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**The Role of Research-Supported Irrigation Policy
in Sustainable Irrigated Agriculture**

The Role of Research-Supported Irrigation Policy in Sustainable Irrigated Agriculture:

An Interpretive Precis of the Case of Pakistan

D. J. Bandaragoda

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Cover shows a conceptional framework which represents a research and development model.

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Foreword

THE BROADEST OF IIMI's five major research programs is that which deals with sector-level management of irrigated agriculture. The objective of this program is to develop strategic planning methodologies and approaches that governments can use in the formulation of policies for the irrigated-agriculture sector. Providing a link with research is the type of support that IIMI can give governments in the development of national and regional policies and plans. IIMI's sector-level research program, therefore, works closely with its other research programs to focus on key issues related to research questions addressed under other programs. Examples of these issues include management transfer, change in public organizations, interagency coordination, implications of various investment alternatives, and rehabilitation and modernization of irrigation systems to adapt them to increased demands.

The sector-level research program is new to IIMI and we do not have a long list of publications in this program as yet. This Country Paper of IIMI's Pakistan Program, written by Mr. D. J. Bandaragoda, addresses the role of national research studies in supporting the development of irrigation policies. The major premise of the paper is that research is capable of converting static policy and institutional conditions into a dynamic development framework. The proviso, however, is that research has to interact closely with policymakers. It is to the credit of the author that he has analyzed the degree of interaction between research and policy in Pakistan objectively, and has drawn lessons from the analysis for both research and policymakers. In doing so, he has avoided the tendency of many researchers who, when confronted with inadequate or outdated policies, give the easy retort that policy should have given heed to the research findings. The Pakistan example as detailed in this Country Paper has many lessons for national and international research efforts that go beyond the country from which the examples were drawn.

I am confident that the paper will stimulate discussion among researchers and policymakers. Comments on the paper are cordially invited.

Jacob W. Kijne
Director for Research

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The author is grateful to Mr. M. Badruddin, IIMI Pakistan Associate, for assistance in obtaining data and for his valuable comments on the first draft of this paper, to Dr. Bagh Ali Shahid and Dr. M. Akhtar Bhatti, IIMI Pakistan's Principal Irrigation Engineers for their advice, and to Mr. M. Saleem Malik and Mr. Saeed-ur-Rehman, IIMI Pakistan's Social Scientist and Senior Field Research Economist, respectively, for their assistance in preparing some of the Tables in the paper. Very useful comments provided by Mr. Robert Rangely, and Dr. Donald E. Parker, Head of IIMI's Bangladesh Field Operations are gratefully acknowledged. Special thanks go to Mr. Muhammad Akram Khan, Secretary/Administrative Assistant for his tireless effort in re-creating the Tables and Figures. Finally, the author wishes to record his appreciation of the very thoughtful suggestions given by Mr. Kinsley Kurukulasuriya while editing the paper.

Summary

THE PAPER USES some case illustrations from Pakistan to highlight the importance of a clearly articulated irrigation policy in the search for technological and methodological advances for sustainable irrigated agriculture. Based on the premise that irrigation development in many developing countries is still a part of an unfinished agenda of the overall development process, the paper points out that planning, design and management of irrigation systems should be closely linked with an irrigation policy which is supported by research and carefully formulated in the context of the country's overall development strategy.

Over the past few decades, Pakistan's irrigated-agriculture environment has gradually changed. The emergence of waterlogging and salinity, the advent of groundwater development, the proliferation of private tubewells, the establishment of new project-based facilities, the demand orientation of farm-level irrigation operations due to improved agricultural practices, and the limitations on overall availability of good quality water, have all added different dimensions to this gradual change. Along with this, other implications of economic and political development have started to emerge in the social environment, also affecting irrigation performance. These changes reflect a series of second-generation problems arising from the massive resource base built over a period of over 100 years to overcome initial constraints on agricultural production.

To meet the demands of this changing situation, Pakistan embarked upon several research efforts and policy initiatives. The paper outlines seven selected state interventions which were fed by both research efforts and policy initiatives. Results of these interventions were of varying degrees of success. Where research and policy proceeded hand in hand, and interacted more closely, the results appeared to be more positive. However, in each of the specific interventions outlined in the paper, this interaction process is seen to have been left incomplete.

One dominant issue confronting both research and policy in Pakistan today, is the stubbornly stagnant performance in irrigated agriculture. Pakistan's crop yields are lower than in many other developing countries

which have much fewer resources than Pakistan. A corollary of this issue is whether sluggish performance signals a serious threat to the sustainability of irrigated agriculture in Pakistan. What research and policy have been able to achieve in the past on this important issue appears to be inadequate. The paper alludes this apparent failure to a neglect of resource management resulting from a long preoccupation on improving the resource base.

Further research efforts and related policy initiatives will greatly assist in realizing the goals of Pakistan's sustainable irrigated agriculture. However, if lessons are to be learnt from the past, these efforts and initiatives should be well-coordinated, and be part of an integrated approach toward irrigated agriculture articulated within a comprehensive national development plan. In such an integrated approach, various projects and programs will be considered as components of a comprehensive policy plan, irrigation considered as an essential input to agricultural production, and the various canals and their command areas considered as parts of a composite irrigation system.

Changes similar to those in Pakistan can be seen in many other developing countries. This changed, and changing, irrigation environment requires a conscious effort on the part of many: the researcher, the manager, the planner, the designer and the policymaker, to ensure not only the establishment of contextually appropriate physical and social infrastructure but the management capability for improved performance on a sustainable basis.

CHAPTER 1

Introduction

I must caution that wheat research alone, no matter how well-done, does not automatically lead to increased productivity on farmers' fields. Both institutional and individual "integrators" are needed to link research and production into an effective technology generation system, if improved technologies are to reach farmers.... We agricultural scientists have moral and professional responsibility that goes beyond our experiments. We also have an obligation to make our case with political leaders so that advances in research are brought to fruition on farmers' fields. (Norman E. Borlaug¹)

IT IS GENERALLY assumed that a country's overall development policy is based on its social aspirations. Thus, while the country's social needs are seen as the basis for its policies on irrigated agriculture, they would also appear to be guiding and fashioning the styles and modes of management of its irrigation systems. Further, they are expected to provide the motivation among the various partners working in the sector, and thereby contribute to the sector's performance. The assumption is also that, where irrigated agriculture has a dominant place in the society, irrigation would naturally play a leading role in the country's economic development.

However, in some developing countries, these assumptions do not appear to be totally true. Substantial changes that have taken place in social and political terms in these countries (particularly in South Asia), have partly accounted for the considerable policy efforts made by them to enhance the resource base and to introduce new technology. Curiously, however, such

1 In his Foreword to the 1989 CIMMYT publication, *Wheat Research and Development in Pakistan*. The wheat scientist Norman E. Borlaug has a special place in the 25-year long partnership between the International Maize and Wheat Improvement Center (CIMMYT) and Pakistan's wheat research institutions.

sociopolitical changes have not resulted in policies to achieve any meaningful qualitative change in the institutions and management systems, which is necessary for making the enhanced physical resource base more productive. The countries still rely on irrigation-related administrative structures and procedures most of which date back to the nineteenth century. Their broad irrigation policies, system objectives and management modes are still largely based on original colonial needs. In the light of new sociopolitical changes, these institutions and management systems are becoming obsolete; they are inept in coping with the rising expectations of a rapidly increasing population.

Apart from being outdated, the irrigated-agriculture policies and institutions in many of these countries have also suffered from being fragmented. Where some policy initiatives and institutional changes have been attempted, their results have hardly formed a part of a cohesive framework which promotes a clear strategy for achieving a predetermined set of social goals. Often, this situation is attributable to ad hoc development efforts, and sporadic responses to individual issues and location-specific problems. Most planning, design and construction efforts are largely based on the analyses of their physical and financial aspects (Feyen et al. 1992), with little consideration of their policy and institutional implications (Bandaragoda 1992), and with still less regard for the value of research for improved policymaking and appropriate institutional reform.

Prompted by national and international evaluations of this situation, there is now an emerging concern about the inadequacy of the existing policies and institutions, and generally about the poor performance in irrigated agriculture, a concern which becomes more real and serious when the low performance is weighed against the heavy investment made in the sector. The situation is compounded by the fact that the needed improvements in performance have to be achieved in the context of the environmental concern which is emerging around the sustainability of irrigated agriculture.

The research conducted during the past few decades at the level of micro studies on irrigation and farming systems is considerable. However, the impact of research results in terms of productivity increases cannot be seen as correspondingly high. This gap between effort and impact can well be traced to a lack of linkage between research and policy, as despite the high validity of some research recommendations, their implementation seems to rest heavily on policy decisions, particularly so when such research recommendations call for institutional change. The inability of research to

influence policy probably results from an unnecessary and easily avoidable communication gap between the researcher and the policymaker.

The case of Pakistan's irrigated agriculture seems to offer some interesting and useful lessons in this regard. While Pakistan has made a commendable effort in generating policy, conducting research and introducing new institutional structures, their combined effect has been more in enhancing the physical resource base for irrigated agriculture than in improving its productivity. Based on Pakistan's experience, the paper argues that attempts to establish, manage, evaluate and improve irrigation systems for sustainable irrigated agriculture can be more successful if such attempts are based on a cohesive irrigated-agriculture policy, supported by appropriate research and rationalized within the overall national development policy. The paper derives from a literature survey and field research conducted on institutional aspects of irrigated agriculture in Pakistan, and from an evaluation of Pakistan's experience in linking research and policy support. The objective of the effort is to draw the attention of both policymaking and research groups on the urgent need to integrate their respective activities in a cohesive research and development approach to achieve improved performance. Although in the paper, the term "irrigated-agriculture sector" has been used generally, the focus of the paper is on the water resources management aspects of the sector.

The paper is organized into five chapters. Chapter 2 below provides the conceptual framework underlying the paper and places the various interventions on irrigation-related institutions, policy and management in the perspective of a research and development model. Chapter 3 outlines the case of Pakistan's irrigation experience and its strengths and weaknesses. To enable some generalizations to be drawn, a general discussion of some selected issues arising from the case material is given in Chapter 4, and the conclusions are in Chapter 5.

CHAPTER 2

Institutions, Policy and Research

OUTLINED IN THIS chapter is the conceptual base for the paper, particularly for its premise that policy and institutions are closely interlinked and that for beneficial institutional change which is required to achieve performance improvement, policy research linkage is an imperative.

DEFINITIONS

The term "institutions" in its popular usage usually refers only to "organizations," but the term basically means sets of "rules" which serve to define, underlie or establish (institute) the "organizations." Organizations are in fact the structured work roles so established or instituted. For the purpose of this paper, institutions are defined broadly to include both rules and organizations. Rules include both purposely established formal rules (laws, regulations, and operational procedures) and socially evolved informal rules (practices, norms, customs and conventions).

For the purpose of this paper, the word "policy" is to be understood as a set of higher-level decisions directed at achieving a set of social goals, which guides the formulation and implementation of specific development strategies or courses of action. The term "policymaker" means a person or a group of persons in a strategic position in the society, which gives the holder or holders a decisive advantage, and in this context it means those who have that advantage in the government. Policy is viewed as an essential companion to management, and policy analysis as an essential supplement to management analysis of irrigation systems.

Also, "research" in this context encompasses search and analysis of issues ranging from policies to system performance, and is seen as a critically important support to introducing change.

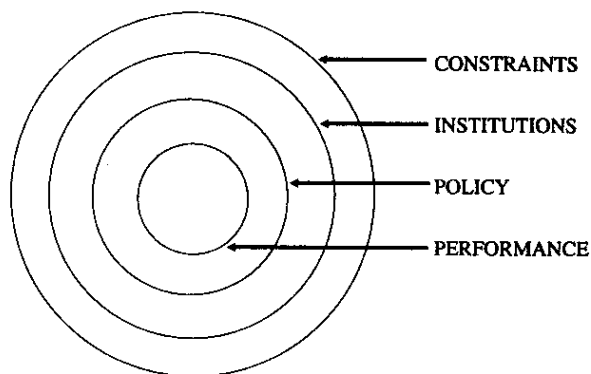
The term "sustainability" is a broad connotation. For the purpose of this presentation, sustainability of the irrigation system is given a narrower

definition to mean the maintenance of an economically favorable net flow of benefits from the system. All what the social, institutional and environmental influences do to a physical system is to make it more, or, less productive, and in this sense, when the system is no longer productive, it ceases to be sustainable by its stakeholders.

CONCEPTUAL FRAMEWORK

The economic policy analysts often consider institutions as a given condition. The institutions are supposed to provide the foundations and the "rules of the game" within which macroeconomic and agricultural policies can be undertaken to influence the various development objectives through system performance (Lecaillon et al. 1987:43). The assumption of this model of concentric influences (Figure 1) seems to be too rigid for a developing context in which resource endowment and technology are becoming limiting factors, and the essential performance improvements can largely be achieved through better management that necessarily needs enhanced institutional support. A static institutional framework which acts as a barrier to progress, therefore, cannot be accepted as an imperative, or a given condition.

Figure 1. Original conceptual framework.



Consequently, the paper adopts a modified conceptual explanation that recognizes the possibility for institutional change and for a more dynamic

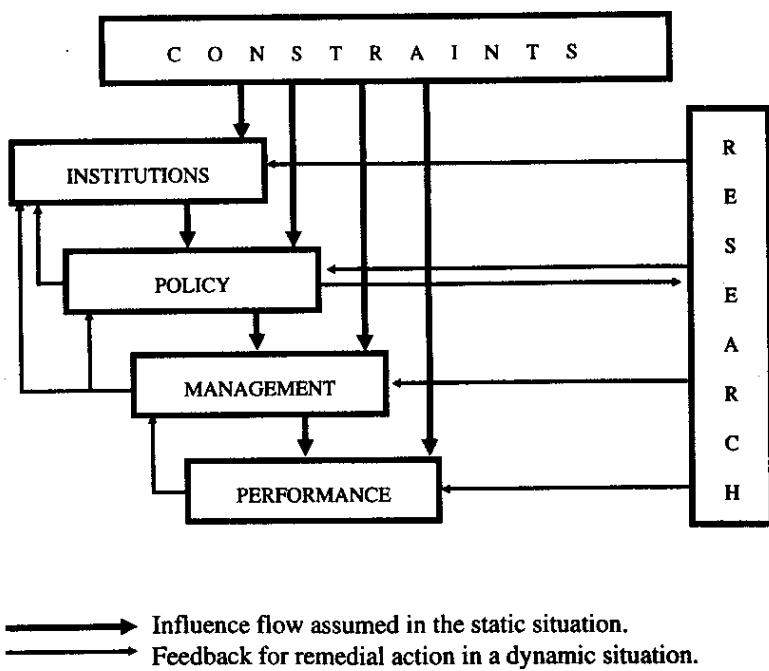
management situation, in which the researcher, the system manager and the policymaker, each has a distinct and useful role to play in institutional reform and policy formulation.

Policy and institutions are intrinsically interlinked; they are mutually reinforced. Policy is the product of institutional behavior, or of how the established formal and informal rules such as laws, regulations and social norms and values, as well as organizations such as bureaucracies, beneficiary groups, legal systems and political parties, interact with one another. Conversely, institutions are the expressions of policy, and new policy can effect some change in the institutions. Experience in many developing countries shows that without a serious policy concern and support, no effective institutional change or adaptation can take place. Whatever the internal and external change agents try to bring about even as the least controversial institutional change at the operational level, can hardly succeed if there is no support from policy.

In a static situation, the existing institutions give rise to stereotype policies which generally arise from existing lobby groups and become mere coalitions of their various vested interests. Such policies also favor the status quo, and are adequate only for maintaining that status quo.

It is research that can bring about a dynamic situation. Research brings out the relevance of new policies which in turn promotes the needed institutional change. For this, research should not only have a close liaison with the policymaking levels in the total system, but should also cover all its components: performance, management, policy and institutions, with varying emphases depending on the context. Ideally, research should be neutral to various interest groups, and should be able to provide objective analyses of the existing situation and viable solutions for appropriate change. This integrated approach is more likely to promote thinking beyond the status quo, and to form a basis for more "progressive" interest articulation aimed at new policies needed for development. Basically, this conceptual framework represents a Research and Development model.

Conceptually, therefore, institutions, policy, management and performance can be seen as interlinked in a dynamic model as shown below in Figure 2. Research acts as a catalyst in creating the dynamic situation.

Figure 2. Modified conceptual framework.

CHAPTER 3

Research and Policy on Irrigation: The Case of Pakistan

THE CONTEXT

PAKISTAN HAD A population of about 34 million in 1951, and growing at an annual compound rate exceeding 3 percent since then, its population increased to about 107 million in 1989. At this rate, the figure is estimated to be about 148 million in the year 2000, and even with some effort to keep the growth rate lower, the country's population is likely to exceed 200 million at the end of the first decade of the twenty first century (WSIP 1990: 2-2). About 70 percent of the present population live in rural areas, and about 22 percent of the overall population and about 26 percent of the rural population are still below the poverty line (Report of the National Commission on Agriculture 1988: 64). This fast-growing population with a large rural sector has to be mainly supported by agriculture which is the mainstay of the country's economy. Agriculture, despite the steady decline in its share of the gross domestic product from 53 percent in 1950 to its present level of 26 percent, still employs about 55 percent of the total labor force, and contributes 26 percent of export earnings.

Under arid to semiarid conditions, with an average annual precipitation around 200 millimeters, Pakistan's agricultural effort requires irrigation as an essential input. Close to 80 percent of the total land under cultivation is irrigated, and this accounts for about 90 percent of the country's total agricultural production. The ratio of irrigated to unirrigated cultivable area in Pakistan is about the highest in the world.

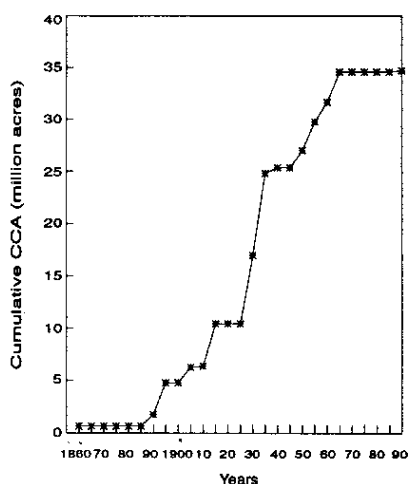
THE RESOURCE BASE

Pakistan's present resource base is the cumulative effect of more than a century of consistent investment on irrigation development. Figure 3 shows

the historical development of this massive canal system and its command area, which made it possible for Pakistan to have the world's largest contiguous irrigation system. For further details of canal construction, see Annex 1.

The World-Bank-sponsored Indus Basin Project (IBP) was started after the Indus Water Treaty of 1960. The IBP was formed basically to replace the sources and modes of supply lost after the Partition, but it acted as a major impetus to develop the country's irrigation system more systematically. The diverted annual supply of about 79 billion cubic meters or 64 million acre-feet (MAF) at the time of independence, rose almost to 135 billion cubic meters (110 MAF) as a result of this effort which saw the high-water mark of public investment on irrigation since independence. For completing and implementing the preindependence projects during the first Five-Year Plan period (1955–60), the share of public investment on agriculture and irrigation was around 30 percent. This share increased to about 46 percent during the second and third Five-Year Plan periods (1960–70) when the Indus Treaty projects were being implemented, but since then had declined rapidly to a level of about 17 percent in the sixth Five-Year Plan period in the 1980s (Hamid and Tims 1990).

Figure 3. Historical development of canal construction.



Source: Derived from information given in Annex 1.

Endowed with substantial glacier-based perennial water resources and supported by monsoonal rains, the Indus River and its tributaries, with an annual inflow of 147 MAF of water, feed this massive system (for details of inflows see Table 3.1 in WSIP 1990: 3–2). Pakistan's contiguous canal irrigation system has 3 major storage reservoirs — Mangla, Tarbela and Chashma, with a total initial live storage of 19.07 billion cubic meters (15.46 MAF) — 19 barrages and 12 link canals. The system serves 43 canal commands and delivers water to about 90,000 *chaks* (unit command areas) through a canal system of about 30,000 miles in total length, and a network of watercourses and field channels of another one million miles. The system serves a total command area of about 16 million hectares, or 39 million acres.

The average historical withdrawals from the canal system are shown in Table 1.

Table 1. Canal withdrawals (average for 1976/77–1986/87).

	Kharif		Rabi		Annual	
	Billion m ³	MAF	Billion m ³	MAF	Billion m ³	MAF
NWFP	4.66	3.78	2.83	2.29	7.49	6.07
Punjab	41.40	33.56	24.97	20.24	66.36	53.80
Sindh/ Baluchistan	36.13	29.29	19.08	15.47	55.21	44.76
Total	82.19	66.63	46.88	38.00	129.06	104.63

Source: Table 3.2 in Water Sector Investment Plan (1990:3–4).

Basically a surface irrigation canal system, Pakistan's irrigation system is being increasingly linked with other sources, and as will be highlighted later in the paper, groundwater is now playing a very significant role. The canal irrigation is supplemented by about 12,500 public tubewells, installed under the Salinity Control and Reclamation Project (SCARP) primarily for the purpose of lowering the water table, and over 250,000 private tubewells. Most of these private tubewells are located in the Punjab Province. As the original canal system was designed for not more than 75 percent cropping intensity, the subsequent increases in cropped area and increased demand for irrigation water could not have been sustained without this phenomenal growth of groundwater development. The present cropping intensity is, on the average, well above 100 percent, and agricultural growth during the period

1950–1985, has averaged at 3.0 percent per annum. This significant contribution by groundwater in what is considered as primarily a canal irrigation system, relates to the presence of a usable underground storage of water much more in volume than all the surface storage reservoirs in the Indus Basin. Of an annual recharge to this groundwater reservoir, estimated at 46 MAF, some 36 MAF are assessed as usable.

The contribution by the various sources of irrigation, and the general growth pattern of available water resources can be seen in Table 2, and their regional distribution² in Table 3.

Table 2 shows that during the period 1960 to 1987, the supply of canal water increased only by 27 percent, whereas the supply from private tubewells increased by 767 percent, and accounted for 57 percent of the total increase in supply for the period. The increase in the quantity of water used per acre seems to be mostly attributable to increased private tubewell water.

Table 2. Irrigation expansion (1960–1987).

	1960–61	1967–68	1977–78	1985–87
A. Farmgate availability of water (MAF)				Average
Canal	48.35	56.82	61.62	61.43
Public tubewells	0.47	1.97	6.21	8.80
Private tubewells	3.70	9.75	21.61	32.09
Subtotal	52.52	68.54	89.44	102.32
B. Irrigated cropped area (million acres)	25.71	30.86	35.14	39.80
C. Depth in feet	2.04	2.22	2.55	2.57

Source: Report of the National Commission on Agriculture (1988:288).

2 Areas irrigated by different sources categories may not be mutually exclusive because of the conjunctive use of water. The figures in the Tables may be understood as indicating assessed areas under different sources.

Table 3. Area irrigated by different sources (in hectares).

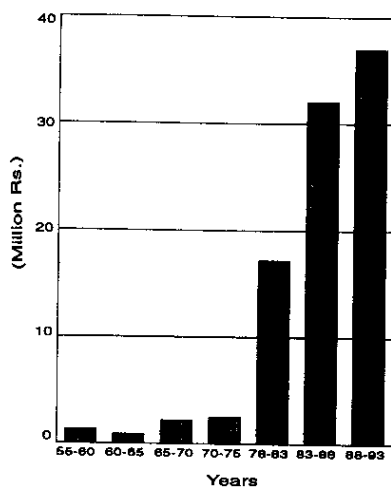
Source	Punjab		Sindh		NWFP		Baluchistan		Pakistan,	
	Area	Per-centage	Area	Per-centage	Area	Per-centage	Area	Per-centage	Total area	Total per-centage
Canal	7952770	69.72	3131700	94.90	669940	81.70	340170	66.70	12094580	75.42
Tubewell	3157800	27.68	49500	1.50	50020	6.10	89760	17.60	3347080	20.87
Surface well	193800	1.70	49500	1.50	40180	4.90	19890	3.90	303370	1.89
Others	102600	0.90	69300	2.10	59860	7.30	60180	11.80	291940	1.82
Total	11406970	100.00	330000	100.00	820000	100.00	510000	100.00	16036970	100.00
Country (%)		71.13		20.58		5.11		3.18		100.00

Sources: Water Sector Investment Plan (1990); Volume IV: Reports prepared by WAPDA.

Figure 3, and Tables 1, 2 and 3, together, represent a fairly impressive resource base by any standard. Pakistan's strategy to invest on expanding the physical resource base for irrigated agriculture has paid dividends; as described above, the system is extensive in its physical layout and substantial in terms of the water resources it provides, and therefore it can be described as a very valuable national asset which the country can hardly afford developing under the present circumstances.

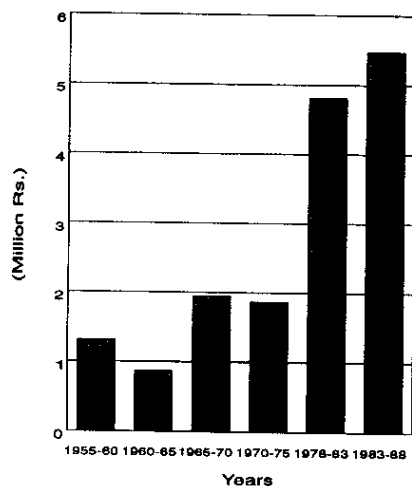
Although the proportion of the national budget spent for the water sector declined after completing the IBP, in amount the allocations continued to grow. The growth of these amounts over the years as given in current prices is shown in Figure 4, and as given in constant prices of 1959/60 is shown Figure 5. The continued growth of the sector's budget despite decreasing construction activity indicates the government's ability and willingness to provide adequate financial resources for the water sector.

Figure 4. Water-sector plan allocation in current prices.



Sources: WSIP (1990) and Badruddin and Afzal (1984).

Figure 5. Water-sector plan allocation in 1959/60 constant prices.



Source: Badruddin and Afzal (1984).

THE INSTITUTIONAL FRAMEWORK

Pakistan has inherited a strong institutional basis for irrigation, the origin of which can be traced to the mid-nineteenth century. With the Irrigation and Drainage Act promulgated in 1873, the state intervention on irrigation issues started to be effected through a government bureau, and was thus the beginning of the present Irrigation and Power Department in the Punjab Province. Provincial Irrigation Departments (PIDs) in other provinces are the offshoots of their older Public Works Departments, but for both legal procedure and departmental traditions their parentage can be traced to the original state irrigation agency created by the British with the Act of 1873. The organizational culture of all these PIDs is strongly linked with the rigid hierarchical administrative setup of the colonial period.

However, the application of rigid formal rules formulated over a century ago has been severely eroded by the informal social practices which have evolved with the rapid social change since independence (Bandaragoda and Firdousi 1992). The formal rules that served the earlier period well are now no longer functional in view of the social dynamics of the present day irrigation sector. To this extent, PIDs remain to be strong organizational structures, but less effective in meeting the present social demand relating to irrigation operations.

Provincial Agriculture Departments (PADs), though of slightly more recent origin, are also related to preindependent institutional creations. PADs were originally entrusted with agriculture extension and adaptive research as their main functions, and their technical importance increased significantly during the green revolution days of the 1960s. More recently, irrigation-related construction work was also given to PADs through the donor-assisted watercourse improvement activities, popularly known as the On-Farm Water Management (OFWM) Program. The newly added responsibilities and substantial budgetary allocations associated with them tended to provide high visibility to the OFWM wings of the PADs. Consequently, there has been a tendency for the PADs' focus of attention to shift away from their main role of agriculture extension work.

Traditionally, except for the resolution of water-related disputes among the farmers, the Provincial Irrigation Departments have restricted their jurisdiction, and more importantly their interest, to the main and distributary canal systems, leaving the area beyond the *mogha* (distributary outlet) to the Provincial Agriculture Departments. To date, this sharp separation of responsibilities, above and beyond the *mogha*, characterizes the institutional

framework for irrigated agriculture in Pakistan, and tends to affect the operation and maintenance of the system as a whole. It also serves as a symbol of a "great divide" between irrigation and agriculture, which runs through the framework from field-level operators to provincial-level departments, and to federal-level Ministries.

Building on the strong institutional base left behind by the colonial administration, Pakistan authorities have added some very important and useful elements to form a fairly complex institutional framework for irrigated agriculture. With the federation of provinces in Pakistan, irrigation remained to be a provincial responsibility, while, for accomplishing its major responsibility of planning for national development in which irrigated agriculture continued to play a very significant role, the Federal Government created its own Ministries of Water and Power (MWP), and Food, Agriculture and Cooperatives (MFAC). The Planning Commission (PC) with administrative support from the Planning and Development Division, and the Ministry of Finance (MF) were to perform their assigned supervisory functions in overall planning and resource allocation.

In the preparation of Five-Year Plans and the Annual Development Plans, the Planning Commission plays a pivotal role and tries to bring about a planning discipline among the various Ministries and Departments by requiring them to follow a specific process. For major projects, five specific PC forms and instructions are to be followed: PC-I for construction or any other developmental activity, PC-II for investigation, PC-III for quarterly progress reports, PC-IV for completion reports, and PC-V for monitoring of benefits. Out of these, PC-I is used as the basis for project choice decisions, and is to be prepared similar to a normal project feasibility report with all relevant technical and financial details, and economic and other decision criteria.

Consideration of various project policy aspects and decisions thereon takes place at different levels.³ For instance, for a project, costing more than Rs.60 million, the process starts with the preparation of a concept paper by the sponsoring Department. Concept clearance is given by the Executive Committee of the National Economic Council (ECNEC) which is the highest

3 Revised procedures for approval of development schemes and powers of various authorities to sanction development schemes are given in Circular No. 20(1)DA/PC/87, dated 15 November 1987, issued by the Planning and Development Division of the Federal Government.

administrative body for project choice decisions. A PC-II is then prepared by the Department detailing the investigation requirements and workplan, and once this work is completed a PC-I is prepared with details of project implementation. The PC-I proceeds through several approval levels: the Departmental Development Working Party (DDWP) or the Provincial Development Working Party (PDWP), and then the Central Development Working Party (CDWP) at the Federal Government level, involving all agencies and the Ministries concerned including Provincial Planning and Development Departments (PP & DDs). Finally, the PC-I is considered by the ECNEC, and the approvals of the provincial and national assemblies are sought depending on the nature of policy and resource-allocation needed.

Research relating to irrigated agriculture is initiated by specific wings of line Ministries at both federal and provincial level, while their activities are supplemented by the Ministry of Science and Technology (MST) and the universities under the aegis of the Ministry of Education (ME). Specifically deployed for this purpose are the Pakistan Agriculture Research Council (PARC) and the National Agriculture Research Centre (NARC) of the MFAC, Pakistan Council for Research on Water Resources (PCRWR), Drainage Research Institute of Pakistan (DRIP) and the National Documentation and Library Information Centre on Water Resources (NADLIN) of MST, and the Centre of Excellence for Research in Water Resources (CEWRE) of the University of Engineering and Technology in Punjab. Research wings of the PIDs such as the Irrigation Research Institutes (IRIs) in Punjab and Sind, and the Directorate of Land Reclamation (DLR) in Punjab, and those of the PADs such as the Agriculture Research Institute (ARI) and the Rice Research Institutes (RRIs) in Punjab and Sind add to this overall research institutional setup.

The Water and Power Development Authority (WAPDA), a semiautonomous or parastatal body created in February 1958, can be recognized as a major postindependence contribution in institutional development for Pakistan's irrigation sector. When it was established in 1958, WAPDA became an agency of West Pakistan, and remained so until 1970 when the West Pakistan's One-Unit arrangement returned to the pre-1958 system of separate provinces. With this change, WAPDA became a federal agency and was given a much greater prominence than it had during its formative period as a West Pakistan agency. The prominence corresponded to the new responsibility given to WAPDA for assisting the Federal Government in its role in resource allocation for irrigation and power

development and for planning and executing all major development projects in the sector. With the advantage of this prominent place in the institutional framework, WAPDA is able to play, and has demonstrably played, an important role not only in irrigation-related policy but also in research, assisting the federal authorities in many policy initiatives. The International Waterlogging and Salinity Research Institute (IWASRI), Mona Research Station, SCARP Monitoring Organization (SMO), the Lower Indus Water Management and Reclamation Research Institute (LIM), and Watercourse Evaluation and Monitoring Directorate (WMED) are WAPDA's subsidiary organizations or units established for specific research, monitoring and evaluation functions.

Annex 2 provides a functional and hierarchical distribution of the various units of the institutional framework in Pakistan's irrigated-agriculture sector.

EXPERIENCE IN IRRIGATION RESEARCH AND POLICY

The beginning of Pakistan's experience in irrigation-related research was almost simultaneous with the birth of the nation. Though locally initiated, the research effort was substantially enhanced by the work of visiting researchers, particularly when the world's attention was drawn by the massive Indus Basin Project heavily supported by international development assistance. The Irrigation Systems Management Research (ISM/R) Program, begun more recently, has been an extensive research effort associated with a larger USAID-funded development program. Four decades of these efforts, however, have yet to reach the full potential in terms of both the application of research results and their impact. Pakistan's effort in policy planning has also been noteworthy. Although the country's irrigation goals are compounded of numerous conventions and practices coming down from colonial times to the present, a range of official manuals and planning documents, and various project reports help to clarify the basic policy issues. An initial exploratory survey found references to irrigation policy in a number of official documents. The seven successive Five-Year Plans, though primarily used for resource allocation purposes, reflect some of the government's policy decisions on irrigation. The country has seen the completion of seven Five-Year Plans, the seventh being for 1988-93. Reports by the Pakistan Economic Analysis Network Project add a special policy dimension to the government's evaluation processes. Policy directions are also implicit in the various PC-I documents prepared for the appraisal of irrigation-related projects. Punctuat-

ing this policy planning process are a number of important master plans Pakistan has generated over the years, which contain some very significant policies specifically for the water sector. The most important of these master plans are the following:

- * Program for Water and Power Development in West Pakistan (January 1964) prepared by WAPDA and Harza Engineering Co.,
- * Report to the President of IBRD and the Administrator of the Indus Basin Project: Study of the Water and Power Resources of West Pakistan (July 1967) by Dr. P. Liefink et al.,
- * Revised Action Program for Irrigated Agriculture (May 1979) by WAPDA,
- * Report of the National Commission on Agriculture (1988),
- * Water Sector Investment Plan (1990),
- * National Agricultural Policy (1991), and
- * The Pakistan National Conservation Strategy (1992).

Thus, Pakistan's research and policy efforts in the irrigated-agriculture sector are commendable and they serve to uphold Pakistan's prime position in the world's irrigation scene.

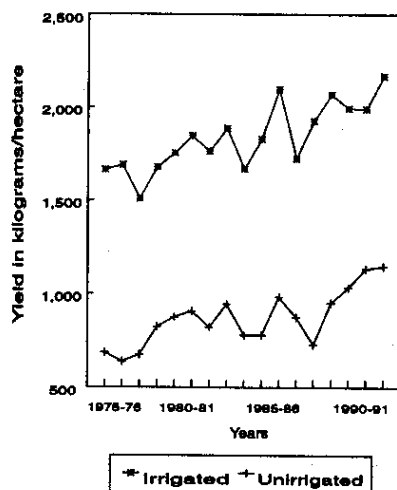
IRRIGATED-AGRICULTURE PERFORMANCE

The seventh Five-Year Plan (1988–93) is estimated to achieve an average annual growth rate of 4.3 percent in the crop sector as against the target of 4.5 percent. During the sixth Five-Year Plan period (1983–88), the growth rate in the agriculture sector was 3.8 percent though the target was 4.9 percent. The average growth rate for the period 1950 to 1985 was 3 percent. Considering the limitations on expanding the resource base, these growth rates appear to be reasonable, but the high population growth as indicated by rates of 3.21, 3.02, and 3.06 percent per annum between the successive censuses in 1951, 1961, 1972, and 1981, respectively, tends to reduce the effect of the growth rate of agriculture production.

Being one of the world's top ten wheat producing countries, Pakistan can justifiably consider its agriculture performance through the achievements in wheat production. Pakistan has had the third highest growth rates in wheat yield and wheat production over the 20-year period 1965 to 1985, averaging

3.2 percent per annum for yield and 5.0 percent per annum for production (CIMMYT 1989:11). This rapid increase in wheat yield is mostly due to green revolution effects gained by irrigated wheat, the average yield of which contrasts sharply with that of wheat on unirrigated land. Figure 6 shows the gap between the growth rates of wheat yields in irrigated and unirrigated land, and reflects, therefore, the effect of irrigation on the wheat cultivation.

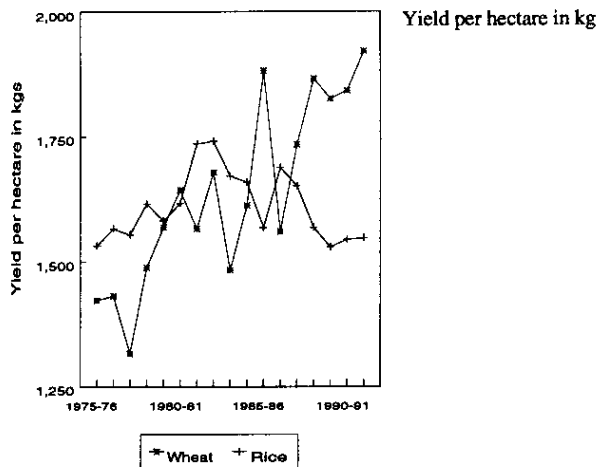
Figure 6. Wheat yield trends under irrigated and unirrigated conditions.



Source: Agricultural Statistics of Pakistan (1991-92).

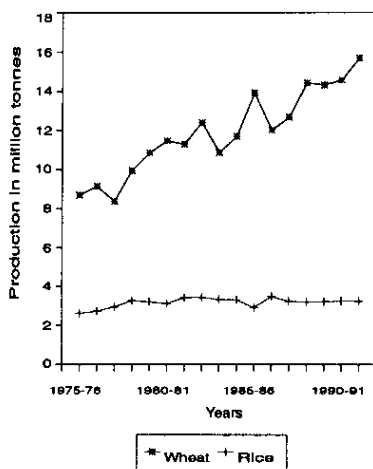
However, during the 1980s and beyond, these rates appear to have slowed down or taken a downward trend. More correctly, the yield and production levels of the two major crops, wheat and rice, can be described as having reached a plateau (see Figures 7 and 8).

Figure 7. Annual yields of wheat and rice.



Source: Agricultural Statistics of Pakistan (1991-92).

Figure 8. Annual production of crops (wheat and rice).



Sources: Agricultural Statistics of Pakistan (1985) and Report of the National Commission on Agriculture (1988).

Development Authority (WAPDA) for West Pakistan in 1958, the work of Punjab's Groundwater Development Organization was transferred to the Water and Soil Investment Division (WASID) of the newly formed WAPDA. With the break up of West Pakistan into provinces in 1970, the Punjab Province could not sustain the allocation of sufficient funds for the program, and the work eventually became a Federal concern in the early 1970s. The initial research base for this interest was substantial and the intentions of ensuring continued research inputs into the program were reflected in the establishment of the SCARP Monitoring Organization (SMO) within WAPDA for the function of monitoring SCARP impacts.

The first Salinity Control and Reclamation Project (SCARP) was undertaken by the public sector in 1960, for pumping out groundwater as a means of lowering the water table to control waterlogging and salinity. This was in response to national and international concerns arising from findings of extensive field research on the environmental issue, but a secondary objective to use the pumpage to supplement canal water wherever the water quality permitted tended to supersede the main objective. By 1986, over 12,000 SCARP tubewells had been installed, and the pumpage had increased from 0.47 MAF in 1960–1961 to 8.8 MAF in 1985–1986.

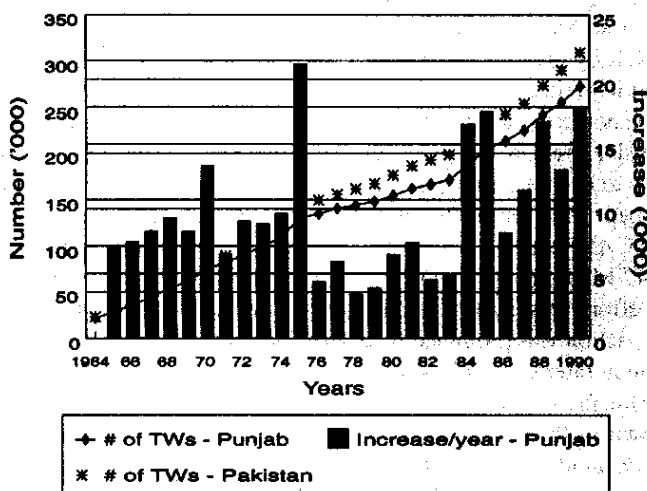
The effort was clearly a positive policy reaction to research results. Initially, action was prompted by external support but there was not enough local policy interest to follow up closely on the environmental issue and to monitor the fast development that was triggered off by this initial action. The breakdown in the policy-research linkages later gave rise to an unfettered private groundwater development effort within the irrigation system command areas, and to the discarding of the public tubewell program in view of their increased O&M costs. A 1975 report titled "Investigation of Tubewell Deterioration" prepared for WAPDA by Thomas P. Ahrens, Special Consultant to Harza Engineering Company International, Lahore, could foresee this problem when it clearly highlighted the need for research on tubewell maintenance and rehabilitation methods.

Development of private tubewells. The SCARP for public tubewells was a precursor to the private-sector interest in groundwater development for supplementary irrigation purposes. The demand for additional irrigation water arising from increased cropping intensities and changed cropping patterns saw a rapid growth in the number of private tubewells which rose from a mere 27,000 in 1964 to 167,200 in 1979, and to 242,160 in 1986. Fairly generous credit facilities provided the initial impetus. As could be expected

because of the province's larger share of the total irrigated area in the country, Punjab showed the greatest enthusiasm in this regard (Figure 9).

The present number of private tubewells is estimated at about 280,000. The total pumpage from private tubewells increased from 3.27 MAF in 1960 to 31.4 MAF in 1985 during which year both public and private tubewells together provided 40.66 MAF of water, constituting over a third of the total irrigation water input in agriculture.

Figure 9. Private tubewell development in Pakistan and Punjab.



Sources: For 1964–1986, IIMI (1992:154) and for 1987–1990, Agricultural Statistics of Pakistan (1990–91).

The steady development of groundwater during this period coincides with an effort to provide subsidies. The total amount of subsidy on tubewells, and the cumulative number of tubewells, including public tubewells installed during the period 1977–1986 are as shown in Table 4.

Table 4. Amounts of subsidy and number of tubewells.

Year	Subsidy Rs. million	Number of private tubewells	Total number of tubewells
1977/78	20	161,480	172,376
1978/79	24	167,217	178,507
1979/80	22	176,466	188,912
1980/81	20	186,256	199,673
1981/82	24	192,612	207,079
1982/83	24	198,540	213,226
1983/84	16	215,871	230,536
1984/85	16	233,914	248,873
1985/86	16	242,160	257,386

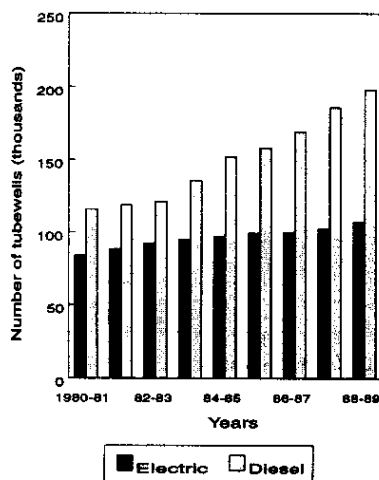
Source: Report of the National Commission on Agriculture (1988: 524).

Implied in this strategy of providing subsidies is a policy that was at least aimed at popularizing the establishment of tubewells, although a clear correlation cannot be seen in the data given in Table 4. Nor is it clear from field data that subsidies have reached the majority of those who have invested in private tubewells. However, certain aspects of this strategy, such as issues relating to differential subsidy rates for different areas and for diesel and electrically operated tubewells, and the absence a clearly targeted group, seem to cloud the exact purpose and effect of the policy. For instance, the rate of growth of diesel-operated private tubewells has been faster than that of electrically operated tubewells (Figure 10). Whether this has been due to a deliberate policy decision, and whether all implications of this have been properly studied and taken into consideration remain unclear.

Perceived immediate irrigation benefits of the public groundwater extraction program were primarily responsible for the private-sector interest in groundwater development. However, the provision of subsidies, supervised credit, technology and other information, and the subsequent decision to gradually replace the existing public SCARP tubewells in usable-groundwater areas by private tubewells, are clearly policy directions aimed at promoting private-sector groundwater development. The issue, however, is that their implications in terms of overall performance and

environmental sustainability, and their impact on rural incomes and income distribution should have been more clearly identified.

Figure 10. Growth of private tubewells (electrical and diesel).



Source: Agricultural Statistics of Pakistan (1989-90).

Also, it is not clear whether there has been any policy interest to properly monitor and assess the extent to which groundwater was being extracted to supplement canal supplies. Lack of monitoring data, for instance, throws some doubt on the reported numbers of private tubewells. A census carried out by IIMI in the Sheikupura District showed that the density of private tubewells could be much higher than was officially reported (Figure 11).

Policy directions are also unclear in the area of overall conjunctive management of surface water and groundwater, and how groundwater can be efficiently used as part of the national pool of water resources. IIMI's research in the Lagar Distributary command area shows that "the total installed capacity of private tubewells is not only more than six times as great as that of public tubewells, but that it exceeds by more than twelve times the amount of canal water authorized for the distributary" (Vander Velde and Johnson 1992: 25). A broad-based survey would clarify whether this finding is location-specific or whether the contribution by groundwater is more widespread than normally perceived. These issues relate to the proper

MAJOR INTERVENTIONS FOR PERFORMANCE IMPROVEMENT

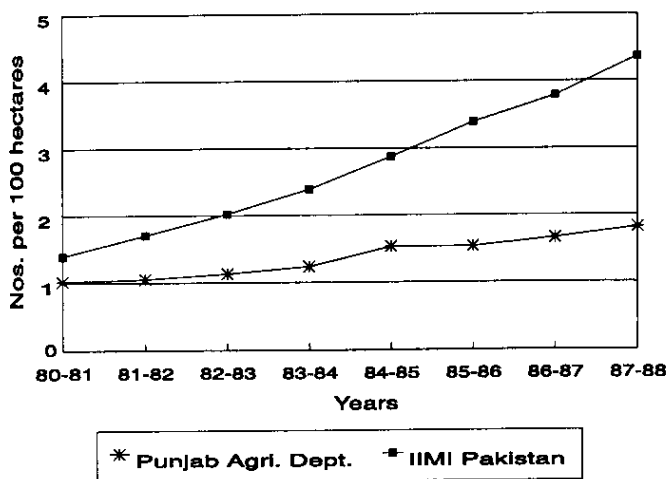
Apart from making a considerable effort on infrastructure development, Pakistan has also invested on a number of programs to enhance operational efficiency within the irrigated-agriculture sector. Seven such programs are selected for brief presentation in this paper. Along with their salient features, a brief discussion is included below to highlight the interplay between research and policy in each of these seven interventions. A summary of this discussion is given in the chart in Annex 2.

Public groundwater development. The origin of Pakistan's interests in groundwater extraction through tubewells can be traced to the mid-1950s when the Punjab Province established its Groundwater Development Organization as a part of a strategy to address a growing national concern at that time. However, the plan of action that was to be formulated in the early 1960s, and pursued through its initial stages of implementation in the mid-1960s, was a result of substantial external support. The effort can be described as one which received the political will and cooperation at the highest level, and one which was founded on a close evaluation of the problems by a team of persons at an equally high level of expertise. Further, the effort in its initial stages can be seen as a good example of research-policy linkage. When the President of Pakistan during his official visit to the United States in July 1961, expressed his serious concern on the waterlogging and salinity which threatened the entire welfare of Pakistan, the President of the United States responded immediately by sending a team of American experts led by Dr. Roger Revelle to advise the Pakistan authorities on their approach to solve this problem. The "Revelle Report" presented a plan of action which consisted of, and depended on, "an interweaving of physical means of increasing agricultural production with the necessary economic and political factors" (The White House, 1964:5), and contained a comprehensive treatment of issues which transcended the boundaries of the problem of waterlogging and salinity. The report also specifically referred to the need to continue with research and application of its results. The comprehensiveness in approach and the close linkage with scientific knowledge are two important characteristics of the "Revelle Report" plan of action, which are yet to be seen being followed in any subsequent policy attempts in the sector.

Certain institutional changes also characterize the history of groundwater development in Pakistan. With the creation of the Water and Power

operation and maintenance of tubewells, the allocation of resources including the provision of subsidies and access to fuel and power, and the establishment of a legal basis for conjunctive use. Currently established water rights are mainly for canal water and continue to be exercised in the same manner as prior to the availability of groundwater.

Figure 11. Densities of private tubewells (Punjab Agriculture Department versus IIMI data).



Source: IIMI (1992:154).

Another emerging problem is the increasing imbalance between the availability and quality of both canal water and groundwater along the distributary and the watercourse. When research would conclude that where groundwater is plentiful, and that canal rights could be transferred to areas where good quality groundwater is scarce, providing for a more equitable, and possibly optimal, allocation of overall water resources, it becomes a political issue which can be best resolved after a thorough policy analysis.

While the advent of groundwater clearly helped the Punjab farmers to increase their production, the emerging institutional and environmental problems are seen to be associated, as discussed above, with a lack of coordination between research and policy.

Watercourse improvement program. Extensive field research in canal commands in the early 1970s by Mona Reclamation Experimental Station, and later by WAPDA's Revised Action Program (RAP) watercourse survey in 1976/77, assisted by a Colorado State University research team, found substantial water losses ranging from 35 percent to 40 percent of the water delivered to the watercourse.

The initiative to link these irrigation system studies (field research and surveys) with subsequent policy measures could be described as "donor-driven." Anyhow, the linkage resulted in the decision to launch an extensive watercourse improvement and partial lining program involving over 10,000 watercourses from 1977 to 1988. WAPDA monitoring studies on this program, although some evaluators would tend to treat their results with great caution (WSIP 1990: 4-11), found watercourse losses to have been reduced by about 30 percent, reflecting a reasonable success in the program's civil works component.

However, the proceedings of the Irrigation Systems Management Research Symposium in November 1990 reported:

...there was a statistically significant improvement in delivery efficiency in main watercourses after the on-farm water management programme. This improvement was associated with earthworks in the watercourses, but not with lining.

While the attempts to improve watercourses generated a fair degree of enthusiasm among the farmers, it was the lining component of the program, including the upgrading of the outlets, that mainly characterized the program and attracted the general attention. Other important components such as the improving of irrigation practices and stabilizing organized behavior among the farmers for watercourse maintenance received less attention, although the program was given the broader title "On-Farm Water Management." More was intended to be achieved than the physical improvement of watercourses but some of these intentions disappeared through the gaps in the research and policy interaction processes.

Despite several study reports by WAPDA's Watercourse Monitoring and Evaluation Directorate, a clear assessment of the effect of lining watercourses or of the efficiency increases has not been given to the policymakers as yet, nor do the policy levels seem to be so much concerned about the validity of program assumptions. The program continues on the basis of its original assumptions.

Command water-management program. For implementing the watercourse improvement program mentioned above, a new On-Farm Water Management (OFWM) wing was established in the Provincial Agriculture Departments (PADs). This structural change almost led to a shift of emphasis in the traditionally extension-oriented PADs, from extension services to construction efforts, as the OFWM started receiving a relatively greater proportion of resources. The effect of this shift of emphasis on the overall agricultural development in the country is yet to be fully realized.

As a response to emerging social science findings on the need to have beneficiary participation for productive and equitable irrigation operations, the OFWM Program was obliged to form and use Water Users' Associations (WUAs). This was a clear policy support initiative based on research recommendations but again the initiative was almost totally donor-driven. There has been no useful local research effort to monitor the farmer organization program and its effects.

The Revised Action Programme of Irrigated Agriculture (RAP) highlighted the need for strong policy directions for coordination, monitoring, and evaluation of institutions managing irrigated agriculture, and for providing them with the necessary administrative, technical and financial backstopping. This emphasis was on the basis that the focus of the institutional support should be on the improvement of agricultural production as an overall objective rather than on individual inputs such as water, fertilizer and seed.

The RAP made five specific recommendations for institutional development:

- * Establishment of a Central Cell for Agricultural Policy, as a coordinating body at the Federal Government level,
- * An Additional Chief Secretary for Agricultural Production at the provincial level to coordinate Provincial Government Departments dealing with irrigated agriculture,
- * Introduction of an area-based project management institutional setup for all major agricultural development projects for maximum coordination at project level — Command Area Management (CAM-I),
- * Introduction of a Command Area Management (CAM-II) for farmer-demand articulation in areas which do not have major agricultural development projects, and

- * Establishment of an autonomous Provincial Minor Works Corporation (MWC) to undertake minor agriculture and water-related works in the provinces.

Only some of these recommendations have been tried out, and the policy-research dialogue on these issues seems to have waned.

Following RAP's recommendations on institutional policies, the Command Water Management Projects (CWMPs) were started to address some of the interagency coordination issues. The watercourse improvement activities which were continued under these pilot projects showed greater success, mainly due to greater coordination achieved through the CWMP's integrated Subproject Management Organization which consisted of staff of both Irrigation and Agriculture Departments working more closely on a command area basis. However, the success was again predominantly in the civil works component.

The institutional package for these projects is not yet complete. This deficiency can be seen in the inadequate arrangements for proper operation and maintenance of improved physical facilities, and for supporting the continued involvement of farmer organizations in post-construction activities. Had the initial research effort been extended to cover the related policy issues more thoroughly and in an integrated manner, the present impasse of difficult interagency coordination and of unclear agency-farmer coordination could have been avoided to a larger extent. In the absence of an adequate objective evaluation of the CWMP, there has been no policy initiative to proceed beyond the program's pilot-scale application.

Irrigation cost recovery. The recovery of costs of irrigation supplies is in the form of water charges which are assessed traditionally on a crop-area basis at a differential rate determined according to different types of crops. Research studies have pointed out deficiencies in the present system in terms of low recovery rates, underrecording of extent under high-delta crops in favor of low-delta crops, the method of assessment, and in the overall, unrealistic water charge rates. The system is also seen as deficient in providing economic incentives for the farmers to optimize water use.

According to present procedure, there is a rebate for the use of private tubewell water, and an increased levy for the use of public tubewells. The schedule of water rates is different (twice that in exclusively canal commanded areas) in SCARP areas where public tubewells supplement the canal supplies. However, this procedure does not seem to prevent the areas irrigated with the conjunctive use of canal and groundwater supplies being

treated in different ways by the field staff in the overall assessment of water charges.

Several studies have produced some interesting reports on the low recovery rates: assessment and collection procedures (ACE Pvt. Ltd. 1990), and the economic aspects of cost recovery by Economic Analysis Network Project, Islamabad. It is presumed that these evaluations are under consideration by the policymakers although any drastic change in policy is widely known to be politically unpalatable. An overall analysis of the present system of assessment and recovery of water charges encompassing these complex issues, including desirability of internalizing water charge collections with operation and maintenance costs in a decentralized manner at the system level would lead to a more rational basis for water charges. The support of a carefully formulated integrated policy in this direction is needed to achieve positive results.

Interprovincial allocation of water resources. Clearly, this is a higher-level policy issue, and has been correctly treated that way to achieve positive results. Allocation of water resources to the various political units has been one of the burning policy issues, which after a long iterative series of evaluations and deliberations has now been resolved through the Council of Common Interests, a constitutional instrument for deliberating on such interprovincial policy matters. The delay was mainly related to its high political sensitivity, dating back even to the preindependence period.

Clearly, the policy lacuna on water allocation at a macro level affected the efficiency of water use at the field level. At least three problem areas were discernible. First, it was an attitudinal problem that pervaded the thinking of those involved in the delivery and use of irrigation water at regional levels to try and obtain the maximum possible quantity of water. The result was the lack of incentive for anyone to optimize on water use. Excellent recommendations on rational water management from research and extension staff are of no avail under these circumstances. Second, it adversely affected the proper conjunctive management of surface water and groundwater, and the effective disposal of surplus water. The desire of the water user was to acquire more water rather than to productively manage it. Third, the indecision resulting from unresolved claims for the share of water tended to demotivate the manager at each level for maintaining, rehabilitating and remodeling the physical systems for the purpose of maximizing the return on this scarce resource.

The effort made in trying to resolve this complex problem can be seen in the number of Commissions appointed, Committees set up, and many Agreements reached during the past. A series of meetings held in 1991 saw a breakthrough in this long-drawn-out negotiation and arbitration process. A meeting of the Chief Ministers of the four provinces was held on 3 March 1991 at Lahore, and was followed by two other meetings, one on 4 March 1991 at Lahore and the other on 16 March 1991 at Karachi, and finally an accord was reached on the apportionment of the waters of the Indus River System between the provinces. A brief summary of the various deliberations conducted and the various levels of agreements reached over time are indicated in Annex 4.

Despite the recent breakthrough in a final decision which was reached after a long gestation period, its effective implementation is yet to be launched through further policy directions. The necessary institutions to monitor the implementation of the Accord are yet to be firmly established. One of the important recommendations of the WSIP is on the resolution of water allocation disputes, but to give effect to this recommendation fully, more than the broad consensus seems necessary. The belief that the river supplies have almost been fully used is identified as one of the deep-rooted concepts in Pakistan's water sector, which is, apparently, triggering off and sustaining water disputes (Kirmani 1990). Further policy decisions and the effective implementation of decisions already reached may benefit from more thorough research on the issues involved.

Demand-based irrigation. To shift from the traditional supply-oriented system of irrigation operations to one which is based on crop water requirements is a more recently declared policy objective in Pakistan. This policy, however, contrasts sharply from the earlier-mentioned cases in that it is not based on any serious research evaluation of the feasibility of demand-based irrigation in Pakistan's context.

Pakistan's irrigation systems are characterized by fluctuations in their supplies in relation to crop water requirements. Even in those areas where groundwater has been developed as a supplement to canal irrigation, the mismatch persists. In this situation, the present warabandi allocation practice is seen as too rigid for farmers to manage water optimally (Bhatti and Kijne 1991). A study for the RAP (WAPDA 1979), which covered an average year, has brought out significant variations (both surplus and shortage) between the crop consumptive use and total irrigation supplies, from month to month and between different canal commands for all months.

The problems of canal irrigation causing low agricultural productivity in Pakistan are variously perceived as:

1. Supplies falling short of the crop-water requirements during the growing periods or at critical stages of growth.
2. Inadequacy of supplies at the time of sowing of crops resulting in protracted sowing periods beyond the proper time, and also restricting the area under crop although excess supplies are available later in the season.
3. The designed capacities of the systems restricting more supplies to meet the crop requirements even if excess supplies are available in the rivers during summertime.
4. Irrigation supplies in excess of the crop requirements causing drainage problems and resulting in waterlogging and salinity.

The National Commission on Agriculture (NCA) of 1988 seems to confirm these perceptions when it notes that there is seldom enough canal water to meet the entire water requirements of a particular crop, with shortages occurring during critical periods of the crop growth cycle and resulting in water stress and lower yields. The Commission therefore recommends the development of macro-level water management plans for the distribution of irrigation supplies including available groundwater, more in line with crop water requirements in different canal commands. The Commission, however, cautions that to bring about a closer link between the irrigation supplies and the crop water requirements, crop zoning and water scheduling should be taken up initially on a pilot scale before their wider introduction.

Another instance of national-level concern on water management efficiency was seen at the series of deliberations that took place in finalizing the Water Sector Investment Plan (WSIP) of October 1990. The assertion according to conventional wisdom has been that currently felt shortages in canal water will not make crop-based irrigation possible in Pakistan. Contrary to this belief, the WSIP Working Paper on Policy and Management Issues (Kirmani 1990) stressed that more water can be made available for productive use by changing the historic withdrawal pattern to a crop needs pattern,⁴ and

4 In the early nineteenth century, all irrigation canals in the Indus Basin were 'inundation canals' drawing as much water as the river flows permitted. The uncontrolled supplies were uncertain and their pattern did not match the crop needs. However, the historic withdrawals represented the legal water rights of the canals. For more details, see Kirmani (1990).

that one of the major factors depressing average crop yields in Pakistan had been the lack of adequate matching of water supplies with crop water requirements.

However, policy statements made both by the NCA and by the WSIP have neither been preceded nor followed by adequate research to support a viable program of action regarding the introduction of demand-based or crop-based irrigation in Pakistan.

Clearly, the changes that have occurred in the irrigation scene alone have prompted the policymakers to come up with the idea of crop-based irrigation. Among these changes were an increase in the irrigation intensity far beyond the design stage expectations, partly aided by the development of groundwater; and the introduction of new and improved high yielding crop varieties, most of which when acting in combination with a package of inputs on which they were dependent, were highly sensitive to irrigation water. Cropping patterns also changed requiring increased quantity and reliability of farmgate water supply. All these changes converged on the need to have a greater control over the availability of water: in adequate quantity and quality, at appropriate stages of crop growth, and at the correct time and place. Thus, a departure seemed necessary from the traditional approach of "protective" irrigation to that of "productive" irrigation.⁵

In Pakistan's North-West Frontier Province (NWFP), the Chashma Right Bank Canal (CRBC) is being newly constructed and the Lower Swat Canal (LSC) has been remodeled, both designed to have greater system capacity than the average type of canal systems elsewhere in Pakistan. The idea has been to allow for peak crop water requirements within a given cropping pattern with the intention of introducing demand irrigation in the two systems. At the request of the government, IIMI has conducted some preliminary research work in the CRBC Stage I and an initial investigation in the LSC to explore the systems' suitability for demand irrigation. This work has been reported in several research reports (Bandaragoda and Badruddin 1992; Bandaragoda and Garces 1992; Garces and Bandaragoda 1992; and Strosser and Garces 1992). Tentative findings are that strict warabandi is not practiced in these systems and that the farmers are already operating in a crop-based mode. With some additional changes in the physical system, a more flexible

5 The concept of "productive" irrigation aims to increase irrigation water availability and to manage irrigation deliveries to meet the consumptive water requirements of the crop (crop demand), and thus creates opportunities for improved agricultural production.

management system could be tried in these two systems to make irrigation operations more responsive to crop water requirements. The issue, however, is whether and to what extent, such attempts could be replicated elsewhere in Pakistan. No research interest can yet be seen on the issue, either among the operating agencies or in local research institutes. Nor can the interest be clearly seen even at the policy levels despite the policy preference already made for crop-based irrigation.

CHAPTER 4

Discussion: Linking Research with Policy

RECAPITULATION OF CONCEPT AND CONTEXT

THE CONCEPTUAL BASIS for this presentation outlined in Chapter 2 of the paper, assigns a prime role to research. It considers research as being capable of converting a static policy and institutional framework into a dynamic developmental context. It stipulates that, to be able to play this role, research has to interact with policy very closely and consistently. Research provides organized and analyzed information to policymakers about problems, issues, constraints and potentials relating to the development process so that they can use such information in formulating new policies. Conversely, policymakers on their own can seek research guidance on unclear situations. These ideas may appear to be mere common sense, but arguably, the use of this common sense is not found to be so common.

The conceptual framework depicted in Figure 2 in Chapter 2 encompasses the various interactions that research should have with the components of a dynamic research and development system. These include research interactions with institutions, policy, and management, in addition to the customary or more popularly known research interaction with performance. Of these, the interaction between research and policy is the most critical factor that helps to trigger off a dynamic situation by promoting other linkages in the system. Research recommends innovations which policy can translate into action for promoting change.

The brief description of the main features of Pakistan's irrigated-agriculture sector given in Chapter 3 of the paper, highlights the attempt made by Pakistan consistently during the past 100 years to expand its resource base for irrigated agriculture. Chapter 3 also tries to place the sector's current performance in the context of its resource base and of irrigation-related research and policy experience in the country. To illustrate this further, Chapter 3 also highlights seven irrigation development programs undertaken during the past three decades in Pakistan, which can be considered

as some of the most important instances where some interaction between research and policy has occurred in the country's long irrigation history. In summary, the information outlined in Chapter 3 suggests that the country's irrigation resource base is certainly not meager in any sense and that the effort in research and policy is substantial. In all of these, Pakistan's case is perhaps relatively better than that of any of its neighbors. The question, however, is whether the sector's performance is commensurate with this favorable context.

WHY THE PERFORMANCE GAP?

Despite having invested on such a substantial resource base, and exerted commendable initial effort in research and policy, Pakistan still appears to have achieved less than desired performance in improving the productivity of irrigated agriculture. Compared with yield figures achieved by a few selected developing countries, Pakistan's wheat yield is 44 percent of that in Mexico, rice yield, 43 percent of that in Egypt, maize yield, 33 percent of that in Turkey, cotton yield, 75 percent of that in Mexico, and sugarcane, 66 percent of that in India (PNCS 1992:26). This situation has to be evaluated in view of the fact that Pakistan is the country least dependent on rain-fed agriculture among all the countries mentioned above, except Egypt.

The stagnant performance in food grain production indicated in Figures 7 and 8 deserves serious policy consideration. Viewed in the light of a number of other trends — increasing costs of production, widening skewedness in the ownership of productive assets and in rural incomes, decreasing cost-recovery rates of state services, and persistent inadequacy in water management efficiency — and more importantly, in view of the rapidly increasing population, a decline or even a stagnancy in food production growth rates is most likely to exacerbate existing rural poverty.

In search of reasons for the sluggish performance in Pakistan's irrigated agriculture, ironically, the situation is often too hastily attributed to lack of resources. Widely acknowledged reasons are linked with the scarcity of good quality land and water resources, lack of educated manpower, and lack of financial resources. While the factor proportions among these various resources may be a general issue concerning agricultural productivity, the emphasis on the inadequacy of resources, however, tends to cloud a number of other important issues.

The search for possible reasons for the current stagnancy in performance may now shift to focus on issues relating to managing the available resources, rather than to increasing resource availability. While the latter may remain as a continuing interest, a shift of emphasis to resource management will throw some light on the effect of second-generation problems that are emerging from the expanded resource base for irrigated agriculture. With this new emphasis, the situation would seem to have some important institutional implications. The resource use efficiency is largely dependent upon the organization for resource use, the organizational performance, and the way relevant performance-related information is collected, processed and handled for improved performance. These organizational and information needs together tend to make a case for some urgent institutional change for improved performance in irrigated agriculture. The case, however, can be developed only through a close linkage between research and policy, because institutional change necessarily needs strong initiatives from research-supported policy.

In Pakistan, an apparent drawback in this regard is the lack of consistency in both research and policy interests, and the lack of comprehensiveness in research which is necessary to pursue the essential linkage between the two interests. Does this drawback explain Pakistan's low performance in irrigated agriculture? Has research played its expected dynamic role, and what has been the policy response? Or to invert the question, has policy played its own due role and been able to extract the necessary dynamism from whatever research done? The seven selected programs outlined in Chapter 3 are illustrative of the well-intentioned efforts that suffered from these deficiencies.

RESEARCH-POLICY LINKAGE IN SELECTED INTERVENTIONS

The author made an attempt to identify the extent to which both research and policy efforts have progressed or been successful for each of the seven programs or interventions highlighted in Chapter 3. The results of this subjective assessment can be seen in Table 5; the levels of relative success of these programs in terms of their contribution are depicted as depending on the degree to which both research and policy have interacted with each other. In this assessment, the information gathered about the seven interventions has been interpreted in the light of concepts and contextual details outlined in the foregoing.

Table 5. Relative success of selected programs.

Program/Intervention	Research support	Policy support	Relative success
1. Public tubewell development	Moderate	Strong	Medium
2. Private tubewell development	Weak	Moderate	Medium
3. Water course improvement	Moderate	Moderate	Medium
4. Command water-management program	Weak	Weak	Low
5. Cost recovery	Weak	Weak	Low
6. Interprovincial water allocation	Moderate	Strong	Medium
7. Demand-based irrigation	Weak	Moderate	Low

In general, it appears that Pakistan's demonstrated concern on having to link research with policy can be presented as a far better effort than can be seen in most other developing countries. At the same time, Pakistan also shows that much more could have been and can be achieved through a systemic approach depicted in the conceptual framework in Figure 2 in which a continuous dialogue and a mutually reinforcing relationship can be established between research and policy. The main reason for not being able to achieve the desired results from this rather laudable effort in research and policy can be linked to the ad hoc and episodic nature of these efforts.

Ad hocism can be seen even where the research effort is assessed as moderate, as the interest was not sustained and some essential components were ignored. The case of groundwater development is a typical example of this deficiency. The initial findings on waterlogging and salinity which led to the initiation of the two programs were not enthusiastically followed up, and the environmental and economic implications consequent on uncontrolled mining of groundwater were neglected. In the case of the watercourse improvement effort, successive stages of a long-drawn-out program of physical improvement activities were not accompanied by an attempt to find out the economic and social effects of the program; nor were they instrumental, as anticipated, in any meaningful institutional change regarding continued beneficiary participation in watercourse maintenance work.

The episodic nature of the abovementioned efforts has its own examples. For instance, when the initial interests surfaced regarding the need to lower the water table and also arrest the salinity problem, the SCARP Program was started. When this led to an unforeseen demand for extra irrigation water and apparently to an unexpected demonstration of private-sector capacity to invest, the private-tubewell promotion scheme was initiated. When the donors were willing to invest in an effort to reduce seepage losses, the watercourse improvement program began, and on similar impulses the command water management projects sprang up. The latest cliché, the demand-based irrigation, is based on the feeling that the persistent inadequacy in water management efficiency is mostly due to the present system of supply-oriented irrigation operations. Each of these policy thrusts can be thus traced to a separate impulse based on some research effort or on other forms of influence.

The projects and programs typified by the seven illustrations outlined in Chapter 3, have had an emphasis on enhancing the resource base. Those which related to infrastructure development and to increases in water supply have received priority, while those relating to more difficult, yet more important, requirements such as institutional development and cost recovery have receded to the background. The latter group consists of projects that would have needed strong policy support.

POLICY PLANNING PROCESS

Pakistan's attempts at policy planning are commendable but their final results are not commensurate with the effort made. The RAP documents of 1979, the report of the National Commission on Agriculture (1988), and the Water Sector Investment Plan (WSIP) of 1990 are very valuable planning efforts which have all tried with painstaking details to comprehend the development setting at each point of time and to isolate some possible actions for the immediate future. In both instances, the recommendations have led to some initiatives. Where the plans have failed to yield the desired results, the reasons are attributable to the lack of a clear direction of policy from a national perspective with full participation of all concerned. For instance, the RAP was an almost centrally evolved technocratic effort by WAPDA, and lacked the necessary broad-based involvement. In contrast, the WSIP was a collation of individual plans from provincial planning cells put together by the federal

coordinating cell, but yet the interest shown by the provinces appears to have been rather peripheral. In either case, results are suboptimal.

As in many other developing countries, the series of sectoral policies in Pakistan has made some positive contributions but their side-effects have also affected the environment and the economy. A recent policy document covering the crosscutting theme of environment refers to this problem of fragmentation in earlier policies. The major shortcomings are seen to have stemmed from "not being comprehensive enough to address all the issues or dimensions," and the impacts of sectoral policies are regarded as "fragmented or disjointed" (PNCS 1992: 116).

The argument can now shift to focus on the need to have a clear policy on irrigated agriculture as part of an overall national development policy. The seven programs outlined earlier in the paper can form the basis for this argument. Had all these programs, originated from a comprehensive policy on irrigated agriculture, developed in the context of the country's overall social goals and had such policy been continuously enriched by a goal-directed and problem-solving research program, logically, the total gains from the various programs and related research efforts could have been greater. With such comprehensiveness in irrigated-agriculture policy, many important socioeconomic criteria such as production, equity, environmental protection and technological advancement would all be considered in appraising the individual projects and programs. The individual programs would then become integral parts of a well-planned implementation package aimed at a predetermined set of goals, providing synergy in terms of the optimum use of resources, and complementing one another for achieving the common set of goals.

INSTITUTIONAL IMPLICATIONS

One difficulty in achieving this cohesion and comprehensiveness in research and policy of irrigated agriculture is the sharp functional and institutional division between irrigation and agriculture. This division and corresponding separation of responsibility (also referred to in Chapter 3 above) seem to account for the emphasis on agriculture in the NCA report and on water in the WSIP. A much greater effort has been made in the recently declared National Agricultural Policy (Ministry of Food, Agriculture and Cooperatives 1991) to make it a more comprehensive statement, but in essence, it has followed the NCA too closely so that some important irrigation issues have

received less treatment in it than desired. These three policy documents and their forerunner in the RAP together cover a wide area of policy on irrigated agriculture, but individually, they tend to reflect the usual bias and inadequacy associated with chronic "departmentalism" in irrigated agriculture. Similarly, research is often bifurcated by two separate sets of institutes related to irrigation and agriculture, respectively.

Hitherto in this chapter, the discussion has focused on the value of a purposive linkage that has to be established between research and policy. The relationship between policy and institutions is somewhat different; as was already commented in Chapter 2, policy and institutions are intrinsically interlinked and are mutually reinforced. The easily observable static nature of the institutional framework in Pakistan's irrigated-agriculture sector can therefore be linked to the policy inertia of recent times in this regard. The essential contribution from research to facilitate some institutional change has also been minimal.

The institutional framework in Pakistan's irrigated-agriculture sector is characterized by its strong base on the one hand, and its complexity on the other. The base was laid at a time when large river-like canals were built and water was conveyed several hundred miles across the barren desert land converting it to a fertile valley of long-sustained agriculture, and attracting for it the popular name, the "Indus food basket." That the base continues basically in its original form, rigid, stable, and seemingly vulnerable, but still resilient in the passage of rather turbulent times, is the positive side of this institutional framework. Having endured the vagaries of social, political and economic turmoil, the Irrigation and Agriculture Departments have continued to manage (or more correctly, to administer) the massive irrigation systems and the related support systems for keeping large tracts of land under cultivation. Their sustainability demonstrated during more than a century is ample evidence of some of their positive aspects.

The complexity arose mainly from the size of the institutional framework, and the numerous additions which kept piling up on the base without much cohesion. Many sociopolitical changes also added disturbing influences in the form of informal social behavior to the rational base established during the authoritative colonial administration. The policymakers rarely had recourse to any meaningful research impulse from sociological and organizational studies, and could introduce only some ad hoc structural changes which were mostly for various project needs, but they were not fully capable of meeting the rigors of rapid changes in informal institutions. In this haphazard development, the institutional structures not only grew out of their

desired size and scope but also became largely irrelevant in the light of changing social demands. While the project-based institutions served the assigned project needs reasonably well, overall, the institutional framework as a whole gradually became outdated.

With the massive Indus Basin Project (IBP) task, major construction responsibility of the Provincial Irrigation Departments (PIDs) was shifted to the newly created WAPDA, which apparently caused considerable demotivation among PID engineers.⁶ However, the novelty itself prompted WAPDA to be more dynamic in terms of promoting, and gaining from, research. WAPDA established several new organizational units, not only for implementing specific programs but also for monitoring program performance. WAPDA was able to assert some planning discipline into the new "project-oriented" infrastructure development programs in which development assistance from various aid and finance agencies played an important role. WAPDA's Revised Action Program of 1979 stands out in many ways as a valuable policy instrument in Pakistan's irrigated-agriculture sector. However, this dynamism displayed by WAPDA does not appear to have permeated the rest of the sector; rather it has perhaps tended to polarize an opposite effect. In fact, at the outset, WAPDA has siphoned off the cream of human resources in the Provincial Irrigation Departments, weakening them considerably, and the net effect of this in terms of the low profile attached to system operation and maintenance can be seen to date.

Other sporadic structural changes included the creation of the On-Farm Water Management wing in the Provincial Agriculture Departments and the pilot Command Water Management organizations. In effect, they too appear to stand aloof from the overall institutional framework, and to serve only minimally to solve the larger aspect of the stagnancy problem. A much greater change in the policy attitudes is necessary to explore the costs and benefits of an overall institutional change in the irrigated-agriculture sector and to take quick and appropriate steps for establishing a cohesive institutional framework.

Even the recent policy planning effort of the Water Sector Investment Plan (1990), which can be described as a major policy contribution in recent times, is still inconclusive in terms of firm recommendations for institutional reform.

6 A 1981 Report of the Committee of Irrigation Engineers and Professors of the University of Engineering and Technology, Lahore, refers to the decline of the PIDs after this institutional change (Ali 1981).

The main report, and also the working paper by A. A. Abidi on institutional issues, have both tended to concentrate more on the institutional arrangements for planning processes. However, most problems relating to the implementation of investment projects, as well as to the operation and maintenance of physical systems, are widely known to be associated with a worsening situation with numerous institutional impediments which the WSIP should have addressed more thoroughly. The Report of the National Commission on Agriculture (1988) refers to the much needed coordination between agriculture and irrigation, and training and extension aspects but it does not extend beyond this to cover broad areas of institutional review either in the field of irrigated agriculture or in the irrigation subsector. Even the pilot-scale institutional coordination attempted in the Command Water Management projects is not among the issues to be pursued for further policy development.

The complex irrigation rules system having its basis in the Canal and Drainage Act of 1873 which has given rise to a range of administrative procedures, as well as the rigid organizational structures developed during the colonial period, both demand some modification that fits the changes which have taken place in the irrigated-agriculture environment. Changed personnel policies which suit the currently needed performance orientation, and which will be required by new management structures, can only be effected through higher-level policy support. Modernizing the institutional environment of irrigation management in Pakistan is a major challenge to policy.

SOME BLIND SPOTS IN POLICY AND RESEARCH

While being preoccupied with the pet projects and causing a relative neglect of institutional issues, the planners also seem to have neglected, mostly unintentionally, some important policy issues. The emphasis on resource-base enhancement as against on system maintenance and improved system management, and the preoccupation with production objectives as against a balanced view covering sustainable development are factors leading to this imbalance, and they seem to have contributed in some way to the present trend toward stagnancy in performance. Some facets of this policy neglect relate to a corresponding lack of research interests.

Regular Versus Deferred Maintenance

A question not adequately addressed by the research effort is whether the government budgetary policy for sustainable irrigated agriculture in Pakistan should be emphasizing on system maintenance or on sporadic major rehabilitation efforts. In the absence of an objective analysis of issues and trade-offs in regular and deferred maintenance, the policy has also been silent on the choices, and has continued to favor funding for major rehabilitation projects. The heavy component of investment in the watercourse improvement program in which lining tends to be the dominant activity (WSIP 1990: 4-10) seems to have been repeated in each new phase of the program without a clear justification from research findings.

Canal Lining

The lining strategy is now advancing to the distributary level. However, the strategy has no apparent research support and does not seem to originate from a clear policy. Results from IIMI's research are increasingly questioning the validity of the lining strategy. Representing the culmination of a long program of field research, a recent IIMI paper presented results which pointed toward the futility of pursuing the indiscriminate lining of canals and extolled the value of effective maintenance with disciplined operations of canals.⁷ The paper highlights some important policy implications. This is a good illustration of a research effort directly calling the attention of policymakers regarding the need to look at choices. More recently, evaluation studies on the rehabilitation projects have indicated that the "structural approach" of canal lining is costly and its impact on equity is very small, whereas, the "management approach" of mogha repair and monitoring is found to be a cost-effective method of improving equity (Gleason and Wolf 1993). Further empirical evidence may be necessary to generate a clear policy shift in this regard.

Waterlogging and Salinity

Another instance where conventional wisdom has not been seriously challenged by local research findings is the continued practice of bracketing

7 Edward J. Vander Velde and D. Hammond Murray-Rust. 1992. Impacts of physical managerial interventions on canal performance in Pakistan: A review of five years of field research studies. (mimeo). IIMI Pakistan, Lahore.

waterlogging and salinity together as the country's "twin menace" in irrigated agriculture. Despite the early observation by the Soil Survey of Pakistan (Choudhri 1977) that secondary salinity could occur as a buildup of high sodicity in nonsaline agricultural land irrigated with low quality tubewell waters, the assumption prevails that with the reduction of waterlogging the problem of salinity is also being largely solved. Though somewhat perceptive, the 1977 observation conveyed an important message to the policy-maker, and if it were explored through further research, a more rational view would have been possible on this crucial environmental issue. IIMI's recent research findings in Punjab reinforce this view with location-specific data, and draw the attention of the researchers as well as of policymakers to the disturbing pattern of increased salinity in canal command areas, which also increases with increasing distances from both the distributary and water-course heads (Kijne and Vander Velde in IIMI 1992). It is now left to the country's research network to consider these findings and validate the results for a larger area. This is an issue that directly relates to the sustainability of irrigated agriculture in Pakistan, and therefore, early research support may be necessary to promote some policies for appropriate remedial action.

Old Design Criteria

Similarly, the widening gap between the original design criteria and the present levels of system performance has been identified in much of the field research undertaken in Pakistan.⁸ The gap may be only partly filled by management improvements. The unbridged part of the gap may well be due to the "unmanageability" of the system in terms of all or some of the original criteria within the present resource structure and system-management requirements. A strategy aimed at filling this part of the gap obviously has to follow a review of the original criteria and the policies on which new criteria have to be based.

8 Preliminary results of IIMI's field research in Pakistan reveal that most of the design assumptions are invalid, or the present canal performance does not confirm to the design assumptions. See Vander Velde (1991).

Equity Criterion

Among these original design criteria which demand greater inputs from research for consideration of appropriate change, is the equity criterion in irrigation management. The norms of equity formulated several decades ago, have formed the basis for most departmental regulations and procedures which still continue to be formally recognized, though less observed now than in their early days.⁹ Over the years, the social acceptance of the concept of equity and its associated norms might have changed but not only policy even the research on system performance continues to be based on the original assumptions. Sampath (1988) poses several interesting questions to the researcher, which he has to answer clearly, before the issue of equity in irrigation is studied. One important question is how to understand "certain axioms or norms that have been accepted as reflecting properly the ethical judgments with regard to the equity principles." Specifically highlighted is the need to understand the goals and objectives of projects and the nature and social structure of the beneficiary groups, as a critical initial step before studying the equity criterion. The difficult question as to why, not only equity, but even efficiency in irrigation service delivery is not achieved in practice as desired, is most likely to be related to some exogenous factors in the larger socioeconomic context of irrigation. This prompts the researcher to study institutions as closely as other aspects of system performance.

There is generally a widespread feeling that the concern on equity criterion in Pakistan's irrigation is on the decline. Some form of acknowledgement of this trend was expressed at a "retreat" workshop held last year by IIMI for the senior officials of the Punjab Irrigation Department and some Federal agencies including WAPDA. The aberrations in the warabandi practices, the influence of large landowners in almost all aspects of irrigated agriculture, the indifferent attitude among the tenants toward improved performance, the persistent illiteracy rates among the rural people, and generally the problems of distributary justice, seem to characterize this decline in the application of the equity principle. Equity in itself may be a major determinant of sustainability of irrigation systems and their contribution to sustained agricultural production. In the selected seven programs outlined above as case illustrations, the equity criterion has escaped the attention of both research and policy. The need for research and policy to interact closely on the issue

⁹ The static nature of the institutional framework for irrigation in Pakistan has been analyzed in an earlier paper. See Bandaragoda and Firdousi (1992).

of equity seems to be critical in ensuring sustainability of irrigated agriculture in Pakistan.

Economic Implications

The "inadequacy theory" mentioned earlier as a commonly perceived reason for Pakistan's low performance contained a reference to the scarcity of good quality land and water. In Pakistan, this scarcity is associated with salinity, a major problem closely being linked with irrigation. To what extent has research contributed to solve this problem? While research has so far helped to identify the problem, its scope and character, and to provide estimates of its effects on land and water resources, research has so far not clearly isolated the effect of salinity in soil, and water on crop productivity, in technical and economic terms. Thus, while the problem has remained at the level of active discussion, the related policy and management actions taken so far appear to have only resulted in reclamation of some land for crop production, but not in addressing the critical issue of stagnant productivity in terms of both unit of land and unit of water. As early as the mid-1970s, the researchers identified secondary salinization as "a cause of great concern" and the need to quantify the economic loss due to this problem (Choudhri 1977), but to date, no clear analysis has been made of the economic implications of the problem.

This brings us to an important issue connected with research-policy linkage. For any researchable problem, including salinity, it is the reference to economic implications of the problem and its solutions in the final analysis that attract the policymaker's mind. In many an instance, where commendable research efforts have not been able to generate sufficient policy support as desired, the absence of an economic sense in the final results may have been the missing link.

Political Implications

Research is associated with the high value it gives to objectivity. Following this notion, most research efforts have a tendency to give a low value to political implications of their work, assuming, understandably, the subjective nature of political action. Whether the objectivity of research can be retained or not, while having to treat research results through a political sieve, is in itself, a debatable issue which is beyond the scope of this presentation. However, what is pointed out here is that the lack of such consideration in research recommendations often makes them stay aloof from policy. The

location of facilities (dams, barrages, reservoirs and canals), and distribution of benefits (water allocation to different regions and water distribution methods)¹⁰ are mostly technical decisions, but of significant political value. Similarly, the socioeconomic decisions relating to recovery of costs and collection of revenue (abiana, agricultural tax and collection methods) obviously have important political implications. Along with these, the fixing of economic incentives (subsidies and pricing policies), allocation of resources (for operation and maintenance, as well as, for further development), and provision of a new legal, procedural and structural outlook in the institutional framework are some of the major policy measures which can significantly affect irrigated-agriculture performance,¹¹ but which need to be developed and implemented with their political implications in mind. On the other hand, should not the need to promote viable research results for solving the problem of sluggish performance be of serious political concern?

In linking research with policy, the process has to include some element of policy analysis as well. Policy analysis is best achieved by an integration of inputs from several disciplines including public administration and political science. Yehezkel Dror (1967) considers this integration to be in the form of a compound rather than a mix, a real synthesis rather than an eclectic collection of unconnected items. The emphasis is not on the need to enhance the available research resource structure but on the need to draw from the relevant decision-making processes both within and outside irrigation systems and relate political, managerial and technical inputs together into a wholesome package of realistic suggestions for innovative application. Dror compares some features of systems analysis, as applied in the US public service, with policy analysis which he recommends as an improved method of dealing with the government decision-making process. Although in his case, systems analysis has been seen particularly in the context of government agencies with emphasis on resource allocation, his arguments for adopting a more flexible analytical approach to cover political decision-making processes are very relevant to public irrigation management.

10 Chaudhry and Young (1987) illustrate the possible analysis of this subject to highlight its policy implications.

11 Pakistan Economic Analysis Network Project has produced several papers on irrigation policy issues relating to cost recovery, resource allocation for operation and maintenance and also economic incentives related to the irrigated-agriculture sector. See M. A. Chaudhry (1988).

It is acknowledged, however, that a broad-based review by the researchers and an objective treatment of issues by the policymakers are equally difficult tasks. In introducing a guide which was meant to be developed as equally valid for the scientist as for the policymaker, Mark Mitchell (1985) highlights this difficulty as:

...It has proved no easy matter to walk the tightrope between the more academic stance of the analyst who needs a portfolio of theory, concepts, analytical techniques and subject matter expertise, and the more practical needs of the decision maker who must embrace political realities, take account of the uncountable, reconcile conflicting factions, weigh the uncertainties and, hardest of all, finally choose and accept responsibility for his choice.

CHAPTER 5

Conclusion: Lessons from Pakistan's Experience

ONE EXEMPLARY FEATURE of Pakistan's irrigated-agriculture sector is the series of attempts made during the postcolonial period to add to its strong institutional base inherited from the colonial administration. Particularly, Pakistan's effort to strengthen its project planning mechanisms is commendable. These mechanisms appear to have served well in planning a number of infrastructure projects in the IBP replacement program, and many subsequent water-related projects. An important lesson which Pakistan seems to offer in this context, however, is that the overenthusiasm for, and the preoccupation in, infrastructure development can cause important operation and maintenance activities to be neglected in the process. During a stage when the larger part of the national development effort is spent on improving physical systems, special attention needs to be paid to modernizing the institutional and managerial systems entrusted with the more difficult tasks of operating and maintaining the improved physical systems. Relative to the positive side of institutional development for resource-base expansion, Pakistan has been conspicuous in neglecting the institutions for system operation and maintenance, and related performance-improvement aspects.

Pakistan's effort to establish a wide network of research institutions in the irrigated-agriculture sector is also noteworthy. However, the lack of coherence in this institutional setup corresponds significantly to the difficulty of coordinating the extensive research work being conducted by the various units. The absence of a single authority to coordinate this research work, which has been highlighted in WSIP (1990) as a major impediment to make this research effort productive for policymaking, should be seen as presenting a valuable lesson to other developing countries embarking upon establishing similar institutions for research.

The specific lesson that may be extracted from Pakistan's experience about the fragmented and uncoordinated research and policy institutional framework that the country has come to possess is the case it makes for a clearly articulated research-based policy statement for irrigated agriculture in

any developing country. When such a clear policy forms an integral part of the overall national policy, it can then guide the irrigation-related developmental projects and programs during both their formulation and implementation stages. The individual projects and programs can all be gainfully interlinked and be directed toward achieving a specified set of social goals. This irrigated-agriculture policy will be as comprehensive, as it can cover the requirements that go into the effective implementation of the policy so defined, such as the research needs, institutional changes, resources, appropriate technological inputs, operational requirements and an overall appreciation of the sustainability of resource use.

Extrapolating from Pakistan's experience, some general observations can also be made, which may be applicable to other similar developing countries. One important issue is the relevance of many political decisions regarding the choice of emphasis of social goals and objectives which their irrigation-related policy instruments, often implicitly, seek to achieve.¹² Should resources be continuously and entirely used for physical infrastructure without considering what such exclusive use does in terms of increased production or in terms of equitable distribution of benefits? Should the rate of return be the sole criterion for appraisal of irrigation-related development projects? Should irrigation water be considered a public good or a tradable commodity? Many such questions arise from Pakistan's experience. Higher-level policy is needed to clarify most of these questions and whether the emphasis of irrigation development should be for new settlements, increased agricultural production, employment generation, poverty alleviation, or food security, or any other goal, or any combination of such goals. Generally, the choice of social goals is linked with the ideological basis of a given society and its socioeconomic priorities, and can best be articulated and decided at the political level. This requires the goals of irrigation to be considered in a wider context of the overall sociopolitical milieu in which many other sectoral priorities and influences also have a role to play, and the

12 Generally, not much attention has been given to possible social goals of irrigation, relative to its various criteria of performance. As a pleasant exception, Robert Chambers (1983 and 1988), deals extensively with the potential for the poor that canal irrigation seems to offer. He contrasts production-thinking with livelihood-thinking where irrigation is assessed in terms of secure livelihoods it generates and sustains, putting anti-poverty effects and people before production per se.

resultant decision invariably becomes a coalition of interests of different segments of the society.

Irrigation systems within a country usually cover an extensive geographical area and overlap with several different units: social, regional, administrative and agroclimatic. They involve a large number of government controlled operators and a much larger number of beneficiaries dependent on them. Thus, the size and complexity of the irrigation sector in a country and its role in the country's economy would determine, and in turn would be fashioned by, the extent and nature of political attention on irrigation. Among the beneficiaries is a large percentage of low-income earners on whose behalf the continued state intervention on irrigated agriculture is often advocated. Considering these aspects, a comprehensive planning exercise in which research provides sufficient inputs to form clear policies for irrigated agriculture is seen as important as the planning for any other sector in a country's socioeconomic system, particularly if the country has to depend substantially on sustainable irrigated agriculture.

RECOMMENDATIONS

Based on the conclusions arrived at in this paper, the following specific recommendations are presented:

1. It is essential that a comprehensive policy for the irrigated-agriculture sector is generated soon in the context of the country's overall development needs. In preparation of this policy, functional and institutional complementarities between irrigation and agriculture, and between research and policy should be recognized. The policy statement should be the basis for future projects and programs aimed at improving the performance of the irrigated-agriculture sector.
2. Emphasis of research and policy interests in irrigated agriculture at this stage should shift from expanding the resource base to resource management aspects including operation and maintenance of irrigation systems (physical), modernization of management conditions (institutional), equitable delivery of services and greater beneficiary participation in decision making (social), increasing productivity of present production systems (economic), and being concerned about the long-term sustainability of the resource base (environmental and financial).

3. There should be greater attention by both research and policy on the possible institutional changes required for improved performance.
4. Mechanisms should be developed to coordinate the Federal and Provincial agencies involved in each of the research and policy functions in irrigated agriculture so that there could be coordinated efforts in linking research with policy.
5. Research on resource management problems should necessarily deal with the economic implications of the problems as well as of the alternative solutions to such problems. Incorporation of economic analyses in research recommendations will increase their likelihood of being accepted by policymakers.
6. Similarly, a recognition of the political sensitivity of issues relating to irrigated agriculture will enhance policy recognition of research recommendations. This should be an important consideration in linking research with policy.

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Annex 1. Chronological Sequence of Canal Construction in Pakistan.

Canal	Diversion site	River	Year	CCA (M. acres)	Cumulative CCA (M. acres)
1. Central Bari Doab	UCC/BRBD	Chenab	1859	0.649	0.649
2. Sidhnai	Sidhnai	Ravi	1886	0.869	1.518
3. Lower Swat	Munda	Swat	1890	0.182	1.7
4. Kabul River	Below Warsak	Kabul	1890	0.048	1.748
5. Jamrao	Jamrao Head	East Nara	1899	1.748	
6. Lower Chenab	Khanki	Chenab	1892	3.03	4.782
7. Lower Jhelum	Rasul	Jhelum	1901	1.500	6.282
8. Paharpur	Chashma	Indus	1909	0.104	6.386
9. Upper Chenab	Marala	Chenab	1912	1.441	7.827
10. Lower Bari Doab	Balloki	Ravi	1913	1.670	9.497
11. Upper Jhelum	Mangla	Jhelum	1915	0.544	10.041
12. Upper Swat	Amendra	Swat	1915	0.398	10.439
13. Eastern Sadiqia	Suleimanki	Sutlej	1926	0.969	11.408
14. Pak Pattan	Suleimanki/Islam	Sutlej	1927	1.049	12.457
15. Fordwah	Suleimanki	Sutlej	1927	0.426	12.883
16. Qaimpur	Islam	Ravi/Chenab	1927	0.043	12.926
17. Bahawal	Mailsi/Bahawal	Ravi/Chenab	1927	0.605	13.531
18. Upper Depalpur	UCC/BRBD	Chenab	1928	0.360	13.891
19. Lower Depalpur	Balloki/Suleimanki	Ravi	1928	0.615	14.506
20. Mailsi	Sidhnai/Mailsi	Ravi/Chenab	1928	0.996	15.502
21. Panjnad	Panjnad	Sutlej	1929	1.348	16.85
22. Abbasia	Panjnad	Sutlej	1929	0.154	17.004

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23. North West	Sukkur	Indus	1932	1.215	18.219
24. Rice	Sukkur	Indus	1932	0.519	18.738
25. Dadu	Sukkur	Indus	1932	0.584	19.322
26. Khairpur West	Sukkur	Indus	1932	0.417	19.739
27. Rohri	Sukkur	Indus	1932	2.561	22.3
28. Khairpur East	Sukkur	Indus	1932	0.373	22.673
29. Eastern Nara	Sukkur	Indus	1932	2.476	24.849
30. Rangpur	Trimmu	Chenab	1939	0.344	25.193
31. Havali	Trimmu	Chenab	1939	0.179	25.379
32. Thal	Kalabagh	Indus	1947	1.641	27.013
33. Pinyari	Kotri	Indus	1955	0.758	27.771
34. Fuleli	Kotri	Indus	1955	0.923	28.694
35. Lined Channel	Kotri	Indus	1955	0.502	29.196
36. Kalri Baghar	Kotri	Indus	1955	0.592	29.788
37. M. R. Link(Int)	Marala	Chenab	1956	0.158	29.946
38. D. G. Khan	Taunsa	Indus	1958	0.909	30.855
39. Muzaffargarh	Taunsa	Indus	1958	0.809	31.664
40. Pat	Gudu	Indus	1962	0.747	32.411
41. Desert	Gudu	Indus	1962	0.328	32.739
42. Begari	Gudu	Indus	1962	1.002	33.741
43. Ghotki	Gudu	Indus	1962	0.858	34.599
44. CRBC Stage-I	Chashma	Indus	1986	0.140	34.739

(UCC/BRBD - Upper Chenab Canal/Bambawala Ravi Bedian Depalpur.)

Sources: WAPDA, 1979; and Federal Planning Cell (WSIP), 1990.

Annex 2. The Institutional Framework in Pakistan's Irrigated-Agriculture Sector.

Irrigation-related intervention	Policy/Planning	Design and construction	Operation & maintenance	Research
<i>Water acquisition</i> River diversion, reservoir Small dams	ECNEC, CDWP, DDWP MWP, MAFC	WAPDA PID	WAPDA PID	MWP (WAPDA) MAFC(PARC, NARC)
<i>Water distribution</i> Main canal Distributary Minor	PC, MF PDWP, WAPDA PP&DD, PID, PAD	WAPDA PID	WAPDA PID	MST(PCRWR, NADLIN) ME(Universities, CEWRE) PID (IRI)
<i>Water use</i> Watercourse Field	PP&DD PAD, PID Farmers	PAD (OFWM) Farmers' Groups Farmers	Farmers' Groups Farmers	WAPDA (WMED, Mona, LIM) Universities NARC, IWASRI, PCRWR PAD(RRI, ARI) PID (DLR)
<i>Water disposal</i> Field drainage Drains (Surface and subsurface) Outfall	Farmers, PAD PP&DD, PID WAPDA	Farmers, PID WAPDA	Farmers, PID WAPDA (SCARPs)	IWASRI, SMO PCRWR(DRIP) Mona, LIM Universities

- Notes :
- CDWP = Central Development Working Party
 - CEWRE = Centre of Excellence in Water Resources
 - DDWP = Departmental Development Working Party
 - DLR = Directorate of Land Reclamation
 - DRIP = Drainage and Reclamation Institute of Pakistan
 - ECNEC = Executive Committee of the National Economic Council
 - IRI = Irrigation Research Institute
 - IWASRI = International Waterlogging and Salinity Research Institute
 - LIM = Lower Indus Water Management and Reclamation Research Institute
 - MAFC = Ministry of Agriculture, Food and Cooperatives
 - ME = Ministry of Education
 - MF = Ministry of Finance
 - Mona = Mona Reclamation Research Project

MST	=	Ministry of Science and Technology
MWP	=	Ministry of Water and Power
NADLIN	=	National Documentation Centre, Library and Information Network (on Water Resources)
NARC	=	National Agriculture Research Centre
NESPAK	=	National Engineering Services of Pakistan
OFWM	=	On-Farm Water Management
PAD	=	Provincial Agriculture Department
PARC	=	Pakistan Agriculture Research Council
PC	=	Planning Commission
PCRWR	=	Pakistan Council for Research on Water Resources
PDWP	=	Provincial Development Working Party
PID	=	Provincial Irrigation Department
PP&DD	=	Provincial Planning and Development Department
RRI	=	Rice Research Institute
SMO	=	SCARP Monitoring Organization
WAPDA	=	Water and Power Development Authority
WMED	=	Watercourse Monitoring and Evaluation Directorate

Annex 3. Major Policy Initiatives in Pakistan.

Policy initiatives	Time periods	Rationale	Positive effect	Negative effect
Public sector groundwater development in canal commands	Early 1960s to the late 1970s	<p>The policy became explicit only after the team of foreign experts appointed by the US President advocated massive groundwater development in the public sector. Initially, the emphasis was made on vertical drainage in fresh groundwater areas with the pumped water providing an irrigation supplement.</p> <p>Public-sector involvement was advocated to achieve planned growth, optimum use of water resources and equity.</p>	<p>Impact on drainage, increased irrigation supplies and cropping intensities.</p> <p>Demonstration effect spurring private groundwater development exceeding public effort.</p>	Lack of consideration to financial aspect and to farmer involvement, coupled with bureaucratic control, made the policy ineffectual leading to a reversal.
Watercourse improvement with farmer participation	Early 1970s to the present	Realization, based on work by Colorado State University study team, that sizeable losses of water took place in the watercourses below the outlet.	Immediately perceived benefits created a great demand and public support for the program.	The WUAs formed to get the improvements effected, did not prove to be viable. As subsequent maintenance suffered, benefits tended to be marginal.

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Private sector groundwater development and dis-investment in public groundwater development	Early 1980s to the present	Demonstrated efficiency of the private sector versus inefficiency in the public sector. Lack of financial sustainability of public operation, due to the low cost recovery rates.	Private-sector growth continued.	Clouded the issue of canal water management. Disinvestment has been slow due to fear of likely adverse political effects.
Integration of irrigation and agriculture activities in discrete areas (Command Water Management)	Early 1980s to the present	Realization of the lack of complementarity of water and non-water inputs due to lack of coordination between irrigation and agriculture agencies.	Substantial impact on project implementation.	Has not resulted in stable institutional mechanisms.
Water charges adequate to recover O&M costs of the irrigation services	Early 1980s to the present	Pressure from the lending agencies.	Marginal increases in water rates.	Overall lack of enthusiasm.
Interprovincial allocation of water resources	Early 1960s to the present	Pressure from provinces and evaluations from donors.	Water accord reached by Council of Common Interests.	
Demand-based irrigation	Late 1980s	Realization of the lack of productivity in the supply-oriented system.	Local interest to find out more about it.	Lip service to "demand-based irrigation."

Annex 4. Agreements and Committees on Interprovincial Water Allocation.

- * **Sutlej Valley Tripartite Agreement (1920)** — reached by Punjab, Bahawalpur and Bikanir States at the request of the Government of India, on the distribution of waters of Beas-Sutlej rivers. On the basis of this agreement, the Sutlej Valley Project was sanctioned in 1921. Sukkur Barrage Project was sanctioned in 1923.
- * **Indus Discharge Committee** — set up by the Government of India for scrutinizing and compilation of hydrological data from sites along the Indus and its tributaries, to help in the assessment of projects and resolving the disputes regarding water distribution.
- * **Sutlej Valley Project Enquiry Committee (1932)** — set up to go into the question of shortage of supplies for the Sutlej Valley Project as against its design assumptions.
- * **Anderson Committee (1935)** — set up under the Central Board of Irrigation, Government of India, to examine and report on proper distribution of water for the Sutlej Valley Project, Sukkur Barrage Project and other projects proposed by Punjab. Based on its recommendations several important decisions were taken in 1937.
- * **Rau Commission (1941/42)** — appointed under Justice B. N. Rau by the Government of India to consider Sindh's complaint in 1939 regarding the effects of the Punjab projects on the inundation canals of Sindh ("The Kharif Case") and the subsequent complaint regarding the effect on Sukkur Barrage Canals ("The Rabi Case").
- * **Sindh-Punjab Draft Agreement (1945)** — based on the findings of the Rau Commission Report submitted in 1942.
- * **Indus Waters Treaty (1960)** — signed between India and Pakistan, entitling India to the exclusive use of the water supplies of the Eastern Rivers (Ravi, Beas and Sutlej), and Pakistan to the supplies of Western Rivers (Indus, Jhelum and Chenab) with the exception of insignificant local uses specified in the Treaty. A system of inter-river link canals and storage reservoirs were to be constructed within a 10-year period, to provide an alternative source of water supplies to Pakistan canals offtaking from the Eastern rivers. Under transitional arrangements specified in Annexure H of the Treaty, historical Eastern River supplies were to be gradually reduced to the extent of replacing them through the Indus Basin Project, subject to the availability of surplus water on the Chenab, Jhelum and the Indus.

- * **Water Allocation and Rates Committee (1968-70)** — constituted by the Governor, West Pakistan (one unit) under the Chairmanship of Mr. Akhtar Hussain in May 1968 to review barrage water allocations, reservoir release patterns, drawdown levels and the use of groundwater in relation to surface water deliveries.
- * **Justice Fazle-Akbar Committee (1970)** — set up by the Government of Pakistan vide its Resolution dated 15/10/70 to recommend apportionment of waters of the Indus and its tributaries considering: existing water allocations of the four Provinces, the consequences of the Indus Waters Treaty 1960, availability of groundwater and its coordinated use with flow supplies, and the reasonable water requirements of the Provinces for agricultural, industrial and urban uses. The Report was presented to the Government in 1971.
- * **Commission of Chief Justices of Provinces under the Chairmanship of the Chief Justice of the Supreme Court of Pakistan (1977)** — appointed by the Government of Pakistan to examine the issue of water apportionment.
- * **Inter-Provincial Water Accord signed on 16 March 1991**, by the Chief Ministers of the four Provinces and four accompanying Ministers and four senior officials representing the four Provinces.

Sources: Water Sector Investment Plan (1990-2000) — Vol I, Federal Planning Cell, Lahore, October 1990, and copy of the Accord of 16/3/91.