Since such training is unique to Pakistan, the services of at least two expatriate staff members would most likely be required for the initial development of an adequate training program. After six months of formal training, each advisor would undertake six months of supervised on-the-job training.

The suggested density of field workers to farmers is quite high. Below, the suggested densities for the Water Management Assistant and Advisor are shown.

Table 1. Position description for Assistant On-Farm Water Management Advisor.

1. Educational requirements
   a. Completion of high school and course in agriculture at training institute.
   b. Completion of six months intensive training at Water Management Training Institute.
2. Experience requirements
   a. Not less than five years of successful work as Field Assistant.
   b. Farm background from small farm.
3. Special knowledge or ability
   a. Ability and personality to maintain good working relationships with farmer groups and individuals.
   b. Basic interest in farmers' problems and their solutions. Ability to motivate farmers to use information and adopt new innovations.
   c. Proven skills and knowledge of subjects taught in Water Management Training Institute.
4. Line of authority
   a. Works under the direct supervision of the Water Management Advisor.
   b. Works under the supervision of the Water Management Specialists during practical field training and during land leveling and watercourse improvement activities.
5. Job responsibilities
   a. Working under Water Management Advisor to perform specified activities (see under Water Management Advisor's responsibilities).
   b. Reside in a village of the watercourse cluster where he is posted.

Table 2. Position description for On-Farm Water Management Advisor.

1. Educational requirements

   a. Completion of B.S. degree in agronomy or agricultural engineering at a recognized college or university.

   b. Associated studies in soils or irrigation desirable.

   c. Training in extension desirable.

   d. Successful completion of special six months' intensive training at water management institute.

   e. Participation in a special crop shortcourse at an agricultural research station desirable. After he assumes his duties it will be mandatory for the Advisor to participate in short courses at the research station and in a special refresher course at the water management training institute.

2. Experience requirement

   a. Successful work experience in the Agricultural Department.

   b. Farm operation and experience desirable.

   c. Experience in supervision of field assistants desirable.

3. Special knowledge or ability

   a. Knowledge of water-soil-plant relationships.

   b. Ability to plan programs with groups of farmers and farm management programs for individual farmers.

   c. Ability and personality to work effectively with groups and individuals.

   d. Ability to supervise and evaluate the work of assistants.

   e. Genuine appreciation of farmers as people, their problems and interest in helping them solve problems. Ability to motivate farmers to adopt innovations.

   f. Knowledge of economic and social conditions of farmers, the agrarian structure, and interest in small farmers.

   g. Knowledge of content of water management training course and how to apply skills.

(Continued)

Table 2. Position description for On-Farm Water Management Advisor. (Continued)

4. Line of authority

   a. Works under the supervision of the water management specialist.

   b. Work will be evaluated by training institute during the six months field experience with assistance from the water management specialist.

5. Job responsibilities

   a. To conduct a watercourse survey with water management specialist to identify physical, social and economic problems confronted by watercourse members.

   b. To assist water management specialist in helping watercourse members to understand the extent of watercourse losses and benefits that can be obtained from collective action to improve the delivery system and participate in land leveling.

   c. To help farmers organize their watercourse association and the village level water users associations.

   d. To build up creditability with farmers through initial activities of watercourse survey and demonstration plots.

   e. To prepare farmers for collective action for watercourse improvements and for land leveling.

   f. To develop educational and training programs for watercourse association members and other farmers.

   g. To help the watercourse association develop work plans on a seasonal basis.

   h. To conduct special farmers' field days to demonstrate improved water management and cropping practices.

   i. Responsible for information flow to farmers of research findings, government policies, and relevant irrigation information (information provided by water management specialist).

   j. Providing crop and watercourse data to agencies related to the on-farm water management program.

   k. Teaching farmers and motivating them to use new practices such as: improved seedbed preparation, improved sowing methods, increased seed rates, furrow irrigation, irrigation schedules, crop fertility needs, plant protection techniques.

   l. Establishing maximum production demonstration plots with carefully selected farmers on the watercourses.

Table 3. Position description for On-Farm Water Management Specialist.

The specialist will work under the supervision of the District or Regional Director of Agriculture's office. In the initial phases of the water management development project he will be the on-farm coordinator for water management advisors, watercourse engineers and land leveling engineers. At some later period the specialist will be located at the district agricultural headquarters to provide leadership, direction, and subject matter technical assistance to water management field staff.

1. Educational requirement

   a. Completion of M.Sc. degree in agricultural engineering at a recognized university or a B.Sc. in agricultural engineering with extensive experience and demonstrated technical and administrative ability.

   b. Associated courses in soils and crops are basic.

   c. Special intensive training in extension education, farm management, administration and evaluation at water management training institute.

2. Experience

   a. Not less than two years of successful field experience with farmers.

   b. Farm background and experience.

   c. Experience in on-farm water management desirable.

   (Those individuals trained under the CSU program would be candidates for this position.)

3. Special knowledge or ability

   a. Knowledge of history, function, and objectives of agricultural extension work.

   b. Knowledge of present irrigation system of Pakistan; strengths and weaknesses and water codes and regulations.

   c. Ability and personality to maintain good public relations and administrative skills.

   d. Ability to recognize and understand physical, socio-economic and institutional factors necessary for improvement of on-farm delivery systems.

   e. Has internalized a definite philosophy about working with farmers to help them solve their problems.

(Continued)

Table 3. Position description for On-Farm Water Management Specialist. (Continued)

4. Line of authority

   a. Works under the District or Regional Director of Agriculture.

5. Job responsibilities

   a. Assistance with leadership

   Represents the Water Management Advisory Service in a creditable manner with other agricultural personnel. Acts as a liaison between water management and other organizations which are related to on-farm water management (i.e. irrigation, training, research). Keeps informed of all regional and province research findings and keeps up to date by studying, analyzing and organizing information from all sources. Prepares appropriate and adequate teaching and demonstration material for use by extension workers and farmers.

   b. Assistance in program planning

   Works with advisors and water users associations to prepare plans of work. Prepares annually a plan of work for the district utilizing watercourse plans and research findings as input.

   Utilizes watercourse survey data, advisors' reports and information from field visits for program development.

   Participates with the training institutes in formal and informal evaluations.

   c. Responsible for in-service training.

   With assistance from the water management training institute will conduct annual refresher courses for water management personnel

   Will arrange special learning experiences for water management advisors at crop oriented research institute.

   d. Linkages with institutions

   Will develop strong linkages with all organizations related to water management activities (research institutes, training institute, irrigation department, water users federation, etc.).

   e. Legislation of policy

   Will keep up to date on all policy changes related to agriculture and will provide these changes to field staff and farmers.

(Continued)

Table 3. Position description for On-Farm Water Management Specialist. (Continued)

f. Supervision and internal evaluation of field staff

g. Reports

Will prepare monthly and annual reports summarizing activities, results and progress toward goals.

h. Communications

Provides Water Management Advisors with extension materials for farmers. Will prepare articles and communications for mass media for wide coverage of farm population. Will develop publicity program for on-farm water management. Will assist in farmers' field days and seminars.

i. Maintaining cooperative relationships

Follows policies and directions of extension administration and department activities and keeps staff informed of new developments and trends.

j. Special assignments

Participates in any research or survey activity related to on-farm water management which might require external cooperation.

k. Professional improvement

Keeps current on research findings. Takes advantage of opportunities such as workshops, conferences, training programs.

Table 4. Recommended density of field personnel to farmers in water management program.

	Workers/ farm	Workers/ acres cropped	Workers/ watercourse
Water Management Advisor	1:1200	1:12,000	1:25
Water Management Assistant	1:240	1:2400	1:5

Table 5. Comparison of extension worker densities in Pakistan (1964-65) with proposed water management program.*

	Workers/ farm	Workers/ acres cropped	Workers/ watercourse
1. Agricultural Department: Lahore Region (20,220,0-0 cropped acres)			
Agricultural assistants	1:8355	1:83,550	1:209
Field assistants	1:1245	1:12,400	1:31
2. Agricultural Development Corp., G. M. Barrage (1,230,000 cropped acres)			
Agricultural assistants	1:5125	1:51,250	1:128
Field assistants	1:1757	1:5850	1:34
3. Scarp I (1,700,000 cropped acres)			
Agricultural assistants	1:6882	1:68,823	1:172
Field assistants	1:585	1:5850	1:15
4. Proposed Water Management Program			
Agricultural assistants	1:1200	1:12,000	1:25
Field assistants	1:240	1:2400	1:5

*See C. A. Suinth's report, "Strengthening Agricultural Extension in West Pakistan (1965-1970)." Distributed by Planning Cell, Department of Agriculture, Lahore, November 1965, p. 14.

When these densities are compared with traditional ratios of field workers to farmers, it is unusually high as shown in Table 5. The rationale for such an increase in the density of field workers to farmers is: (1) on-farm water management improvement activities are new to Pakistan; (2) intensive efforts will be required to organize farmers adequately and produce substantial results; and (3) present densities and level of skills of field workers have proven to be inadequate.

Institutional Arrangements for Training Water Management Advisors

Either a new training center could be established, or existing training facilities could be utilized. For example, the Agriculture Department in the Punjab has two training centers for agricultural assistants and the Agricultural University at Lyallpur has a special institute for extension and short course training purposes. The use of existing facilities appears more feasible and the location at Lyallpur related to the university appears to have several advantages. A major advantage is the possibility of using selected staff members of the university and the Agricultural Research Institute for assistance in several phases of the training. Over time this could serve as a catalyst to the university in beginning to realize the importance of developing increased capabilities for training students in on-farm water management related subjects. Perhaps, as a long range strategy, a part of the loan program could include training selected university staff members in several departments such as agricultural engineering, agronomy, economics, sociology, and extension in water management fields. This same approach should be undertaken with the Agricultural Universities at Peshawar and Hyderabad.

Concept and Methods of Training

The basic approach to training should be based on teaching problem-solving skills under actual field conditions. This involves problem conceptualization, identification, and acquisition of essential skills required to help farmers solve water management problems. Agout 75 percent of training time should be in farmers' fields. With a ratio of about one trainer to five trainees, it should be possible to teach many of the required skills by conducting actual watercourse surveys and other activities in villages near Lyallpur, Peshawar and Hyderabad.

Special training materials will be required and the medium of instruction should be Urdu. Emphasis should be given to visuals, maps, charts, case studies, problem sets, result and method demonstrations, simulations and learn by doing. Trainees should be provided materials in the form of handouts, outlines, etc., to develop their own field books.

Many of these teaching materials should be developed from research data in Pakistan. Some of these materials could possibly be developed by CSU under its present contract.

The training required at the center will be about six months duration. Another six months of on-the-job training should also be required in which the trainee would assist in the evaluation, planning for improvement, and action phases of watercourse improvement projects and land leveling. This period will be under the supervision of the Water Management Specialist who will also participate in the evaluation of each trainee. After the successful completion of the twelve months of training, an official certificate should be awarded.

The evaluation procedures are discussed under a separate section (Section 6).

The Training Content

The major areas of training suggested are shown in the tentative curriculum outline, Table 6.

Selection and Evaluation

Selection procedures and evaluative processes will be designed for the training program. For example, criteria such as past work experience, farm experience, interest in training, educational level, etc., should be used for careful selection. Evaluative methods are required during the training, after the completion of the first six months of training, and for the period of six months on-the-job training. Evaluative techniques will be discussed in more detail in Section 6.

In-Service Training

Each year, a short in-service training program should be conducted for all Water Management Advisors. This should be the joint responsibility of the Training Institute and the Water Management Specialists. This would be a means of updating the training of each field worker and of providing feedback to the Training Institute for improvement. The training could be done on a district level.

Supervision

Supervision is to be provided at two levels. The Water Management Advisor, a B.Sc. graduate with experience and training, will supervise five field assistants. The Water Management Specialist will provide supervision and technical support for the Advisors and Assistant Advisors.

Table 6. Training content for on-farm water management advisors.

		Estimated duration
I.	Orientation	2 days
II.	Socio-Economic Skills	2 months
	Communication methods with farmers	
	Organization of farmers for collective action	
	Farm surveys to identify needs	
	Program planning and needs of farmers	
	Farm management decision making methods	
	Design and conduct water management surveys	
	Design of educational materials for farmers	
	Program evaluation	
	Record keeping	
III.	Physical Engineering Skills	2 months
	Surveying techniques	1 month
	Taping, spacing, differential leveling	
	Watercourse design and layout	
	Land leveling design and layout	
	Plane table survey	
	Water measurements	1 week
	Float method	
	Flow meter	
	Flume	
	Soil water measurements	1 week
	Gravimetric method	
	Touch and feel method	
	Conducting a water losses survey	2 weeks
	Delivery losses	
	Application losses	
IV.	Agronomic Skills	1 month
	Crop water requirements	
	Crop fertility requirements	
	Deficiency symptoms	
	Crop scheduling	
	Plant protection measures	
V.	Planning Water Management Improvements	1 month
	Delivery system	
	Improved low cost nakkas	
	Improved application methods	
	Land leveling	
	Irrigation scheduling	
	Cleaning and maintenance of watercourses	
VI.	On-the-Job Training Under Direct Supervision	6 months
	Application of skills acquired on watercourses selected for improvements	

Incentives for Water Management Advisors

All personnel who complete the training successfully should be provided salary increments for the new positions. Other increments should be based on positive field evaluations each year. The Assistant Advisors at the watercourse cluster level should be provided living facilities in the village. The advisors and supervisors should be provided motorcycles to increase their mobility and efficiency. It is usually considered that adequate transportation is essential for effective advisory services for farmers.

Training of Other Personnel

The training needs of land leveling engineers, watercourse construction engineers, and the coordinator for all on-farm improvements must also be considered.

Land Leveling Engineers:

The training component for these personnel has been developed under the Agricultural Engineering Directorate by the Pakistan Land Leveling Program. This well conceived program is described in detail by Cox (3). A number of engineers have been trained and are receiving field experience. Given the nature of the land leveling activity, and the fact that these engineers will move from watercourse development areas to other areas for land leveling, we feel that this specialized training must be continued as a separate component of the total program under the Agriculture Department.

Watercourse Construction Engineers:

We recommend that these engineers be provided by the Irrigation Department. Their training could be done at the Agricultural Universities in short courses. This would further aid in improving the capability of the University in field-oriented applied training. Personnel are available in the Irrigation and Drainage Department at Lyallpur, for example, who can provide this training. The training should also be basically field oriented and the field work could be done at the WAPDA Research Center at Mona, where extensive work has been done in the construction of various types of watercourses. Several designs of lined watercourses with permanent junctions and gates exist, as well as experiments in rehabilitation of earthen watercourses. Adequate training for these engineers appears possible in a six month period, with the major focus on field training experiences.

Water Management Coordination:

We recommend that the Coordinator of all Water Management improvements on watercourses be engineering personnel from WAPDA. This team leader or coordinator is mobile in the

sense that after improvements in watercourses and land leveling have been completed in one area, he will move on to supervise personnel and coordinate activities on another cluster of watercourses. This individual will require special training in all the technical areas where he will provide supervision. It is suggested that he be given training with watercourse engineers and also special training in the land leveling program. Since he will coordinate all activities during the land leveling and watercourse rehabilitation phases he should also receive some special training at the Farm Managers Training Institute. The Water Management Coordinator must be carefully selected both for his technical competence and his ability to manage people productively.

Summary

In summary, the proper training of personnel required for water management improvement should receive top priority, because it will be the major factor in program success. The roles and functions of the land leveling engineers, watercourse engineers, farm level advisors and the coordinators are sufficiently distinct to merit separate training geared to the particular skills required. By utilizing personnel from several departments, there is an added advantage in developing the capabilities of several organizations for on-farm water management. By utilizing the universities in certain aspects of the training, they also may be stimulated to develop more capabilities in training students for future careers in applied fields necessary for helping Pakistan utilize its water resources more efficiently.

SECTION 5

PROGRAM IMPLEMENTATION

Criteria for Selecting Watercourses

Selection of individual watercourses to form a cluster of project watercourses is one of the most critical points at which the success or failure of the water management project will be determined. Selection of individual watercourses must be made on objective grounds, based on criteria that will ensure a high payoff for the investment. Political and subjective considerations such as interprovincial equity or assisting backward areas can be achieved by distribution of the number of clusters. However, selection of those specific watercourses that constitute a cluster must be done objectively. With their much higher water duties, water losses are substantially higher in SCARPs than elsewhere. Hence, potential water savings in terms of gross volumes of water are greatest in SCARP. However, water scarcities limit cropping and income most severely in non-SCARP areas. Water savings in this environment will generate more income and employment than in SCARP's.

Outside of SCARP areas, water limitations are an effective constraint to cropping intensity. When a farmer installs a tubewell he can expect a 20-30 percent increase in cropping intensity before other factors become constraints. Furthermore, water scarcity, particularly on the tails of watercourses, limits many farmers to drought tolerant but low income crops such as sorghum, millets, winter oilseeds and indigenous wheat varieties.

All of the above says that the type of water management problems and their consequences for cropping vary significantly between the two environments. Before selecting specific watercourses, the government must make a basic choice as to the percentage of SCARP and non-SCARP watercourses that will be included in the water management program.

Almost all watercourses in Pakistan are in need of improvement. The problem is to limit the program in the initial stages to those watercourses with a high probability of success, while at the same time ensuring that it is a program available to the average Pakistani small farmer. The goal of the criteria outlined below is to identify as closely as possible the top 20 percent in terms of potential for a significant success. It is this screening process that must be done objectively if the program is to make an important and lasting contribution to the rural development of Pakistan.

Criteria for Selecting Critical Areas

General conditions of water supply can identify areas in which better water management is most urgent or beneficial.

1. Low Duty Command Areas--Several canal commands exist where the discharge is only 1 cusec (cfs) per 350 acres. This discharge is believed to be the lowest of the duties in common use and provides only two acre-feet per acre per year. Obviously, even with a system efficiency of 100 percent, these areas face serious constraints. In view of this fact, the program might well be concentrated in these areas.

2. Saline Groundwater--In areas where groundwater is too saline for use, water lost from surface flows is effectively lost. In this case, the full value of the water lost becomes the primary benefit if the losses can be prevented. Consequently, water loss prevention measures are much more justified in saline groundwater areas.

3. High Groundwater Levels--In some areas, groundwater tables (levels) are rising, largely as a result of overirrigation and excessive delivery losses. Effects on cropping are already evident. For example, water tables in much of Lyallpur and Sargodha are high enough to force farmers out of cotton production. Further waterlogging will occur if better management of surface water is not achieved. Those areas where the water table is currently ten feet or less from the surface and rising must be considered as primary candidates for improved water management.

A command area combining saline groundwater with an allocated discharge rate of 1 cusec/350 acres has to be among the highest priority candidates. Since private tubewells are out of the question, the farmers only source of increased water for his fields is better water management.

Criteria for Selecting Specific Watercourses

Once the general types of areas to be served have been selected, applications will be solicited. Clusters of watercourses will be selected from the applicants using the following criteria. These criteria seek to identify watercourses in which substantial progress is technically possible, that are large enough to make water user's associations worthwhile entities, and watercourses where the users are socially capable of working together for the common good.

4. Low Delivery and Application Efficiencies--In order to maximize the benefits resulting from mounting a water management program on a given watercourse, delivery and

application efficiencies should be low enough so that significant improvements can be achieved. It is suggested that watercourses selected be those with system efficiencies below 25 percent. This results from delivery and application efficiencies of 50 percent each, or some related combination. These levels of water mismanagement will not be hard to find particularly on the larger watercourses.

5. Low Cropping Intensities--As another criterion to ensure that saving water and using it efficiently will contribute to farm incomes, it is suggested that project watercourses include a large number of those with cropping intensities below 120 percent. This criterion will reinforce the selection of watercourses with low discharges per acre and saline groundwater. In sweet groundwater areas, water losses are often compensated by tubewell pumping and there is little room for increasing cropping intensities. With efficient water use, cropping intensity can probably reach 140 percent before other factors become limiting. Choosing project watercourses with cropping intensities of 120 percent or less ensures that expanded cropping can play its role in increasing production. By choosing watercourses where some benefits will be realized through expanded cropping, rather than only through higher yields, planners may be able to skew the emphasis toward rural employment generation rather than displacement. This possibility should be tested.

6. Farm Holdings Characteristics--These related criteria are designed to prevent the program from being distributed solely among the lands of large farmers and to ensure that there are enough clients within each watercourse to support collective action. Some flexibility should be allowed in the application of these criteria but the general intent should be preserved.

A. Not less than 20 farmers in a selected watercourse.

B. No more than two individual farmers per watercourse with holdings in excess of 35 acres. (This would not apply where family members operate joint farms; farm size in these cases can be determined by dividing total acres by the number of partners.)

C. No single farmer to own more than 20 percent of the watercourse command area.

D. No more than 30 percent of the land to be cultivated by tenants.

7. Probability of Collective Action--Several related social indicators may be used to gain an early impression of the ease or difficulty of organizing farmers to work out

their water problems together. These indicators must be evaluated at two levels; first, at the watercourse level and secondly, if several watercourses within a village are to be chosen, a village-level evaluation is also needed. It is suggested that watercourses be selected which meet at least two of the following three criteria.

A. Demonstrated past cooperation, such as the construction and upkeep of a village mosque or communal construction of a school. Particular value would be placed on previous informal cooperation on water management issues, such as solving water disputes and cleaning the watercourse.

B. Caste or Brotherhood Dominance--If a single caste dominates the village population, say to the extent of having half again as many households as the next largest caste, it is highly likely that leadership will emerge and cooperative action will be possible. Previous research has shown that watercourses are maintained more frequently and more adequately under this situation.

C. Leadership Centrality--Whether or not there is a single leadership structure within the watercourse or village is an important determinant of what groupings are possible for collective action. Even in cases of strong caste or brotherhood dominance, village size or other factors may lead to multiple leaderships which may or may not be able to work together on water management.

For reasons elaborated elsewhere in this report, it is essential that a water users association be formed at the local level. The ability of the water users to elect leaders and support these leaders with collective action is the prime prerequisite for inclusion in the program. An association is needed for the functions of pooling farmers' desires on water issues, making commitments on behalf of the village or watercourse, ensuring compliance of all members in new changes or in contributing to the watercourse improvement, representing the farmers on water policy issues and implementing a routine maintenance program on the watercourse. The association can be formed either at the watercourse or the village level depending on size and homogeniety considerations. As a minimum, the association should include all of the water users farming land within the command of the project watercourse.

8. Willingness to Support a Regular Cleaning and Maintenance Program--Much of the water loss occuring during water delivery can be prevented by routine maintenance. Without it, much of the water saved in one section will be lost

in another and the improvements made will have their lifetimes drastically reduced. It is not sufficient to simply clean the watercourse regularly. The routine maintenance will include bank rebuilding to maintain freeboard and proper cross section and permanent closure of all noticeable leaks. Such a program must be accompanied by a set of rules and regulations which prevent deterioration of the channel (i.e. crossing of animals only at culverts, watering and bathing of buffalo only in specially constructed sections, no trimming of banks to expand field sizes, nakkas only at authorized points etc.). The farmers will probably prefer an alternative to the hired beldar approach.

Summary

Meeting all of the above criteria is not necessary. Some are more important than others and some tradeoffs will occasionally be necessary. It is suggested that criteria numbered 7, 1, 2 and 4 receive top priority in essentially that order.

We do not want to overemphasize the selection process or we will find more time being invested in selection than in improving the watercourses. Survey of "several multiples" x 500 watercourses for all of the above criteria would use as much technical manpower as the improvement. The basic criteria are that there be a potential for improvement with high benefits/cost ratio, and that the users be sufficiently cooperative to do the job. A 10 percent failure rate would be more tolerable than a 50 percent production rate. Our objective is not to completely exclude failures at all costs, when the selection cost is this high, we should cut the cost, take the "necessary chances" and prepare to learn from "difficult" watercourses.

A tabular summary of the criteria is presented in Table 7 for easy reference.

Phasing of Program Activities

The following sequence of events is suggested so that the implementing and funding agencies can plan the delivery of needed skills, supplies, and decisions:

1. Based on incentives to be offered and regional public solicitation, a list of applicant villages should result. In response to regional solicitation, a list of villages will be created. Applications could be solicited through channels that connect directly to the nambardar (head man) in each village.

Time required: six to eight weeks

Table 7. Criteria for selecting project watercourses.

Criteria	Desired Status	Measurement Method
For Selecting Critical Areas of Need		
1. Water Duty	Low (1 cfs/350 ac. preferred)	Identified by Irrig. Dept. Verified by flume measurement
2. Groundwater Quality	Saline areas preferred	Identified by WASID Verified by field sampling
3. Watertable level	10 feet or less and rising	Identified by WASID Verified in local open wells
For Selecting Specific Watercourses for Program		
4. Delivery and Application Efficiency	50% less each or system efficiency $\leq$ .25	Field measurement by Team Coordinator and staff
5. Cropping Intensity	Less than 120 percent	Farmer interview (25% sample)
6. Farm Holdings		
A. Farms/Watercourse	$\geq$ 20 operational units	
B. Large Farmers	2 or less with 35 acres or more	Determined by interviews with key respondents during screening process
C. Land Concentration	No owner to farm more than 20% of watercourse	
D. Tenancy	Tenanted land not to exceed 30%	
7. Collective Action		
A. Past Cooperation	Actively demonstrated on communal projects, esp. on water related issues	Maintenance and cleaning of watercourse, presence, maintenance of mosque, school, other public issues--cooperative tubewells
B. Caste Dominance	One caste with 40-50% more households than next largest	Interview with village headman, school master or chokidar
C. Leadership Centrality	Single leadership structure	Interview, Key respondent
D. Water Users Association	Active status required	Team Coordinator
8. Routine Maintenance Program Agreed to	Full time watercourse chokidar employed	Team Coordinator

2. Applicant watercourses would then be screened against a set of objective criteria to select a set of watercourses falling into a high priority category (say the top 20 percent) with respect to potential for success and expected water savings. These criteria would include physical and social variables indicative of the village's ability to unite for sustained cooperation; physical factors indicating that substantial water savings may be possible; and cropping, economic and other variables to ensure that water savings are particularly critical to the candidate watercourse. This objective screening process is particularly important to ensure that the program is developed in relation to need and ability rather than according to other criteria.

Time required: one month

3. From among the applicants, high priority watercourses will be selected in clusters of approximately five containing 1500-2500 acres in total and close enough geographically so that the team leader and engineers implementing the program can work on all five out of a central location. The On-Farm Water Management Advisor and his Assistant will be assigned to the watercourse cluster or unit under supervision of the Water Management Specialist.

4. Watercourse surveys will be conducted (these surveys will be economically designed for the collection of only the most relevant data) on the five or six watercourses to identify physical, economic, and human factors for the following purposes:

a. Problem identification and understanding of the major watercourse subsystem's constraints;

b. As a means of developing credibility with farmers and understanding their needs;

c. As information input to utilize in educational and motivational programs with farmers to help them understand the magnitude and costs resulting from watercourse losses and inefficient irrigation practices;

d. As basic information to utilize with farmers in designing a development program; and

e. As benchmark data necessary for evaluations.

Time required: Estimated one week per watercourse for survey and one week per watercourse for tabulating data in preparation for farmers meetings. Total of ten weeks or 2 1/2 months per cluster.

5. Meetings with each group of watercourse members to present them with information about their watercourse problems.

a. At these meetings it is important to dicover from farmers what they think about the facts and what they perceive the solutions to be.

b. At this meeting or subsequent meeting of farmers, audio-visuals can be used to show what has been accomplished on other watercourses in Pakistan. Farmers at this point should be made aware of the details of the government program.

c. If farmers are willing to develop a program, efforts are then made to help them organize water users associations. There should be specified basic guidelines for the organizational activity printed and available.

d. After the organization of the associations, the coordinator should conduct meetings with farmer members to design a feasible development program which stipulates the conditions and responsibilities of all parties. Signed agreements are necessary, as well as records of each meeting with farmer and association members.

e. The advisor and his assistant should select a farm at the head, middle, and tail of each watercourse for maximum yield demonstrations of major cereal and cash crops.

f. At least two farms per watercourse should also be selected for land leveling demonstrations combined with irrigation trials for major crops. These demonstrations should be conducted as early as possible as a means to convince other farmers.

Time required: Estimate three weeks for the organization of five or six watercourses and the selection of demonstrators.

6. Coordinator and engineers arrive to begin watercourse improvement activities and land leveling.

a. Decide what watercourse will receive improvements first in consultation with watercourse associations.

b. Begin watercourse survey and design new watercourse with the watercourse association members.

c. Begin land leveling on the demonstration farms and conduct a continuous extension campaign to let all farmers in the watercourse cluster know of developments.

d. If the land leveling on demonstration farms is well done, then expect the demand for land leveling within the watercourse cluster to increase. Meet this demand and also utilize land leveling equipment in the construction of the improved watercourse when possible.

e. Give watercourse association members responsibilities for the construction of the new watercourse including supervision with the engineers and definite work responsibilities for all watercourse members. (In some areas farmers may even be able to fire their own brick and/or provide the masons if planning is done properly and time is available.)

Time required: Estimated time is four to five months for completion of each watercourse.

7. Feedback Mechanisms: Through the water user association members, feedback channels must be developed by means of regular consultations and meetings to handle problems and issues as they arise.

Time required: Continuous

8. Focus must be given throughout on the trials and demonstrations on farmers' fields.

a. When results are good or exceptional, see that all farmers in the cluster visit the plots and talk with farmer owners.

b. Only when there is something to demonstrate, organize farmer field days and invite selected officials and influential farmers from potential future watercourse clusters. Place the focus on the farmers and allow them to interact with officials.

c. Make available simple and well-designed extension-type materials to farmers on relevant subjects about on-farm water management improvement (e.g., maintenance of improved watercourses; package of agronomic practices for various crops; over irrigation and costs to farmers; when, how much and how to irrigate; new methods of irrigation, etc.).

d. Keep good pictures of farmers on this watercourse and their activities to use with these farmers and other farmers for motivation.

Time required: Continuous

9. Move from watercourse to watercourse in the cluster for undertaking improvements and do land leveling on demand.

Time required: One year

10. At the end of a one year period, have a formal evaluation by external personnel to measure progress in relation to the "benchmark" survey and program objectives.

a. Use this information to analyze progress achieved and problems;

b. Use this information for next phase of program design with farmers; and

c. Use this information for official records for headquarters.

Time required: Estimate one week per watercourse for evaluation.

11. The land leveling team, the watercourse engineers, and the Water Management Coordinator move on to another watercourse cluster.

a. The On-Farm Water Management Advisor and his Assistant remain on a continuous basis to help farmers.

b. At a later stage, it should be possible to have one advisor for five watercourse clusters and one assistant for each cluster. This density is certainly advisable since the techniques and concepts involved in water management require intensive extension and continuous application.

Organizational Linkages

Improved water management systems for irrigation require an orderly control and management of complementary and interdependent factors on the farm and the institutional levels. To provide farmers the inputs and services required, a set of complementary institutional and infrastructure arrangements are necessary for increased production possibilities. These include a continuous flow of research findings, engineering services, advisory services, input and credit arrangements, and improved codes and regulations for water distribution. It is seldom possible for a single organization to provide these complex and diverse arrangements for large areas.

One alternative is that of designing a new organization similar to WAPDA which has responsibilities for all functions required in the proposed program. The time required and the

risks involved in developing such an institution are great, but there are many advantages for strengthening personnel selection, training and evaluation in order to motivate personnel and maintain a high morale. Although this process is always difficult, it can be accomplished easiest by organizing a new semi-government agency.

A second possibility is to utilize an existing governmental agency, (e.g., the Irrigation Department, Agriculture Department, or WAPDA) to handle all of the necessary field improvements such as watercourse improvement, precision land leveling, and the water management advisory service. An On-Farm Water Management Directorate could be established within the selected governmental agency to facilitate the implementation and coordination activities.

Another alternative is similar to that of the former village A.I.D., or the present Integrated Rural Development Program, which attempts to coordinate and integrate the services of several departments at the village level through a multipurpose field worker. Past and present experience in Pakistan suggest that though the model is sound, in practice these programs have been less than successful. The IRDP as a coordinating entity has been unable to develop sufficient coordination between departments and has also been unable to effectively integrate various services thr ugh a multipurpose field worker at the farm level.

A third alternative suggested is similar to the IRDP model with several unique differences. This model would utilize services from only those few departments or organizations which are related directly or indirectly to improved on-farm water management. Each department would have specified roles in the total program and coordination would take place at higher organization levels. Unlike IRDP village level generalists, all field workers would have special training in on-farm irrigation technology and crop production techniques. Existing institutions, such as major agricultural research centers, the Agriculture Department, WAPDA, the Irrigation Department and the Agricultural Universities would have specific functions in the water management development program. Enabling or functional linkages could be created and top level coordination developed at the provincial level. Gradually, as perceptions of threats are reduced and compatibilities are developed, efforts could be made for increased coordination at other levels. Another advantage is that this would involve several key departments and organizations in the improvement of on-farm irrigation systems. At a later stage, other necessary organizations could be added.

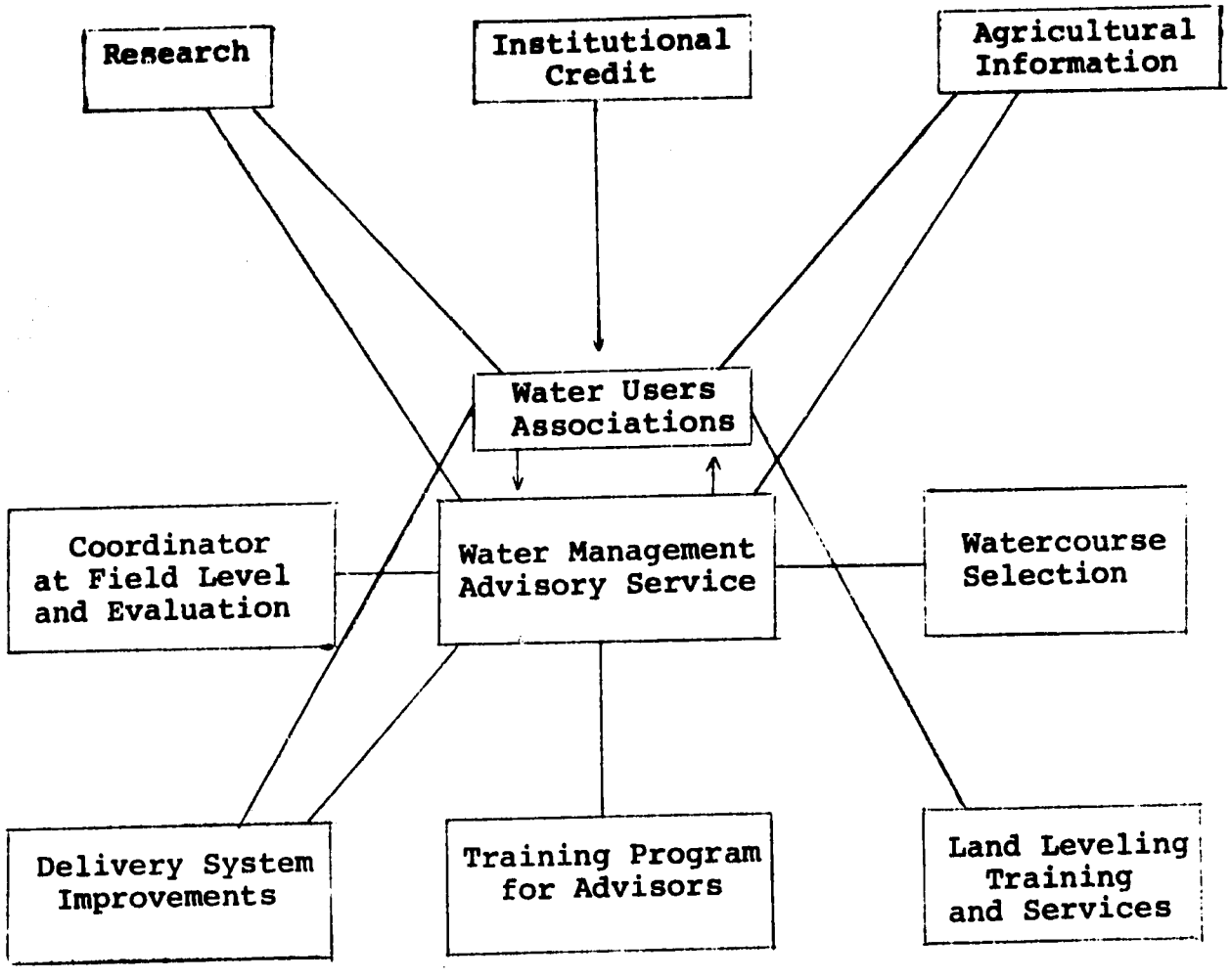


Figure 6. Functional linkages for water management field program.

As a minimum, the following institutional inputs are necessary: water management related research; training programs; engineers for land leveling; farm level advisory service; watercourse selection and evaluations; information and communication; institutional credit for inputs; and engineers for watercourse construction. These institutional inputs and their linkages with the water users' associations and the on-farm advisory service are shown in Figure 6.

The suggested organizations to provide these functions are given below:

1. Provincial Planning and Development Department--Since the planning and Development Department has linkages with organizations to be involved in the program, and can be objective in decision making, the following functions are suggested:

   a. Selection of watercourses for development against specified criteria; and

   b. Monitoring of progress reports and evaluative studies.

2. The Agriculture Department--It is suggested that two major functions be given to the Agriculture Department:

   a. Water management advisory service which will work with farmers on a continuous basis. Selected field staff of the department would receive special training.

   b. Land leveling service which presently is under a separate directorate in the department.

3. The Agricultural Research Institutes--The Agricultural Research Institutes are already part of the Agriculture Department. However, functional linkages and the flow of information within the Department can be improved. Major functions would be:

   a. Establishment of a post of Water Management Research Specialist to conduct research and serve as a link to the On-Farm Water Management Advisory Service.

   b. Expand interdisciplinary research in the area of soil-plant-water relationships.

   c. Provisions for delivering water-soil-plant related research to the advisory service.

   d. Provide short one-week courses on special crops or problems to members of the advisory service.

4. Water and Power Development Authority

a. Evaluation of the improvement activities.

b. Provision of Water Management Coordinators at farm level.

5. Irrigation Department--Linkages are needed especially between the watercourse engineers, the farmers' water users association, and the advisory service. The Irrigation Department, with improved capabilities, should be able to design watercourse structures and provide engineers for the construction program.

a. Research on delivery structures

b. Provision of engineers for watercourse construction.

c. Enforcement of rules and regulations related to waribundi system.

d. Provision of information about delivery schedules, etc.

6. Agricultural Universities-- Some linkages exist between the University and the Agriculture Department. A new linkage is suggested whereby the training program for farm level advisors in water management be done at the University facilities. Also, the universities can be linked with the Irrigation Department by providing training for watercourse engineers, as well as being linked with WAPDA by training the Water Management Coordinators.

a. Six months' training course for water management advisors at university training institutes.

b. In-service training for water management advisors.

c. Training of engineers for watercourse rehabilitation.

d. Training of Water Management Coordinators.

7. Agricultural Bureau of Information-- The Bureau of Agricultural Information is under the Agriculture Department. With improved capabilities, this organization can do much in supporting the water management development program.

a. Provision of extension materials for water management advisors and farmers.

b. Mass media support.

8. The Agricultural Development Bank or Other Banks--Development activities with small farmers should generate increased demand for short-term credit. In each development area, assurances must be made that credit and necessary inputs are available.

a. Provision of credit for land leveling and watercourse improvement.

b. Provision of credit for other inputs essential to increased crop production.

SECTION 6

PROGRAM EVALUATION

One of the most important program components to assure success of the activities of the Water Management Improvement Program is effective and objective evaluation. Two types of regular evaluations are necessary. First, all program activities, such as land leveling, watercourse improvements, water users association, the training, and on-farm advisory services should be required to build in internal evaluative processes to provide adequate feedback for program improvement. As an example, each training program should evaluate trainees' progress in terms of training objectives during the training period, at the conclusion of the formal training and during the on-the-job training which is a six months period. This internal evaluation by each program component is also essential for learning by those involved. For example, engineers who participate in land leveling and watercourse construction should have a continuous internal process of "before" and "after" evaluation to gauge the success of their own activities. What is learned will be of tremendous value in upgrading their work.

Secondly, the overall water management improvement program should be formally evaluated each year by an external evaluation unit. The requirement of a separate external evaluation unit is essential for overall objective evaluation. This unit would conduct periodic evaluations of each activity, analyze the data, and prepare reports for planning and for the relevant Pakistan and USAID Mission organizations. It is recommended that the provincial Planning and Development Department develop a team to conduct these evaluations since they have extensive experience in planning and project evaluation. In order to evaluate physical improvements, training programs, and institutional achievements, the team should include experienced engineers, an agronomist, an economist, and a sociologist who have been given training in the evaluation of water management improvement programs.

Effective evaluation for each program component will require that each has a set of clear and specific objectives which can be measured. The objectives given in this paper must be made more specific so that measurement indicators can be identified. Most activities, such as land leveling, watercourse improvements, training programs and the on-farm advisory program, lend themselves to this type of evaluation. Benchmark studies will be necessary to provide the "before" data required as a comparison with the actual changes which are brought about over time.

Each of the program areas are given below with stated objectives along with suggested indicators that can be evaluated. This is only a sample of some of the ways external evaluations could be conducted for some activities.

Watercourse Improvements

Objectives

A. To collect benchmark data on ____ (number) of watercourses per year.

Measure - The number of watercourses for which benchmark data exists.

B. To construct lined watercourses and improve earthen watercourses for the reduction of delivery losses.

Measures (1) The actual feet of lined and improved earthen watercourses completed per year plus the number of pacca nakkas, junction boxes, etc., installed.

(2) Comparison of the delivery efficiencies before and after improvements.

(3) Quality of masonry work and alignment plus elevation.

(4) Costs of construction per food compared with estimates.

C. To gain maximum participation of watercourse members in the watercourse improvements.

Measure - Number of man-days contributed by farmers in excavation work, hauling materials and supervision of supplies; monetary contributions, use of tractors, trolleys, bullocks, etc.

Land Leveling

Objectives

A. To provide (number) trained and experienced land leveling engineers for work on (number) of watercourse clusters.

Measure - The number provided for watercourse clusters.

B. To motivate farmers for precision land leveling.

Measure - Number of farmers who have land leveling work done and acreage.

C. To provide precision leveled fields for farmer clients of adequate size for improved efficiency in irrigation.

Measure - The "before" and "after" topographical surveys; the size of basins; measurements of improved efficiency in water application (actual field experiments should be designed by the engineers to determine ways to isolate the effects of land leveling).

D. To encourage private entrepreneurs to manufacture land leveling equipment and private contractors to accumulate equipment and expertise for land leveling.

Water Users Associations

Objectives

A. To organize effective water users associations on each watercourse for the improvement and maintenance of delivery systems.

Measures - Number of associations established; man-days of members given to watercourse rehabilitation work; number of associations which have appointed ditch tenders, number of associations which have established regular cleaning schedules; number of meetings held, disputes settled, etc. Associations which have developed sets of work plans. Assess the impact of the above activities on watercourse improvements.

B. To encourage the associations to federate at village and distributary levels for increased participation in decision making, monitoring and enforcement regarding the efficient, equitable and regular delivery of irrigation water. This is particularly necessary on distributaries where moghas are being altered. The distributary is frequently blocked to increase water supplies upstream from the block, which reduces supplies downstream, and there is extreme fluctuation of operating level in the distributary, which complicates watercourse design and planning for improved water management.)

Measures - Number of federations established, number of linkages developed with institutions (i.e. canal department, etc.); regularity of information received from canal department about closures for cleaning, rationing, etc.; number of village level associations which collect abiana; number and types of appeals to canal departments; (interviews from association members will be necessary to ascertain much of this information plus their attitudes about participation and benefits from decision making); Size and discharge

of moghas and operating levels to detect illegal actions.

C. To encourage water users associations to develop a system of irrigation scheduling on selected watercourses for experimental purposes.

Measures - Number of experiments conducted and outcome in terms of water use efficiency, and changes in cropping intensities and yields/acre (yields determined by crop cutting experiments).

On-Farm Water Management Advisors

Objectives

A. To provide (number) trained advisors for (number) watercourse clusters per year.

Measure - Numbers provided.

B. To conduct specified watercourse surveys and analysis of data for each watercorse prior to improvement activities.

Measure - Number of surveys conducted and quality of data (to be utilized for benchmark survey).

C. To demonstrate to farmers the importance of improved water management practices for increased yields by demonstration plots on each watercourse.

Measure - Numberof maximum yield plots/worker and yield results by crop cutting methods.

D. To motivate farmers to adopt improved cultural and irrigation practices for increased per acre crop production.

Measure - Numbers of farmers who have adopted the following: land leveling, furrow irrigation for row crops, recommended seedbed preparation, seeding methods, seed rates, fertilizer rates. (Information on adoption rates for these practices are to be compared with these in the benchmark survey.)

E. To work with watercourse members in organizing water users associations and supporting their activities in improving delivery efficiencies and water management practices.

Measures - Qualitative data from association members as to the assistance provided by the advisor in

organization, in program development, his participation in meetings, in conducting group meetings of farmers for motivational and educational purposes.

Training Programs

Three types of training are required, which are: farm level advisors, engineers for watercourse improvements, and engineers for land leveling. Each program will need to be evaluated separately in terms of numbers trained and adequacy of training. The first level of evaluation is the number of trained personnel provided for the improvement programs. Secondly, several ways to evaluate the effectiveness of training for each program are provided below.

A. To provide training facilities and instructors for the training programs.

B. To provide (numbers) of farm advisors, land leveling and watercourse engineers per year for the program.

Measures - The establishment of the facilities, staff, and the output per year of trained manpower.

C. To train personnel who have adequate technical skills to perform specified tasks for each program.

Measures - (1) Interviews with supervisors can be made to gain information on work performance of personnel

(2) A sample of trainees can be tested in terms of knowledge and performance of specified skills.* Some examples are:

(a) Landleveling engineers' skills--topographic surveying, differential leveling, land leveling design and layout, staking a field, developing a cut-fill grid, etc.

(b) Watercourse engineers' skills--surveying, watercourse design and layout, measuring delivery and application efficiencies, etc.

(c) Farm advisors' skills--measurement of delivery and application efficiencies; soil moisture determination; crop water and fertility needs; conduct of a watercourse survey; farm management decision making; extension methods of teaching; design of demonstrations and trials, etc.

*These are only indicative of many skills or knowledge areas which can be evaluated by tests.

Evaluation of Total Impact of Improvement Activities

The evaluative data collected for all separate program activities, except the training programs, could be combined with additional information for the evaluation of changes over time in a watercourse cluster.

Objectives

A. To increase crop production for small operators through improved water supplies, efficient distribution of water, increased application efficiencies and the provision of on-farm advisory services.

Measures

1. Changes in delivery efficiencies.
2. Changes in application efficiencies
3. Changes in cropping intensities.
4. Changes in cropping patterns.
5. Changes in marketed surplus.
6. Changes in yields for selected crops.
7. Numbers of small farms involved in program.
8. Changes in small tubewell installation.

B. To provide farmers a means of increased participation and decision-making on the management of irrigation water.

Measures

1. Water user associations established.
2. Federations established.
3. Watercourse improvements completed.
4. Linkages of associations established with government institutions.
5. Cooperative tubewells established.
6. Watercourses with specific and regular maintenance programs.
7. Number of associations collecting abiana.
8. Number of irrigation scheduling experiments.

Part III

PROGRAM EXECUTION

Section 7

U.S.AID/PAKISTAN

The USAID Mission for Pakistan is proposing a program to improve water management in Pakistan. This program would help Pakistan's farmers to increase food production, and to improve use of the nation's resources. The focus is on improving the use and management of water resources. This resource is one major component of the constellation of resources in the country necessary to increase crop production in order to meet the food and fiber requirements that are so essential for improving the quality of life within the country. The other natural resources of the nation, such as the land and mineral resources, must also be properly used. One of Pakistans greatest under-utilized resources is its rural labor. This water management improvement program can provide work opportunities whose benefit/cost ratios are commonly above 5, often exceed 10 and contribute directly to Pakistan's drive to increase crop production. The focus upon water resources can help to all sectors and segments of society and available resources to contribute effectively to increased crop production. By concentrating upon the improved use of water by agriculturalists, the country can achieve a high level of independence by meeting its own food and fiber needs, as well as eventually developing surpluses for export.

To undertake this program, it is suggested that the Mission adopt a four prong approach which is designed not only to complete the physical components of the program, but insure the long range success of the total effort in improved water management. These four phases include:

1. Program execution
2. Program implementation
3. Program monitoring
4. Program evaluation

The contribution of this part of the report is not to describe in great detail all the components of the program previously described, but rather to emphasize what are considered key factors to insure that the water management program will be successful as an assistance effort.

A primary factor is institutional and image changes within the country. It is recommended that the Government of Pakistan be encouraged to take the necessary steps to achieve formation of water users associations. A policy declaration outlining the functions of and need for water users associations and provision of the legal mechanism to facilitate

their organization would be a positive first step. The essentiality of water users associations lies in the need to create a legal entity which will go beyond the life of the immediate users, and continue beyond the construction phase of the project, and the duration of the loan program. These associations are essential to insure the proper long term operation, maintenance and continued improvement of the irrigation system.

The water management program is a dynamic proposition, not a static thrust of foreign assistance during a development stage or crisis of the country. Pakistan badly needs to give its farmers an identity and develop a chain of communication with the government agencies which have been assigned responsibility to help manage water and increase crop production.

In the process of executing this contract, sufficient assurances should be made by the government to demonstrate their capability to make the necessary procedural changes and have the capability to implement the conditions of the loan. A philosophy of arms-length bargaining should be adopted in which the parties to the contract specify the terms and conditions of the program and agree to a suspension of the contract should the conditions be abused.

The implementation phase of the program includes not only the physical transfer of funding and technological components of the program, but also an examination of the efforts by the government to meet the conditions of the contract. During the implementation phase, the Colorado State University Field Party for Water Management Research should work with the Soil Conservation Service team and Pakistani officials in selecting the watercourses and undertaking technical and institutional activities.

The history of USAID projects bears out the need to adopt a program for monitoring and evaluating the efforts of the recipient country in implementing foreign assistance. For this reason, it is considered essential that the Mission adopt phases three and four to monitor and evaluate the work done under the loan program. The first purpose is to make a realistic determination of the country's capability for carrying out the program and to identify the areas of need for expanded or directed assistance. The second purpose is to enable the Mission to evaluate the progress or problems on this project and use the lessons gained to plan effective assistance programs in other subject areas.

Monitoring the program activities should be through two channels. The primary monitoring should be through regular field reports, submitted through the project administration, on attainment of the program objectives. These reports should be available to appropriate advisory and Mission personnel.

Additional monitoring is essential in the form of advisers working closely with the Pakistanis, conducting on-site examination of progress and assisting as needed and as much as possible to overcome obstacles to progress. These American personnel advising on the project should also prepare reports evaluating progress, which could be available as needed to USAID and Pakistani administrators.

The reports and other monitoring activities should be periodically evaluated in light of program objectives and changing needs of the country. Evaluation scheduling should coincide with water delivery and agrarian activities and not purely on a calendar basis.

If Pakistan wants to improve its water management, it must be the Pakistanis that do the work. Assistance should be conditional upon a willingness of recipients to utilize, to the best of their ability, their own resources. Pakistan has an excellent farmer work force and natural resource base. A basic objective of the program is to provide farmers the opportunity to make their independent decision to seek improvement, rather than force them to comply with government edicts. Recognizing the farmers as intelligent cooperators increases the feedback. Time invested in listening to farmers will generally pay rich dividends in terms of understanding their problems so we can better solve them and in terms of learning their solutions, which can often be used to strengthen the technical package to be delivered to other farmers.

This loan program should have a two-fold purpose of improving agriculture output within the country, and giving the water users proper identity within the country.

Section 8

A NOTE ON ALTERNATIVE ORGANIZATIONAL APPROACHES

General Comments

In the process of executing and implementing this project, the position described in Part II (Section 4) of this report sets out the institutional components considered necessary for a successful project. Those institutional components primarily being: (a) the adoption of the concept of the water users association, (b) changes be made in the existing organizational structure; and (c) the amending or enacting of certain specific legislation in the field of water resources control and management. Another necessary consideration is the issuing of a directive that the irrigation departments will work with the farmers, provide information on water availability, closures, etc. These matters should be consumated shortly after the loan program is accepted.

During the implementation phase, the government should attempt to work very closely with the farmers in identifying the most appropriate watercourses to begin the work. The recommendation is made that watercourses of different internal characteristics be selected as testing grounds for the program. Regarding the water users associations, it is suggested that several alternative organizational forms be tried among the selected watercourses or villages in order to determine which is the more feasible form of organization under the geographical, cultural and social conditions of the country.

Again, a major concern is that this program not remain static. The program should be the initiation of a dynamic phase of improved water management in the country and, therefore, it is necessary to develop a system of monitoring the program and evaluating the results so that this feedback can be constantly used for improving the implementation of the program objectives within the country.

The question is frequently raised as to what agency or agencies would be appropriate implementing bodies for the water management program. Several of the existing branches of government have been suggested, as well as a newly created agency. In favor of creating a new agency is that: (a) the organizational structure could be developed specifically around the objectives of the program; (b) the new agency could be the communication link between the water users and the government; (c) established bureaucracies with their rigid modus operandi would not restrict the program; and (c) the agency could begin with a simple structure and mature into a sophisticated entity as the program develops.

Against creating a new agency is that: (a) considerable duplication of responsibilities, staff and efforts would result; (b) the strong probability that a new agency would be staffed by people drawn from existing agencies by deputation or seconding with the result that the new agency would start out staffed by less productive people with split allegiances; (c) another potential level of influence and corruption would be created; and (d) considerable time lag is necessary before a new agency matures sufficiently to implement a major program.

Also, water is a provincial subject; so in keeping with this mandate, theoretically, only provincial organizations would be acceptable to the provincial government as an implementing agency. The exception to this case may be with WAPDA.

In view of these considerations, it is recommended that the program be implemented within existing departments. Some reorganization is recommended in many cases to adequately encompass the necessary functions and responsibilities. Where these new duties will require a new conceptual framework, or new administrative procedures, ample training has been recommended (see previous sections) so that the personnel in existing agencies can adequately implement the program.

Several departments have skills and resources which should be brought to bear on this program. The Irrigation Department has the experience of water collection, delivery and allocation. They have responsibility for construction and maintenance of water delivery structures and the administration of most of the water regulations affecting individual farmers. Also, the Irrigation Department has the engineering skills for water channel design, construction and modification. One conceptual change will be necessary; the Irrigation Department must accept certain additional engineering responsibilities below the mogha, on the watercourse.

The Agriculture Department has the extension function nationwide, with an existing field staff located throughout rural areas. These men currently lack training in water related areas, a deficit which needs to be remedied. Also in the Agriculture Department is the Directorate of Agricultural Engineering, whose current responsibilities include implementation of the governmentally supported land leveling program. While skills are there, the techniques and equipment currently being used are unsuitable for precision land leveling. Again, a training program is suggested as described in previous sections.

The Water and Power Development Authority (WAPDA) has concentrated within its staff much of Pakistan's expertise in managing the implementation of water development projects. In addition to administrative competence for water developmental projects, internal WAPDA offices handle research and

evaluation functions. Furthermore, recent internal reorganizations have resulted in a major subdivision dealing directly with on-farm water management. The program structure outlined below draws on all of these capabilities.

Finally, because the program envisioned is interdisciplinary, involving the coordinated services of several agencies, the Planning and Development Department (P&D) has essential roles to play. In any event, some evaluation and monitoring will be necessary in P&D in order to administer the Annual Development Program. One or two critically needed additional roles are suggested below as functions that should only be accomplished under the P&D aegis.

Program Structure

Planning and Development Department

The Planning and Development Department is the one place at the provincial level that the inputs and requirements of the different departments can be brought together, each on an equal basis. Also, this department could provide independent analysis to assist in the decision-making process. An interdepartmental program of this nature requires strong coordination to ensure that each participating department fully meets their expected functions when and where required. Furthermore, selection of watercourses must be done at the provincial level in a manner that allows bringing to bear the maximum objectivity, together with inputs from all departments. The Planning and Development Department is uniquely suited to these roles.

Therefore, it is suggested that the Planning and Development Department in each province establish a permanent Water Management Program Committee convened and chaired by the additional Chief Secretary of Planning or the Chairman/P&D. The permanent committee should include the Secretaries of the Agriculture and Irrigation Departments, Director of Agricultural Engineering, Director of Agricultural Extension, a senior representative from WAPDA and from the P&D staff, the Chief Economist and the Chiefs of the Agriculture and Irrigation Sections. A representative of USAID's Office of Agricultural Programs should be associated with these committees, as well as for the watercourse selection process.

Staff work for the Water Management Program Committee should at the outset probably be the responsibility of the Agriculture and Irrigation Section Chiefs within P&D. As the program matures, it may be necessary to establish a separate section for on-farm water management.

This Water Management Program Committee would have the following functions: (a) selecting watercourses for

participation in the program; (b) broad overview responsibilities to ensure that adequate coordination is being accomplished and that the resources required by each department involved are forthcoming; and (c) review and analysis of any changes needed in water policy, or water law, and preparation of recommendations to be forwarded to the Governor.

The Implementing Field Team

The seven field personnel to be employed with each cluster of watercourses identified elsewhere in this report are drawn from three different agencies. In each case, some internal modifications are probably necessary to provide these men full administrative support.

Water and Power Development Authority

The overall responsibility for coordinating program implementation is recommended for assignment to WAPDA. Also, the recommendation is being made that the Water Management Coordinator leading each field team be a WAPDA employee. By giving the coordinative responsibility to a central organization, interdepartmental rivalries within the program can be minimized. In addition, WAPDA's salary scale and condition of services should facilitate staffing the crucial position of Water Management Coordinator with top quality, dedicated individuals.

In order to support these coordinators adequately, WAPDA will have to establish at least one, possibly two, levels between the Field Teams and the central office. Most coordination and implementation problems should not have to be brought all the way to the provincial capitals for solution, since the implementing agencies (Agriculture and Irrigation Departments) have several intermediate levels with various powers. Initially, offices of Water Management Coordination should be set up by WAPDA at the Divisional level. Subsequently, as the number of clusters in the program expands, there may be a need for some District-level offices.

WAPDA then would have the function of coordination between the implementing agencies at all levels from the field team to the provincial capital. This role will be a new one for WAPDA and may be questioned by some. However, the program envisioned requires great flexibility to meet local requirements. Different mixes of services from each department will be needed in every cluster and it is felt that a coordinator who is not a member of either Agriculture or Irrigation is in a better position to objectively obtain maximum effort from both.

WAPDA will also have responsibility for monitoring and evaluation. Again, as an organization outside the Provincial

Government, they are in a better position to be objective. However, it should be stressed, that the primary recipients of their evaluations of this program should be the Water Management Program Committee of P&D, plus the Secretaries of Irrigation and Agriculture.

The responsibility for field data collection to support the monitoring process will lie with the Water Management Coordinator at the Field Team level. Then WAPDA's Central Monitoring Organization (or other appropriate division), with explicit USAID participation, could be the responsible entity for conducting field evaluations and verifying the data being received on a spot-check basis.

Irrigation Department

The Irrigation Department will be responsible for providing and supporting the cadre of watercourse engineers, two of which will be members of each Field Team. These men provide the engineering services to direct whatever watercourse renovation efforts are mounted in each cluster. To minimize the need for reorganization, it is suggested that the Watercourse Engineers be placed administratively under the Sub-Divisional Officers and Executive Engineers, or an appropriate watercourse engineering branch of their offices.

However, at the Secretariat level, it will probably be necessary to establish an office of Deputy Secretary/Water Management. The program is important enough, broad enough in its implications, and new enough in concept, to justify the fupport of a specialized office of Deputy Secretary.

The actual implementation of the watercourse renovation component, whether ditch lining or reconstructing earthen ditches, will be the responsibility of the Irrigation Department. At the local level, the Watercourse Engineers will be responsibe to the leadership of the Water Management Coordinator. Hence, as team leader, the Coordinator as well as the Watercourse Engineers should have direct access to appropriate officials of the Irrigation Department.

Agriculture Department

The Agriculture Department will have the responsibilities of precision land leveling and water management advising. The two land leveling engineers and the Water Management Advisor and his Assistant Advisor will be Agriculture Department personnel. The land leveling engineers will be under the Agricultural Engineering Directorate, while the Extension Service will field the Water Management Advisors. Field personnel in each entity then have channels of upward mobility open to them.

No serious reorganizations are necessary within Agriculture; however, some revisions in the terms and conditions of service may be needed for project field personnel. In particular, the incentive structure for personnel involved in an extension function needs modernization if the Water Management Advisors are to make full use of the special training they will receive. And if modern irrigation techniques are not extended by these men, the viability of the entire project becomes questionable.

The program calls for a gradual multiplication of trained water management advisors as increasing numbers of watercourse clusters are completed. Eventually, therefore, there may be sufficient numbers of specialists in the field to warrant creation of separate positions in the Extension administration which specialize in administering the water management advisory function.

Financial Channels

After negotiations are completed with EAD, it is expected that USAID loan funds would be transmitted directly to the provinces in the agreed upon proportions. Each department will contain in their own budget and development program the necessary line items to cover their expected responsibilities within the program. The Finance Departments then will release funds directly to each implementing department as necessary.

Summary

A graphical summary of the administrative structure outlined above is shown in Figure 7. Agencies are identified by normal typescript and their responsibilities in italics. Administrative linkages are identified with solid lines, communicative relationships by dotted lines. This organizational arrangement shows primarily the structure within the provinces which would have similar organizational arrangements that respond to the central government.

Summary

The primary advantage of the proposed administrative structure is that all of the major government agencies in Pakistan concerned with "water" are involved, thereby maximizing the national involvement in on-farm water management. Such arrangements, if successful, would also result in the maximum development of "institutional capability"; however, it is recognized that this feature adds to the complexity of the water management loan program.

There is room for considerable debate as to whether this proposed organizational arrangement is superior to organizing a new government agency for on-farm water management, or whether an "On-Farm Water Management Directorate" should be

set-up within one of the existing governmental agencies such as WAPDA, the Agriculture Department, or the Irrigation Department.

This report was prepared in order to provide the U.S.AID Mission to Pakistan with the combined thoughts of the CSU Water Management Research Project staff. As stated earlier in this report, there is much room for "judgement" when discussing an institutional framework for improved on-farm water management in Pakistan.

The Government of Pakistan will decide how the water management loan program will be organized and implemented. Hopefully, this report can provide at least some guidelines as to the requirements for a successful field program involving the interaction between farmers and water management professionals.

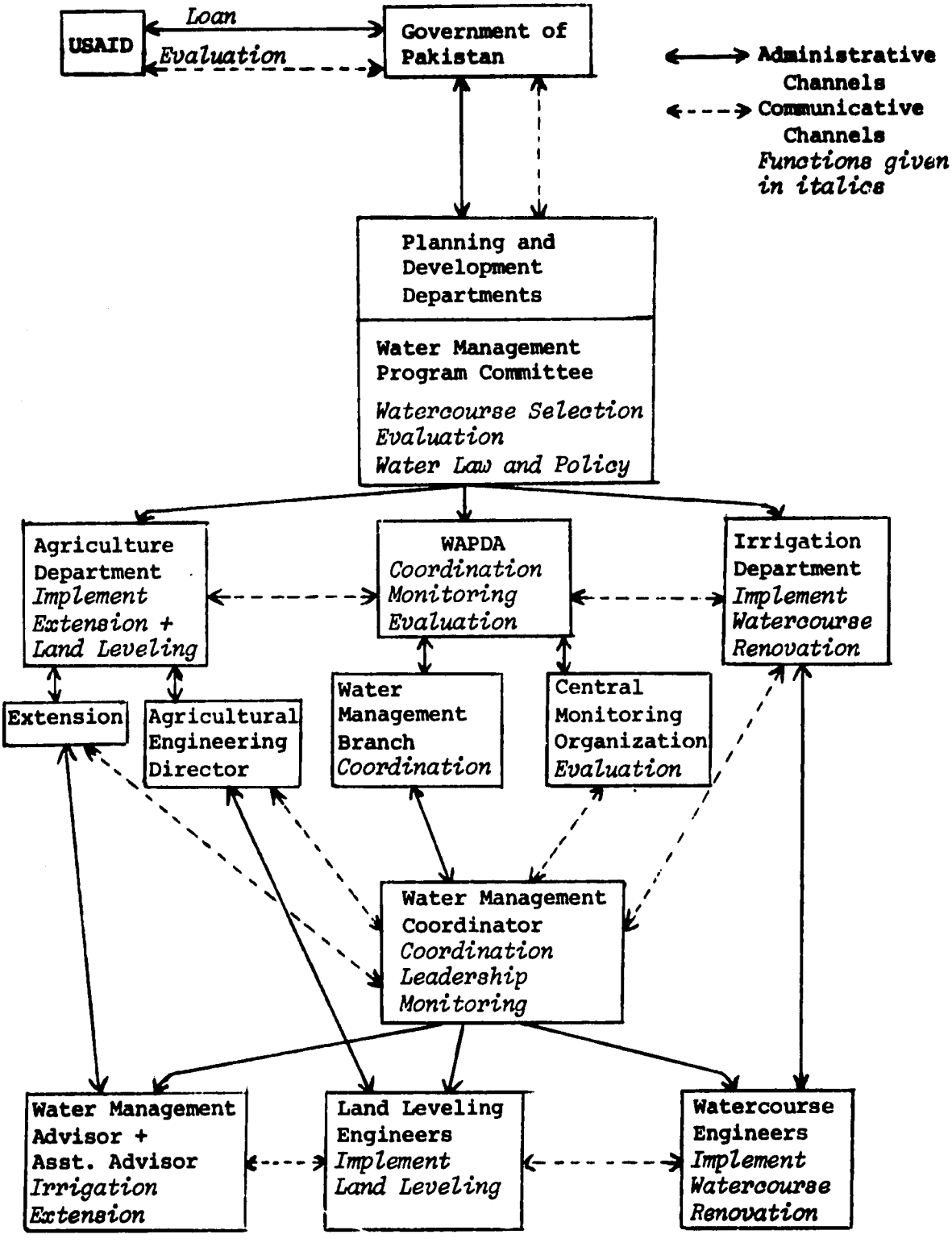


Figure 7. Proposed administrative structure for implementing an On-Farm Water Management Program in Pakistan.

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