Report No. 16840

Pakistan
Impact Evaluation Report

Scarp Transition Pilot Project (Credit 1693-PAK)

June 30, 1997

Operations Evaluation Department

Document of the World Bank

Currency Equivalents (annual averages)

Currency Unit = Pakistani Rupee (PRs)

1985	US$1.00	PRs 15.9
1986–90	US$1.00	PRs 18.9
1992	US$1.00	PRs 25.0

Abbreviations and Acronyms

ADBP	Agricultural Development Bank of Pakistan
ERR	Economic rate of return
FAO/CP	Food and Agricultural Organization of the United Nations/ World Bank Cooperative Program
IDA	International Development Association
IFPRI	International Food Policy Research Institute
IIMI	International Irrigation Management Institute
M&E	Monitoring and evaluation
NGO	Nongovernmental organizations
NPV	Net present value
O&M	Operations and maintenance
ODA	Overseas Development Agency
OED	Operations Evaluation Department
PCR	Project Completion Report
PERI	Punjab Economic Research Institute
PID	Provincial Irrigation Department
RAP	Pakistan's Revised Action Plan for Irrigated Agriculture
SCARP	Salinity Control and Reclamation Project
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WAPDA	Pakistan Water and Power Development Authority

Fiscal Year

Government: July 1–June 30

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Office of the Director-General
Operations Evaluation

June 30, 1997

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Impact Evaluation Report on Pakistan: SCARP Transition Pilot Project (Credit 1693-PAK)

Attached is an impact evaluation report (IER) on the SCARP Transition Pilot Project (Credit 1693-PAK) in Pakistan. The credit of US$10 million was approved in FY86 and closed in FY92. The evaluation is based primarily on the findings of a series of surveys, some commissioned by the Operations Evaluation Department (OED), carried out by the Punjab Economic Research Institute (PERI) from 1989 to 1995 that focus on the project's impact on beneficiaries and the environment. It is also based on a review of Bank files, including project completion and audit reports, field visits to the project site, and interviews with beneficiaries and Government and Bank staff. OED's evaluation team made three visits to Pakistan and discussed the pilot project with farmers, central and provincial government officials, PERI, researchers from the International Irrigation Management and International Waterlogging and Salinity Research Institutes, and representatives from nongovernmental organizations.

The Salinity Control and Reclamation Projects (SCARPs) were initiated in the 1960s to address Pakistan's drainage problem and to supplement irregular supplies of canal water. The SCARP projects are part of a long struggle to deal with the twin problems of waterlogging and salinity that are the side effects of this semi-arid country's heavy dependence on irrigation. For two decades, the SCARP public wells did their job well. However, increasingly problematic operation and maintenance and rapidly rising costs made the SCARP wells an unsustainable financial burden on the government.

The SCARP Transition Pilot project was designed to alleviate these problems in fresh groundwater areas by transferring responsibility for drainage and irrigation from the public to the private sector. The project's objectives centered around decommissioning 213 public SCARP wells and replacing them with 2,100 private wells, providing electrical supplies for private well operation and improvements to minor irrigation canals. The project covered about 46,000 ha of irrigated land and about 11,500 farm families in north-central Punjab Province. Fifty percent of project cost was for electrification. Actual project expenditures were only 68 percent of appraisal estimates primarily because private wells were installed at only a third of the estimated cost and electrical power load management was canceled. Even so, installed private well capacity exceeded irrigation requirements.

The evaluation estimated the ERR for the pilot at 18 percent compared to an appraisal estimate of 23 percent. While there were substantial investment savings, the ERR is primarily a reflection of the savings to government from shutting down public wells. Net agricultural productive gains due to the project were small because private wells were installed independently of the pilot. Well ownership inthe pilot area increased from 52 percent of farms in 1989 to 82 percent in 1994. The effects of the project on

equity were not negative, as had been anticipated, but mildly positive. Benefits were relatively well distributed because of the market that developed for private well water. Although project actions to foster group ownership of wells were ineffective, water buyers were able to achieve substantially the same farming results as well owners.

The outcome of the project is satisfactory. The project's ambitious institutional objectives were fully achieved. Responsibility for groundwater-based irrigation and vertical drainage was successfully transferred to the private sector without the angry demonstrations that had been anticipated. Despite having to absorb irrigation and drainage costs, farmers were able to increase their productivity enough to come out ahead. The impact evaluation rates the project's sustainability as likely. With increased groundwater irrigation, secondary soil salinity increased, but farmers were able to keep it to agronomically acceptable levels. While the water table has thus far remained stable, there is no guarantee that this result can be maintained with thousands of farmers operating pumps independently. Great care has to be taken in selecting appropriate regulatory instruments and the evaluation suggests that differential water pricing may be the least harmful.

The main lesson from this pilot project is that Pakistan and the Bank lost an early opportunity to save significant operations and maintenance expenditures because they hung onto the public sector SCARP model for too long. From inception of the idea for a transition project in 1980, it took more than a decade to prove it would work. In preparing the follow-on Privatization of Groundwater Development project, both the Bank and the borrower are mindful of the lessons of the SCARP Transition Pilot project and of its on-going sequel, the Second SCARP Transition project. General subsidies for private well investment have been eliminated as unnecessary, as have electricity subsidies, which skew the choice among diesel, electric, and tractor-powered pumping (most farmers opt for diesel). The new project is expected to focus its promotional efforts exclusively on community-owned wells rather than a large number of underutilized individually owned wells, because the community wells will provide the greatest social benefits.

Attachment

Contents

This report was finalized by G.T. Keith Pitman (Task Manager). It is based on a draft report prepared by William I. Jones. The report draws on field surveys carried out by the Punjab Economic Research Institute under the direction of Muhammad Jameel Khan and Shaukat Ali Shahid (consultants). Emily Chalmers edited the report. Constance Frye and Michael Dineen provided administrative assistance.

Annexes

Figures

Tables

Boxes

Maps

Preface

The Salinity Control and Reclamation Projects (SCARPs) were initiated in the 1960s to address Pakistan's ongoing drainage problem and to supplement often irregular supplies of canal water. The SCARP projects were part of a decades-long struggle to deal with the twin problems of waterlogging and salinity that are the side effects of this semi-arid country's heavy dependence on irrigation. For two decades, the SCARP public tubewells did their job well, but in the 1980s they began to fail because of increasingly problematic operation and maintenance. Pumping declined significantly, and rapidly rising costs made the SCARP tubewells an unsustainable financial burden on the government.

The SCARP Transition Pilot project was designed to alleviate these problems by transferring responsibility for drainage and irrigation to the farmers themselves. Farmers in fresh groundwater areas had already begun installing their own shallow tubewells to improve irregular water supplies. The pilot provided assistance (including electrical hookups) to farmers in order to encourage the construction of private tubewells. It also aimed to address the issues that arose naturally from the project's central objective of shifting a public sector burden to the private sector: cost-effectiveness, equity, sustainability (including operation and maintenance), and potential agricultural and environmental impacts.

This Impact Evaluation Report is based primarily on a series of surveys carried out by the Punjab Economic Research Institute (PERI) from 1989 to 1995 that focus on the project's impact on beneficiaries and the environment. PERI questioned farmers within the project area and a control group of nonproject farmers, revisiting the same samples each time (the control group was changed slightly to more accurately reflect the nonproject area). Three Operations Evaluation Department (OED) missions to Pakistan in the period 1993–96 also held discussions about the pilot project with farmers, central and provincial government officials, researchers from the International Irrigation Management and International Waterlogging and Salinity Research Institutes, and representatives from nongovernmental organizations. The final mission produced an extensive draft report that drew on earlier OED reports and documents. This impact evaluation, which is based on the report, addresses the major issues raised by the SCARP transition concept.

Copies of the draft Impact Evaluation Report were sent to the borrower and its executing agencies for comments, and these are attached in Annex B. Where appropriate the text has been changed to reflect these comments.

Basic Data Sheet

SCARP TRANSITION PILOT PROJECT (CREDIT 1693-PAK)

Key Project Data *(amounts in US$ million)*

	Appraisal estimate	*Actual or current estimate*	*Actual as % of appraisal estimate*
Total project costs	21.8	14.87	68
Credit amount	10.0	6.1	61
Cofinancing			
Government of Pakistan	6.6	7.3	111
Farmers and banks	5.2	1.5	29
Cancellation	—	SDR 4.14	
Economic internal rate of return	23	n.a.	
Institutional performance		substantial	

Cumulative Estimated and Actual Disbursements

	FY87	*FY88*	*FY89*	*FY90*	*FY91*	*FY92*	*FY93*
Appraisal estimate (US$M)[a]	2.6	6.7	8.8	9.7	10.0	-	-
Actual (US$M)[b]	1.9	2.7	3.9	4.3	6.5	6.6	6.1[c]
Actual as % of appraisal	73	40	44	44	65	66	61

Date of final disbursement: January 19, 1993[d]

Project Dates

	Original	*Actual*
Identification	02/82	1982
Appraisal	10/83	06/85
Negotiation	06/84	03/11/86
Board approval	09/84	05/08/86
Credit Signature	n.a.	05/28/86
Credit Effectiveness	01/85	10/08/86
Closing date	n.a.	06/30/92
Credit Completion	n.a.	03/30/96[e]

Staff Inputs (staff weeks)

	FY81-88	*FY89*	*FY90*	*FY91*	*FY92*	*FY93*	*Total*
Preappraisal	65.0	—	—	—	—	—	65.0
Appraisal	41.1	—	—	—	—	—	41.1
Negotiations	8.4	—	—	—	—	—	8.4
Supervision	45.2	12.6	7.8	8.7	16.6	6.9	97.8
Other	12.6	—	—	—	—	—	12.6
Total	172.3	12.6	7.8	8.7	16.6	6.9	224.9

Mission Data

	Date (month/year)	*No. of persons*	*Staff days in field*	*Specializations represented* [f]	*Performance rating* [g]	*Type of Problem* [h]
Identification	n.a.	n.a.	n.a.	n.a.	—	—
Preparation 1	05/83	3	11	EC,AG,EN	—	—
Preparation 2	08/83	1	17	EC	—	—
Preparation 3	12/83	3	12	EC,Ag,EN	—	—
Preparation 4	03/84	1	n.a.	EN	—	—
Appraisal	06/85	5	n..a.	AG,EN(3),LW	—	—
Supervision 1	11/86	2	5	EC,EN	1	—
Supervision 2	04/87	2	9	EC,EN	2	M(2),I
Supervision 3	10/87	2	15	EC,EN	2	M(2),I
Supervision 4	03/88	2	11	EC,EN	2	M(2)
Supervision 5	01/89	2	12	EN(2)	2	M(2)
Supervision 6	02/90	4	8	EN(3),EC	2	M(2)
Supervision 7	10/91	1	9	EN	2	M(2), L(2),F(2)

a. President's Report, April 1986.
b. IDA Records.
c. Decrease due to refund of amount outstanding in Special Account.
d. The final application (No. 26-P, received October 29, 1992) was erroneously returned to the Borrower and resubmitted in December 1992.
e. The credit account was kept open beyond the closing date to accommodate final disbursement applications (four months and pending refund of the outstanding amount in WAPDA's Special Account).
f. EC = Economist; AG = Agriculturist; EN = Engineer; LW = Lawyer.
g. 1 = No significant problems; 2 = Moderate problems.
h. M(2) = Project management, moderate problems; I(2) = Project impact, moderate problems. L(2) = Compliance with legal covenants, moderate problems, F(2) = Availability of funds, moderate problems.

Other Project Data

Borrower/Executing Agency:

FOLLOW-ON OPERATION			
Operation	*Credit no.*	*Amount (US$ million)*	*Board date*
Second SCARP Transition Project	2257	20	06/04/91
Punjab Private Sector Groundwater Development Project	2901	56	07/11/96

Executive Summary

1. Pakistan depends heavily on irrigation. Its irrigation system, which dates from the nineteenth century, is one of the largest contiguous systems in the world. Despite the extensive irrigation, however, the country faces two ongoing problems—salinity and waterlogging—that have come to be known as Pakistan's "twin menaces." Annually, they reduce production on millions of hectares of farmland, put large tracts out of production altogether, and jeopardize the system's integrity.

2. The problem of salinity is all the more serious because the groundwater in the Indus basin is saline except where the fresh water of the Indus and its tributaries has refreshed it over the millennia. Furthermore, the irrigated area is extremely flat and, without proper drainage, prone to waterlogging. The problem of adding irrigation water to groundwater is accentuated when the irrigation water supply must be increased to leach salts or when farmers overirrigate to compensate for an unreliable system (or in response to artificially cheap irrigation water).

3. Attacking the twin menace is a massive undertaking, and the IDA's assistance is only a small part of the effort. The IDA has made 27 irrigation loans or credits to Pakistan for a total of US$1,305 million. Nine of these, or US$457 million, were principally for drainage to control salinization and waterlogging. Nevertheless, the problem is far from solved, and Pakistan continues to lose almost as much irrigated land each year as it gains from investments.

4. There are three potential solutions to this problem. The traditional *vertical* approach, dating from 1958, uses a network of large, deep public tubewells to lower the water table. Where the groundwater thus pumped is suitably fresh, it is used for irrigation and household purposes. Where it is saline, it is dumped into rivers or evaporation ponds. Where it is brackish, it is mixed with fresher surface water and used for irrigation. This approach was embodied in Pakistan's Salinity Control and Reclamation Projects (SCARPs), which were financed with local resources and a variety of external financing, including IDA funds.

5. The second approach—*horizontal* drainage—was piloted by an IDA-financed project (Khairpur Tile Drain, Credit 648, approved FY76) and promoted by two more (SCARP Mardan, Credit 877, approved FY79; and Fourth Drainage, Credit 1375, approved FY83). Although this approach generally uses open drains, the flat Indus basin requires subsurface tile drains. The investment cost of tile drainage is roughly three times that of its vertical competitors, but its operating costs are much lower, as are the volume and salinity of the effluent pumped.

6. The *SCARP Transition Pilot Project* represents the third approach. It was supported by an IDA credit for SDR 8.7 million (US$10 million). Although the vertical SCARP tubewells had been highly successful at lowering the water table and reducing soil salinity, they were an unsustainable burden on the government's budget. The costs of operating and maintaining the wells were substantial, and the government did not recoup these expenditures from the farmers. Service grew progressively worse as the tubewells began to deteriorate and power supplies grew less and less reliable. The transition pilot was designed to resolve these problems by eliminating public tubewells in areas with plentiful fresh groundwater and enabling farmers to construct their own tubewells.

Objectives

7. The transition to private wells would relieve the government of the substantial burden of subsidizing well water and providing vertical drainage, instead transferring these costs to farmers. This shift in water delivery would ultimately improve the reliability of the water supply. With more reliable irrigation, farmers would be able to increase production of wheat, paddy, and vegetables, raising household incomes.

8. While the IDA's President's Report stresses the project's potential productivity gains and fiscal savings, a review of IDA files shows that equity was also a major concern.[1] Private tubewell investment was already proceeding rapidly on its own. In subsidizing tubewell construction, the project, it was hoped, would reduce the possibility that control of the water supply would fall into the hands of the richest farmers. Thus, the project's objectives also included institution building among smallholders in an effort to encourage farmer groups that would own and maintain tubewells.

Implementation Experience

9. The implementation problems that seemed so significant at the time of the Project Completion Report (PCR) do not seem as important at impact evaluation. Most significantly, the SCARP public tubewells were shut down without the major protests many had feared. Project costs were far lower than anticipated, and half the credit was canceled. Since many more farmers than anticipated opted for diesel pumps, the electric grid that was installed to facilitate private electric pumping was not used as extensively as anticipated.

Results

10. The PCR and audit of the SCARP Transition Pilot expressed considerable doubt about the extent and equity of the project's actual productivity gains. To address these doubts, the Punjab Economic Research Institute (PERI) was commissioned to repeat its 1989 benchmark and 1990 farm-management and technical studies. The results show distinct changes between 1989 and 1994, not only on project farms but among a control group of farms outside the project area.

11. SCARP public tubewells were shut down in the project area but not in the control area. Well ownership in the project area rose from 58 percent of farms in 1989 to 82 percent in 1994, but well ownership rose even more (though from a lower base) in the control area. In both areas, individual ownership increased more than group ownership, and large farmers continued to be more likely to own wells than smaller farmers. Well owners' operational holdings in 1994 averaged 4.4 ha, compared with 1.7 ha for nonowners who bought water from them and 1.0 ha for the 3 percent of farmers who did not use tubewell water. Between 1989 and 1994, pump capacity utilization fell from 13 to 7 percent in the project area and from 8 to 5 percent in the control area, but capacity utilization by larger farmers was more than three times that of smaller farmers.

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1. A Staff Appraisal Report (SAR) was not prepared, and the Report and Recommendations of the President to the Executive Directors (the "President's Report") summarizes the justification for the project.

12. The water table dropped modestly to within the desirable range. Water quality improved. With increased groundwater irrigation, secondary soil salinity increased, but farmers were able to keep it to agronomically acceptable levels. And despite having to absorb irrigation and drainage costs, farmers were able to increase their productivity enough to come out ahead: average net farm income per hectare increased 16 percent in the project area and 12 percent in the control area.

13. The 1994 survey found few differences in tubewell ownership, access to tubewell water, and productivity between the project area and the control area (where some farmers still had access to SCARP public tubewell services). For this reason, the stream of on-farm benefits stemming from the project, whether economic or financial, was negligible. The economic rate of return (ERR) to the resources engaged in the project was 18 percent, down from the appraisal estimate of 23 percent and the PCR estimate of 32 percent. This ERR reflects primarily the savings to the government from shutting down public tubewells—savings that far exceeded the costs of building, operating and maintaining the private tubewells. The SCARP Transition Pilot, then, was not only a successful pilot but a satisfactory investment.

14. Private tubewell development occurred at the same rate in the project and control areas. Whenever possible, farmers in both areas used canal irrigation for their base capacity and private pumping for peak capacity. The financial rate of return to private wells in this scenario was about 24 percent (for electric) and 46 percent (for diesel). The insignificant differences between net on-farm benefits per hectare between project farmers and farmers in the control group suggest that the wells were a good investment with or without a transition pilot.

15. The project's ambitious *institutional objectives* were fully achieved. Responsibility for groundwater-based irrigation and vertical drainage was successfully transferred to the private sector. The government's public tubewell service was dismantled in the project area without the angry demonstrations that had been anticipated.

16. The impact evaluation rates the project's *sustainability* as likely. Nevertheless, the findings raise new problems regarding sustainability. First, while farmers appeared to be managing the salt buildup satisfactorily, soil salinity is part of a widespread problem that shallow tubewells cannot solve (and may actually make worse). Second, while the water table has thus far remained stable, there is no guarantee that this result can be maintained with thousands of farmers operating pumps independently, without coordination or planning.

17. The effects of the project on equity were not negative, as had been anticipated, but mildly positive. Although project provisions to foster group ownership were ineffective and ownership was more common among large farmers than among smallholders, benefits were relatively well distributed because of the market that developed for private tubewell water. Water buyers without their own wells were able to achieve substantially the same farming results as well owners, for two reasons. First, small farmers have been unable to utilize their tubewells to full capacity. Second, the large number of wells has resulted in excess pumping capacity for the area, lowering water prices. As a result, small farmers who own tubewells have had poor returns on their investments. The situation has been a good one for water buyers but not for tubewell-owning smallholders.

Findings and Issues

18. In areas with plenty of fresh groundwater, the transition from public to private tubewells has been socially worthwhile for Pakistan, fiscally worthwhile for Pakistan's governments, and financially worthwhile for farmers. But farmers in these areas tend to build private wells even in the absence of extra incentives. Therefore, a lower-cost solution than providing a transition project would be simply to close the public tubewells in these areas—what the Punjab Irrigation Department called the "do-nothing mode."

19. Simply doing nothing may not be enough, however, for several reasons. First, at present pumping intensities, salt buildup will ultimately contaminate the aquifer, making it unusable. Second, in the long term the water table will fall if pumping at current levels continues. Third, unplanned tubewell installation leads to overinvestment and low rates of capacity utilization for everybody, especially for those well owners with the smallest plots. Capacity utilization for farmers operating less than 2 ha, for instance, cannot easily be raised from the current 4 percent to the 13 percent of farmers operating more than 10 ha.

20. Group ownership promotes greater capacity utilization (and thus equity) among the smallest well owners—about one-third higher, according to the impact survey. Mindful of the transition pilot's failures in promoting group ownership, however, Pakistan's follow-on Privatization of Groundwater Development project is expected to focus its promotional efforts exclusively on community-owned tubewells, an effort that would break new ground in Pakistan, although it has parallels in India. Successful projects there share several characteristics: (a) identification and fostering of community groups; (b) public construction or rehabilitation of groundwater systems to high standards; and (c) community ownership and operation of the systems. While rehabilitation of SCARP tubewells is not a viable alternative, similar community-based measures are being proposed for Pakistan—an optimistic outlook for the future of the country's essential irrigation system.

1. Introduction

1.1 Irrigation is the lifeblood of Pakistan's agricultural economy. Without the Indus river and its abundant waters, most of this arid and semi-arid country could not be farmed. Irrigated land supplies almost 90 percent of agricultural production, accounting for 26 percent of GDP and providing employment for 54 percent of the labor force. The importance of irrigation to agriculture lies at the heart of the debate about the merits of Pakistan's Salinity Control and Reclamation Project (SCARP), of which the Transition Pilot was a part. SCARP provided Pakistan's farmers with heavily subsidized water from large public tubewells. The SCARP Transition Pilot aimed to test the effectiveness of replacing publicly provided irrigation with incentives to invest in small private wells. This report looks in detail at the project, its effects on agricultural production, and its impact on the producers themselves.

Background

1.2 For centuries the Indus River has been developed to meet Pakistan's expanding irrigation requirements. The Indus Basin irrigation system is now the world's largest: it commands 14 million hectares, distributing water through a network made up of more than 1.6 million km of canals, watercourses, and ditches. While this extensive development has dramatically increased agricultural production, the gains have not been without cost. Adequate drainage facilities were not provided, resulting in seepage losses (possibly as much as 40 percent of the water supply) from irrigation canals, watercourses, and deep percolation from irrigated lands. These seepage losses have in turn caused water tables to rise and created waterlogging and salinity, with a measurable effect on crop production.[1] Estimates of the irrigated areas affected by waterlogging vary from 1.6 to 3.0 million ha, and of "salt-affected" areas from 2.2 to 4.6 million ha—up to 26 percent of irrigated land (Mian and Mirza 1993; Sandhu 1993).

1.3 Farmers and both central and provincial governments, sometimes supported by international financiers, have been addressing the drainage problem for decades. The IDA's efforts are only a small part of the whole, although the agency has made 27 irrigation loans and credits to Pakistan for a total of US$1,305 million (annex 1). Nine of these, for US$457 million, were principally for drainage to control waterlogging and salinization. But despite the ongoing efforts, the problem is far from solved. In value terms, Pakistan loses almost as much irrigated land each year as it gains from investments.

The Salinity Control and Reclamation Project (SCARP)

1.4 In 1958, the government of Pakistan assigned responsibility for the expanding waterlogging and salinity program to the Water and Power Development Authority (WAPDA). WAPDA's technical solutions focused on improving drainage, reducing seepage losses from canals, increasing the efficiency of farmers' water management practices, and various

1. Waterlogged areas have water tables to within 5 feet of the surface for at least part of the year. "Salt-affected" areas have salinity levels high enough to impede growth. The government's Water Sector Investment Plan estimates that average yield loss in salt-affected areas relative to dry-foot crops is 25 percent; the loss is actually higher because farmers also switch to low-value crops as salt levels increase. The figures given are in fact a simplification of the effects of waterlogging, salt, and soda. See Government of Pakistan 1991; Ahmad and Kutcher 1992, pp. 3–4.

combinations of these approaches. A USAID-sponsored groundwater survey begun in 1954 led WAPDA to initiate SCARP, which had two primary objectives: to control waterlogging and salinity, and to develop Pakistan's extensive fresh groundwater supplies to supplement the often irregular supplies of canal water (Lieftinck, Sadove, and Creyke 1968).[2] SCARP's approach to alleviating these twin problems used large public tubewells to lower the water table and thus induce vertical drainage of the overlying soils.

1.5 The first project, SCARP I, was launched in 1961. It installed 2,100 public tubewells to provide drainage for about 0.6 million ha in Punjab Province. Suitably fresh groundwater was transferred to canals to be used for irrigation, saline water was dumped into rivers or evaporation ponds, and moderately saline discharge was sometimes mixed with canal water for irrigation. Using these methods, the project enjoyed considerable success. It virtually eliminated waterlogging in the project area, nearly doubled the amount of water available for irrigation, reclaimed 60 percent of previously saline lands, and increased cropping intensity by 50 percent. Because of its success, SCARP I greatly influenced the pattern of future investment. In the decades following, some 13,500 SCARP tubewells (almost 75 percent of them in the Punjab) covering 3.7 million ha were installed, funded with local resources and a variety of external financing from the IDA and other donors.

1.6 In the mid-1960s, the government commissioned the Lower Indus Project for Sindh (WAPDA 1966) and the Indus Special Study[3] to prepare a master plan for drainage. These plans endorsed the expansion of the SCARP concept, arguing that large public sector tubewells had significant economies of scale, could be used in areas with both fresh and saline groundwater, augmented water supplies from canals, and ensured equitable access to groundwater, particularly in the tail ends of canal commands, which were frequently short of water. By the late 1970s, however, it was clear that public tubewells were no longer the solution to Pakistan's drainage problems. Subsidies were absorbing 40 percent of the government's nondevelopment budget.[4] In some areas, the wells were so deep that they were drawing saline water to the surface, and waterlogging had again become a problem. Pumping by SCARP tubewells nationwide had declined to 40 percent of capacity, and problems in the centralized management structure meant that deliveries of water from the wells were poorly coordinated with deliveries of canal water. The electricity supply was equally as unreliable.

1.7 In both project and nonproject areas, farmers in areas where fresh groundwater was plentiful were installing small private tubewells to provide irrigation.[5] The number of these wells grew rapidly, and in 1995 there were over 300,000 (fig. 1.1). In the 1970s, they were already providing approximately 75 percent of irrigation supplies in fresh groundwater areas and successfully keeping the water tables down. Ironically, when the SCARP public tubewells failed to deliver, areas without SCARP intervention but with numerous private tubewells had some of the best drainage and most reliable irrigation in the country.

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2. For a review of early U.S. involvement in Pakistani drainage, see Rock and others (1982).

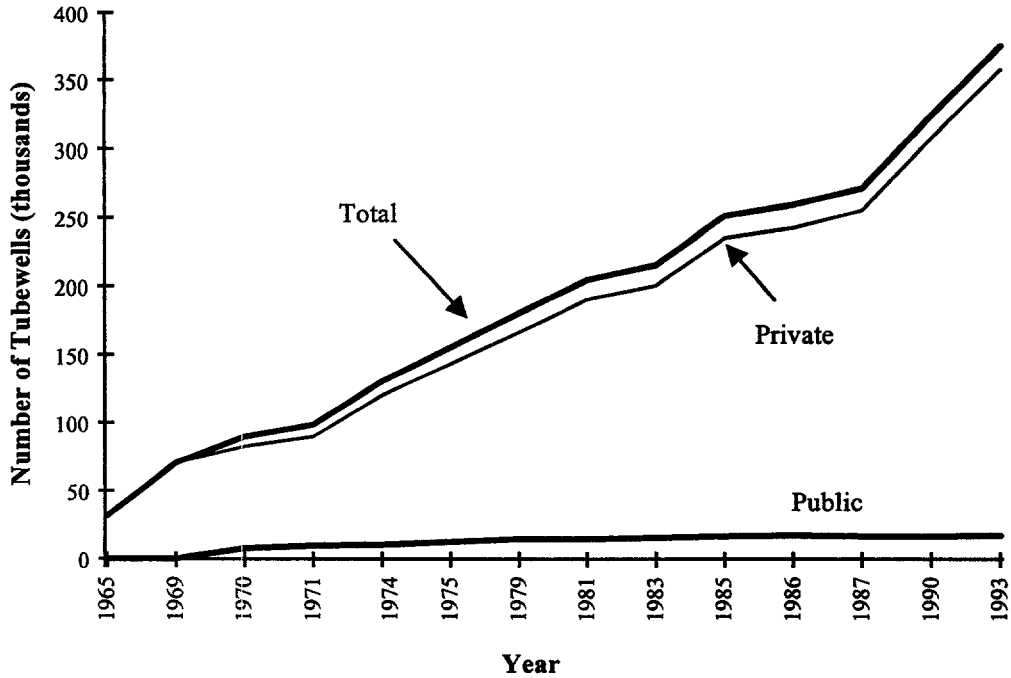
3. The Indus Special Study is summarized in Lieftinck, Sadove, and Creyke (1968).

4. In 1995, each SCARP tubewell cost PRs 150,000 (US$4,500) annually in operation and maintenance (O&M).

5. Private tubewells are mainly shallow, 30–50 m in depth. They use locally manufactured engines and centrifugal pumps that typically discharge about 28 liters/second (equivalent to one cusec) or less. While farmers are driven by the need for irrigation water, drainage is an important by-product.

1.8 This development, coupled with the shortcomings of the SCARP system, made the alternatives to public tubewells increasingly attractive. As the number of private tubewells burgeoned, specialists began to question the use of the large publicly funded tubewells in areas with significant fresh groundwater (Mohammed 1965). Most policymakers, however, continued to support the expansion of SCARP, although with some reservations. The IDA report was ambivalent on this important strategic point. It recommended that public tubewell development "not be undertaken in large (fresh groundwater) areas where private tubewells are spreading rapidly." But it also said of the SCARPs, "The public tubewell program tries to steer a middle course, including projects in areas which are predominantly underlain by fresh groundwater and where the reclamation problems are not the most severe, but excluding areas where conditions are the most favorable to continued rapid growth of private wells." The number of SCARP tubewells continued to grow.

Figure 1.1: Number of Tubewells in Pakistan (1964–93)



Sources: WAPDA (1993); Government of Pakistan (1979, 1994).

The SCARP Transition Pilot

1.9 In 1977, the IDA, never enthusiastic about the large public sector tubewells, agreed to finance another project (SCARP VI) that would support the development of private tubewells. The project offered farmers credit for constructing wells and promised to provide electrification in all areas with plentiful fresh groundwater. Because of financial constraints on the government, SCARP VI was radically redesigned in 1980. Financing for private tubewells was deleted from the project on the grounds that existing incentives were adequate, including a doubling of the density of the power grid (financed by the German donor agency KfW) and low electricity tariffs. Public tubewell development was concentrated in saline groundwater areas. Even without project assistance, farmers in the SCARP VI fresh groundwater areas installed enough wells to

keep the water table down. Using the new water supply and canal water, they were able to achieve cropping intensities of up to 200 percent.

1.10 At the same time, the UNDP funded a new master plan, the Revised Action Plan for Irrigated Agriculture (RAP) (WAPDA 1979), which the Bank agreed to execute. Once the government formally adopted the RAP in 1980, Bank lending for Pakistan changed significantly to support the plan's recommendations: improving watercourses, rehabilitating the irrigation and drainage system, strengthening the provincial irrigation agriculture departments, and accelerating the transition from public to private tubewells, in part by ending the tubewell subsidies (box 1.1). Under the new plan, "water markets" were expected to develop as farmers banded together to develop wells and smallholders who could not afford their own wells negotiated with larger landowners for supplies.

1.11 With IDA support, WAPDA began preparing the SCARP Transition Pilot in 1981, with the World Bank as executing agency. The project would test whether farmers, particularly smallholders, provided with credit and subsidies would install their own tubewells when the public wells shut down. Ancillary to that question were two others: whether the system of private ownership would create inequities, and whether the private tubewells would be environmentally and fiscally sustainable. Discussions on these issues took some time, and the project was approved for an IDA credit only in May 1986.

Box 1.1: World Bank–assisted Irrigation Projects Implementing RAP Recommendations

Project Title	L/C Number	Commitment (US$ million)	Financial Year Approved
(a) *Watercourse improvement projects:*			
On-Farm Water Management Project	C1163	41.0	1981
Second On-Farm Water Management Project	C1603	34.5	1985
Third On-Farm Water Management Project	C2245	47.3	1991
Third On-Farm Water Management Project	L3327	36.3	1991
(b) Irrigation and Drainage Rehabilitation Projects			
Irrigation Systems Rehabilitation Project	C1239	40.0	1982
Command Water Management Project	C1487	46.5	1984
Second Irrigation Systems Rehabilitation Project	C1888	79.5	1988
Fordwah Eastern Sadiqia Project	C2410	54.2	1993
(c) Public/Private Tubewell Transition Projects			
SCARP Transition Pilot Project	**C1693**	**10.0**	**1986**
Private Tubewell Development Project	C2004	34.4	1989
Second SCARP Transition Project	C2257	20.0	1991
Punjab Private Sector Groundwater Development Project	C2901	56.0	1996
Total		**440.2**	

1.12 The Bank review during project preparation raised the following issues:

- *Sociopolitical feasibility.* Was there sufficient political support for ending the tubewell subsidies? The government of Sindh, which had serious reservations about the project concept, did not expect the pilot to succeed and pulled out in early 1985. The government of Punjab proposed a pilot project that would be spread throughout the entire SCARP I area at sites where public tubewells had stopped operating or were likely to need replacing. When Bank staff pointed out that this plan would raise electrification costs, make it more difficult to determine whether private pumps could meet demand, and render the project impossible to replicate, the government agreed to locate the pilot in a specific irrigation command.

- *Equity.* This issue was the IDA's principal concern. Without the subsidized tubewells, the livelihood of farmers who could not work out a joint investment in a tubewell could be jeopardized. The idea that a fair water market would develop had no precedent in Pakistan. In some areas, there might be only one or two wells, or even none, so that smallholders would confront an oligopoly or market failure. The Bank felt that more than enabling legislation would be required to protect the poorest farmers in such situations. In addition, staff feared that the volume of canal water would be reduced when the SCARP tubewells closed, increasing the water-short areas at the tail ends of the canals.

- *Electricity distribution systems.* Would dedicated power lines be necessary to provide reliable power supplies for private tubewells, or could power be supplied from a common feeder?[6] Following regional public sector irrigation practices and the experience of SCARP VI, the staff took the position that dedicated power lines were essential incentives.

Initial Assessments of the Project

1.13 Although the Project Completion Report (PCR) presented a relatively sanguine picture of the SCARP Transition Pilot, subsequent Operations Evaluation Department (OED) reviews disagreed with the findings. The only negative aspects the PCR discussed were delays in procurement and consultants' appointments and possibly unnecessary costs caused by "administrative wrangling between departments." It reestimated the economic rate of return (ERR) at 32 percent, well above the appraisal estimate of 23 percent, primarily because actual costs were 32 percent lower than appraisal estimates. The benefits were also lagged two years to account for the actual implementation schedule. Benefits were assumed to be as estimated in the appraisal report despite the PCR's admission that "data collection during implementation for the impact evaluation study are insufficient to show if there has been any increase in agricultural production due to the project."[7, 8]

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6. In neighboring India, through the Second Uttar Pradesh Public Tubewells Project (Credit 1332, approved March 1983), IDA financed dedicated power lines to public tubewells to assure reliability. An OED audit (Report 14732 of June 29, 1995) finds that the dedicated power lines did not serve their purpose and that public provision of electricity to the public wells in question was not reliable. The experience was confirmed in the Bihar Public Tubewells Project (Credit 1737, approved October 1986). The ICR is Report 14409 of April 28, 1995.

7. While implementation delays delayed benefits, they are not the reason why monitoring and evaluation (M&E) did not find any increase in agricultural production. In fact, the M&E contract was delayed until early 1989, and a baseline survey was possible only because construction was delayed. After the "negative" findings of the 1990 surveys (no productivity gains, a decrease in equity), neither the borrower nor IDA showed any inclination to find

1.14 The PCR did identify two issues that could jeopardize project sustainability. The first was the question of how to maintain acceptable groundwater levels with unregulated private tubewells. With too few wells, the land would become waterlogged; with too many, smaller wells would dry out as the water tables dropped. The second issue involved financial viability: under SCARP, farmers received tubewell water at 20 percent of cost. If farmers could not generate sufficient returns to pay for electricity for their newly installed wells, the wells would cease operating, groundwater levels would rise, and the government would have to reintroduce subsidies to prevent waterlogging.

1.15 The PCR rated overall outcome as satisfactory, sustainability as likely, and institutional development as partial. OED's Director General advised the Board that the project demonstrated conclusively the practicality of the government's privatization policy but warned that the reestimated ERR might be exaggerated. However, in its PCR review, OED downgraded institutional development on the basis of the PCR's muted criticisms of implementation.[9] OED also found that while private sector development had been substantial, the outcomes for the project's poverty, natural resource management, and water quality concerns were unknown. An audit and impact evaluation were strongly recommended.

1.16 OED's field audit benefited from the preliminary results of the field work for this impact assessment. The audit found that it was impossible to calculate an ERR and rated the project as marginally unsatisfactory pending the outcome of the impact evaluation. It again rated sustainability as likely, but with the same qualifications expressed by the PCR. It rated institutional development as substantial in view of the project's success "in destroying a loss-making public institution of declining effectiveness." It criticized the cessation of benefits' monitoring after the 1990 survey (Shahid, Haque, and Khan 1990), particularly since the project was a pilot.

1.17 One of the findings from the preliminary survey conducted for the impact evaluation was that the same degree of agricultural intensification occurred in both the project and control areas. On the strength of these preliminary indications, the audit changed its overall assessment from satisfactory to marginally unsatisfactory, an assessment the IDA's operating division contested, but maintained its position that the impact survey alone would isolate the project's benefits.

The Impact Evaluation

1.18 PERI was responsible for the monitoring and evaluation (M&E) of the project's impact on farmers. The preproject benchmarks for agricultural conditions, depth of the water table, condition of the facilities, and other technical parameters were based on the 1989 survey of 24 project tubewells and a control sample of six matched nonproject tubewells (Shahid, Haque, and Khan 1990). This survey was followed by the 1990 evaluation, which took place shortly after the

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further funds for this work. When the FAO/CP PCR mission visited Pakistan, it was not "too early to make such assessment." There were no data, because none had been gathered.

8. The Region, after review of the draft of this report, stated that PERI's case studies carried out in 1990 showed an increase in production attributable to the project tubewells. OED has examined the evidence and can find no information supporting this statement.

9. Of course, the essence of the project was not to build but to replace public institutions in fresh groundwater areas by turning over their functions to private farmers. It was anticipated that the reduced public sector program would be able to focus its efforts on improving performance in saline groundwater areas where there is no private sector alternative.

transition pilot (Shahid and others 1992). The budget for M&E was then exhausted, and the contract was not extended.

1.19 In October and November 1993, the Bank's impact evaluation mission visited Pakistan. The mission observed that the evaluation of the SCARP Transition Pilot Project was carried out before the full impact of the project developed. The mission also recommended that the Punjab Economic Research Institute (PERI) repeat the ex-post surveys to update the data on the project's impact on agricultural production and equity and to determine whether a system of private ownership remains in place. Accordingly, PERI conducted an ex-post evaluation of the SCARP Transition Pilot Project (Shahid and Khan 1995).

1.20 The evaluation found that the number of private tubewells increased dramatically throughout the project. Despite concerns about protests from farmers, tubewells in the SCARP Transition Pilot area were closed, and farmers installed their own wells or began procuring water from tubewell owners. Crop yields did not fall dramatically. The government stopped subsidizing water for irrigation in the project area, releasing funds for other much-needed purposes. From this standpoint, the SCARP Transition Pilot was an unqualified success.

1.21 The evaluation also found, however, that private tubewells proliferated in nonproject areas, where farmers had not received subsidies and SCARP tubewells were still operating. Crop yields in these areas were virtually the same as those in the project area. These findings suggest that projects such as the SCARP Transition Pilot may not be necessary, since it may be possible to achieve the same results simply by shutting down public wells. But a trade-off is involved in this assumption, for while the SCARP Transition Pilot does not appear to have created large inequities (or even to have amplified those that already existed), it did not reduce inequities to the degree planners had hoped. And the project outcomes raise questions about the sustainability (particularly environmental) of the new system.

1.22 The survey assesses the project's impact from the point of view of the beneficiaries rather than the government.[10] A cross section of farmers responded to questions aimed at evaluating the following:

- the availability, accessibility, reliability, and cost of water before and after the project;
- changes in cropping patterns (especially the expected shift toward high-value crops), cropping intensity, and yields;
- changes in the use of modern agricultural inputs; and
- economic and financial performance.

Layout of the Report

1.23 The evaluation first discusses the project and its outcomes (chapter 2). The following chapters respond to the issues the project aimed to address. Chapter 3 explores private sector irrigation development, chapter 4 the effects on equity. Chapter 5 analyzes the economics of the

10. For survey methodology, see Shahid, Haque, and Khan (1990); Shahid and Khan (1995); and Shahid and others (1992).

SCARP Transition Pilot. Chapter 6 attempts to determine the project's sustainability, and chapter 7 presents the conclusions.

2. The Project

2.1 The SCARP Transition Pilot was to be implemented over four years (FY97–FY90). Located in the province of Punjab in the Khanqah Dogran block of SCARP I (a region known for its high-quality basmati rice) the project would cover 46,000 ha and affect some 11,500 farm units with an average size of approximately 4 ha. SCARP I had installed 213 high-capacity deep electric tubewells in the project area, but the farmers wanted better, more reliable service than these wells and the canals could supply. On their own initiative, they installed an additional 1,600 private tubewells, 600 of them diesel powered, and, at project inception, these private tubewells were providing about 40 percent of the area's irrigation water.[11]

Project Design

2.2 The objectives of the project were to develop, on a pilot basis, a replicable package of technical and institutional components designed to:

- implement the government's policy of transferring the main responsibility for pumping fresh groundwater to the private sector in a representative SCARP area; and
- increase agricultural production and farm incomes by improving the use of surface and groundwater supplies, especially among small farmers.

2.3 The project included the following components: (i) electrification for private tubewells; (ii) the construction of private tubewells; (iii) improvements to irrigation and drainage schemes, including the lining of minor canals and smaller distributaries over 32 km, and an on-farm water management program for renovating watercourses; (iv) institutional development, comprising technical assistance, training, and M&E; and (v) project management and supervision.

2.4 The project would fulfill its primary objective by shutting down 213 SCARP tubewells and offering subsidies to hasten the installation of private wells and thus make a serious reduction in drainage capacity and irrigation water supplies less likely. The project proposed to help farmers install 2,100 private tubewells, 1,500 of them with a subsidy of PRs 16,000 for electrical connection.[12] Farmers connected to the grid could take advantage of the heavily subsidized agricultural electricity tariffs. Farmers located too far from the power lines would receive a subsidy of PRs 4,000 to install a diesel tubewell. The Agricultural Development Bank of Pakistan (ADBP) agreed to provide credit for up to 95 percent of tubewell costs.

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11. SCARP tubewells are 40–120 m deep and have deep-set pumps with a capacity of 60–140 liters per second. Private tubewells are much shallower and have smaller discharge capacities (from 7–28 liters per second). Because of the lower discharge, the drawdown in private tubewells is much reduced, making cheaper centrifugal pumps feasible where the water table is shallower than 10 m. Because these small tubewells draw better-quality groundwater from the upper part of the aquifer, they help reduce salt buildup in the soil.

12. The remaining 600 would be diesel powered, with pump capacities of 14–28 liters per second.

Project Benefits

2.5 Improved agricultural productivity would provide the bulk of project benefits. Cropping intensity was to increase from 125 to 150 percent and crop yields from 10 to 35 percent. Large increases were expected in rice, wheat, and sugar cane production; the predicted incremental production was 13,800 tons (rice), 15,200 tons (wheat) and 36,900 tons (sugar cane) at full development in 1995. Because the cost of irrigation water would rise, the project was also expected to double production of high-value crops such as vegetables and orchard-grown fruit. On the basis of these assumptions, the ERR was estimated at 23 percent.

Project Costs

2.6 Total project costs were estimated at US$21.8 million (PRs 383.5 million). An IDA credit of SDR 8.7 million (US$10 million equivalent) was to fund 46 percent of total costs, with the government contributing 30 percent and project farmers, supported by the ADBP, the remaining 24 percent. Fifty percent of project cost was for electrification, 25 percent for private tubewells, 11 percent for irrigation improvement works, and the balance for project management, technical assistance, and M&E. Four agencies—the ADBP, Punjab's Departments of Irrigation and Agriculture, and WAPDA—were to implement the project. It would be coordinated by a new Project Management Office in the Department of Irrigation.

2.7 When the project closed in mid-1992, its implementation targets had been met at substantially lower costs than projected, and US$3.9 million of the credit was canceled. Significantly, actual expenditure on private tubewells was only 35 percent of the amount approved, while expenditure on electrical systems reached 83 percent. The average public cost of replacing each SCARP tubewell was about US$57,000, primarily because of the high cost of the electrical transmission system.

Project Implementation

2.8 Implementing the project proved as politically delicate as some had feared it would be. The first boreholes were not sunk until April 1987, almost a year after project approval, and then the needed electrical equipment did not arrive. None of the public tubewells had been closed, farmers had begun to doubt that they ever would be, and borehole drilling had slowed dramatically. On November 1, the government of Punjab created a potentially volatile situation by removing the pumps from eight public tubewells despite the fact that the electrical equipment the project was to supply had not yet arrived.

2.9 As project staff later observed, it was a bold step. Protests were expected from farmers, who were suddenly deprived of a heavily subsidized source of irrigation, and from tubewell operators, who had lost their jobs. WAPDA defused the situation by hooking up, on its own, 100 private tubewells to replace the eight closed SCARP wells. After that, farmers began to believe that the public services really would be withdrawn and to invest accordingly. To everyone's great relief, the anticipated protests did not materialize.

What the Project Achieved

2.10 The project enjoyed several notable successes. It allowed the phasing out of some large SCARP tubewells; encouraged the installation of small, private tubewells; helped with some

improvements in irrigation; and provided electrical hookups for tubewells at a lower cost than had been estimated. The renovation schemes were the least successful: some planned renovations were not completed, and expected beneficiary contributions did not materialize.

Phasing Out SCARP Tubewells

2.11 Prior to the installation of private tubewells, 68 of 213 SCARP tubewells were closed down, either because the groundwater had gone saline or because they had deteriorated. Of the boreholes, 150 were sold to individual farmers at PRs 2,000 each (US$100–115), generally to the owner of the land on which they were located. WAPDA removed the 3 cusec (84 liters/second) pumps for use elsewhere, and the new owners installed a variety of 1–1.5 cusec pumps. A plan developed by WAPDA and the IDA for transferring ownership of the SCARP tubewells to a water users' association or a group of farmers did not work out, in part because the farmers were not sure how they could maintain the wells and in part because the farmers preferred to have their own tubewells.

Installing Private Tubewells

2.12 A total of 2,100 private tubewells were installed, representing 100 percent of the original target. The original plan had assumed that about 70 percent of these 2,100 tubewells would have a capacity of 0.5 cusec (14 l/sec). The remaining 30 percent would have a 1.0 cusec (28 l/sec) capacity. In fact, a majority of project farmers opted for the more powerful 1.0 cusec (28 l/sec) tubewells (1,740 tubewells or 83 percent of total).

Improving Irrigation and Drainage

2.13 The 32 km of delivery canals specified in the original document were lined as planned, a renovation that cost more than had been expected because the work followed the original SCARP design, which took into account discharge into the canals from public tubewells. With the installation of private tubewells, tubewell discharge into the canals ceased, and the canals could have been renovated to lower conveyance capacities. Fifteen of the 182 watercourses due for improvement were not completed for various reasons, including a lack of water users' associations willing to participate in operation and maintenance (O&M). Beneficiaries were to pay 70 percent of the cost of these improvements, but only 36 percent was collected.

Making the Electrical Distribution System More Efficient

2.14 A total of 220 km of 11 kV feeders was completed, representing 113 percent of the original target. The number of private tubewells connected to the grid was 100 percent of target. The average cost of each tubewell connection was PRs 110,000 (a decrease from US$6,250 to US$5,750 over the life of the project).

The Growth of Private Tubewells

2.15 The number of private tubewells increased within the project area during the SCARP Transition Pilot. But the number of private tubewells increased by almost the same amount *outside* the project area. Could the same results have been achieved without the pilot project? The following chapters attempt to address that question and to determine the actual effects of the project on private sector tubewell development.

3. Private Sector Development

3.1 The overriding objective of the SCARP Transition Pilot was to encourage the ownership of private tubewells, particularly among small farmers. This chapter shows that the number of private tubewells increased during the project for all farmers but that inequities in the pattern of ownership remain. The chapter also presents an important conclusion: all other factors aside, the increase in the number of privately owned tubewells was virtually the same in project and nonproject areas. Private tubewells were widely used before the project started. They increased by the same amount *with* and *without* the project—in other words, whether SCARP tubewells were removed or not, whether incentives were provided or not, and whether the electric grid to facilitate pumping was built or not. Additional findings show only small differences in farmers' access to irrigation with the project and without it. These findings suggest that the SCARP Transition Pilot served its purpose well and may have proved that such projects are unnecessary.

Private Tubewell Ownership and Access

3.2 The audit of the SCARP Transition Pilot found that provisions for encouraging groups of small farmers to invest in private tubewells had not met with much success. There was no evidence that the project had altered the earlier balance between the number of tubewells owned by single farmers and the number owned by groups of farmers. Data on farm size and ownership in the project and nonproject areas confirmed the relationship between wealth and well ownership. The impact survey showed that farmers operating farms of over 10 ha in the nonproject area who own tubewells were always sole owners. Conversely, in the project area the number of large farmers who were sole owners decreased between 1989 and 1994. As farm size declined, the proportion of farmers who did not own their own wells increased. Although farmers with the smallest holdings made the greatest gains in well ownership between 1989 and 1994 in both project and nonproject areas, inequitable tubewell ownership remained the pattern (table 3.1). Farmers without their own tubewells either invested in a jointly owned well or depended on others for their irrigation water.

Table 3.1: Ownership of Private Tubewells on Sample Farms (percent)

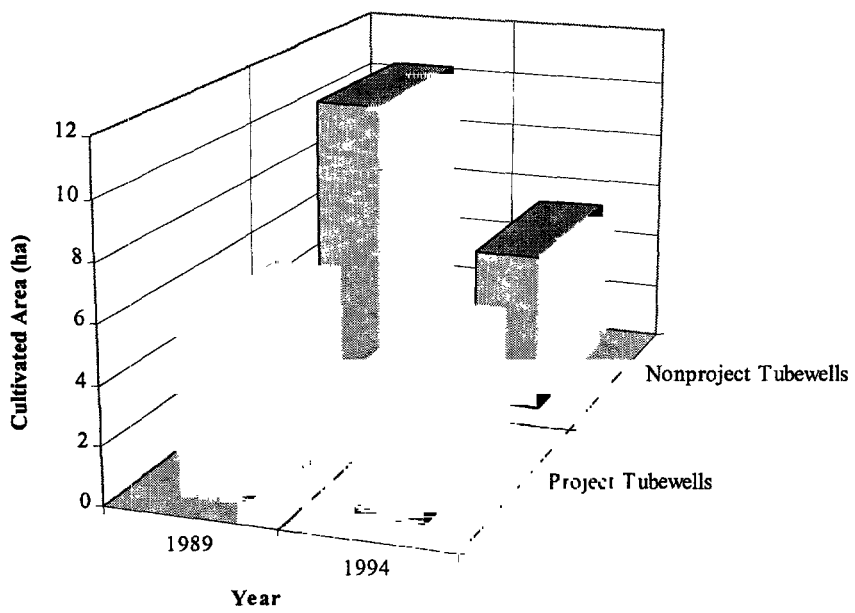
Farm Size Category (ha)	*Project Area*				*Nonproject Area*			
	Farmers with Private Tubewells		*Tubewells in Sole Ownership*		*Farmers with Private Tubewells*		*Tubewells in Sole Ownership*	
	1989	1994	1989	1994	1989	1994	1989	1994
0-2	34	62	12	43	15	53	5	26
2-5	67	91	31	48	43	82	22	48
5-10	94	98	57	62	33	75	19	67
>10	100	100	95	86	67	100	67	100
Overall	58	82	30	52	33	71	15	47

Note: Shahid and Khan 1995, Table 4.1, p. 55.

3.3 The growth in tubewell ownership among small farmers may be due in part to a trade-off between capitalization costs and what Meinzen-Dick calls the "social transaction costs of group

ownership."[13] Among the smallest farmers in the project area in 1989–94, collective ownership seems to have fallen to about 57 percent, while sole ownership almost quadrupled. Clearly, private tubewells were widespread *before* the project, and their number grew during the project. But as table 3.1 shows, expansion of private tubewell ownership was even greater *without* project intervention. Part of the greater growth in nonproject tubewell numbers can be explained by the fact that there was more room for expansion in the nonproject area. In 1989, there was one private tubewell for each 10.5 ha of cultivated area, compared with one per 5.6 ha in the project area. By 1994 almost equal coverage had been achieved, with one tubewell per 5.5 ha in the nonproject area and one per 4.7 ha in the project area (fig. 3.1).

Figure 3.1: Cultivated Area per Tubewell



Source: Shahid and Khan 1995.

3.4 The 1994 impact survey showed that, on balance, the better-off farmers invested in tubewells, and farmers with smaller holdings bought water from them. Tubewell owners farmed an average of 4.4 ha. Farmers who bought tubewell water had average holdings of 1.7 ha, and the 3 percent of farmers who neither owned a tubewell nor bought water from one owned an average of 1.0 ha. Since irrigation water is difficult and expensive to transport, the potential for exploiting poor farmers remains high.

3.5 In the project area, the benchmark survey showed that 70 percent of farms had access to private tubewell water in 1989, *before* the project—far more than the 10 percent that IDA staff

13. Meinzen-Dick (1995) states: "The major disadvantage of joint tubewell ownership lies in the social transaction costs, which are higher than for sole ownership. Farmers must negotiate with each other for making the initial purchase and deciding where to locate the tubewell. The agreements must be reached for how to share water, expenses, and maintenance responsibility on an ongoing basis. This may be difficult in areas without established traditions of cooperation, which has been identified as a problem in many areas of Pakistan" (pp. 95–96).

reported during appraisal. Five years after the beginning of the transition pilot, 89 percent reported access (table 3.2).[14]

Table 3.2: Farmers' Access to Private Tubewell Water (percent)

	Project Area		*Nonproject Area*	
	1989	*1994*	*1989*	*1994*
Number farmers with access	70	89	75	95
Of which: Sole owners	30	52	15	46
Joint owners	32	30	18	25
Nonowner, water purchaser	—	15	—	6
Nonowner, non-water purchaser	—	3	—	23

— Not available
Note: Total no. of farmers: 391 (project area); 100 (nonproject area).
Source: Shahid and Khan 1995, Tables 4.1 and 4.2, pp. 55–56.

Reliability of the Postproject Water Supply

3.6 While having access to irrigation water is important, the reliability of the supply is probably more so.[15] For this reason, farmers were asked what percentage of the time they were able to get private tubewell water when they needed it (table 3.3). Satisfaction with the water supply increased across all groups of farmers, but small farmers showed the greatest increase.

Table 3.3: Farmers Who Believe That Private Tubewell Irrigation Is Reliable (percent)

	Project Area			*Nonproject Area*		
Farm Size Category (ha)	*1989*	*1994*	*Change*	*1989*	*1994*	*Change*
0–2	45	81	78	55	89	61
2–5	61	82	34	65	90	39
5–10	84	87	4	57	77	34
>10	80	93	17	87	89	2
All farmers	59	83	40	67	88	33

Source: Shahid and Khan 1995, Table 3.2, p. 19.

Tubewell Capacity Utilization

3.7 Small farmers do not have enough land to use their pumps, even small ones, to full capacity. To do as well as their larger neighbors, they have to sell water they cannot use

14. While 89 percent of farmers in the project areas reported having access to private tubewells when asked by enumerators, clearly 97 percent had access—52 percent as sole owners, 30 percent as joint owners, and 15 percent as water purchasers. It is not clear why 29 respondents (8 percent of those in the project area) said they had no access to private tubewell water in 1994, when their other answers clearly show that they did.

15. One of the chief complaints of farmers who relied on canals and public tubewells had been that supplies were unreliable. As Meinzen-Dick (1995) reports, "Though quality of irrigation service is acknowledged to be critical, analysis of the reliability of purchased private irrigation services and its impact on productivity has been missing from most studies of groundwater markets."

themselves at its long-run marginal cost, which includes investment costs.[16] Alternatively, they can increase the return to water inputs through high-value cropping. The survey collected data on capacity utilization, here defined as actual yearly hours of use divided by a theoretical capacity of 24 hours/day.

3.8 The 1989 benchmark survey data showed that tubewell utilization increased with both joint ownership and farm size (tables 3.4, 3.5). Medium-sized farms (2–10 ha) in the project area with tubewells in joint ownership had maximum utilization, defined as exceeding 20 percent, or the equivalent of 1,750 hours per year.

Table 3.4: 1989 Tubewell Utilization by Type of Ownership (percent)

	Sole Ownership		*Joint Ownership*		*Overall Utilization Factor*	
Farm Size Category (ha)	*Project Area*	*Nonproject Area*	*Project Area*	*Nonproject Area*	*Project Area*	*Nonproject Area*
0–2	4	3	12	9	9	8
2–5	6	4	20	10	13	7
5–10	10	9	20	10	13	14
>10	13	5	12	—	13	4
All Farms	8	5	17	10	13	8

— no data.
Source: Shahid, Haque and Khan 1990, Table 5.2, p. 120.

Table 3.5: Private Tubewell Capacity Utilization by Farm Size (percent)

	Project Area		*Nonproject Area*	
Farm Size Category (ha)	*1989*	*1994*	*1989*	*1994*
0–2	9	4	8	2
2–5	13	6	7	5
5–10	13	10	14	7
>10	13	13	4	13
Average	13	7	8	5

Source: Shahid and Khan 1995, Table 4.4, p. 58.

However, as the number of tubewells increased over the life of the project, overall utilization almost halved. As cropping patterns did not change and intensity did not decline under the project (paras. 4.5–4.7), the reduction in utilization is a clear indication of excess pumping capacity.

16. Shahid and Khan (1995) do not cover water pricing, but Meinzen-Dick (1995) does.

Costs

3.9 Appraisal estimates put the cost of tubewells with a capacity of one cusec (28 liters/sec) at PRs 56,250 for an electric well (including the electrical connection) and at PRs 27,000 for the diesel version. The government subsidized these costs by remitting drainage charges and offering a cash incentive of PRs 16,000 for the electrical connection (28 percent of the cost of installing electric wells) and PRs 4,000 (15 percent of cost) for each diesel tubewell. In the end, actual costs to sampled farmers were significantly below appraisal estimates, as the 1989 benchmark survey costs illustrate (table 3.6). Given the size of the cash incentive, many farmers could have made a small profit from the subsidy.

Table 3.6: Average Capital Cost of Private Tubewells (1989 PRs)

Farm Size Category (ha)	*Electric*		*Diesel*				*Tractor Driven*[a]	
			Cold Start Engine		*"Peter" Engine*			
	Project	*Non-project*	*Project*	*Non-project*	*Project*	*Non-project*	*Project*	*Non-project*
0–2	15,250	9,233	19,761	19,650	18,116	17,333	9,485	—
2–5	14,803	10,700	21,183	21,924	17,124	16,304	8,713	8,403
5–10	14,995	10,700	19,605	19,990	17,514	15,333	6,317	—
>10	11,765	—	20,304	19,900	17,706	20,800	8,477	10,780

a. Costs are for the well only. Power is provided by a portable belt drive attached to a tractor.
Source: Shahid, Haque and Khan 1990, Table 5.21, p. 122.

3.10 The PCR notes that farmers did not opt for tubewells with sumps or for pump houses with concrete floors but for the least-cost solutions they could finance themselves. Less than 10 percent utilized the credit facilities available through the ADBP. Even so, nonproject farmers managed to install electric tubewells for two-thirds of the price of the project wells, suggesting that the project design encouraged an element of "Rolls Royce" engineering.

3.11 Although "peter" and "cold start" diesel tubewells were 18–38 percent more expensive than the electrical alternative, farmers may have chosen them not only because they are more reliable but because of the relative shift in fuel prices. Between 1989 and 1993, the flat-rate electric tariff increased by 120 percent, while diesel prices increased by only 60 percent. In the project area, 23 percent of farmers complained of unreliable water supplies for technical reasons, and almost three times as many farmers blamed electric loadshedding rather than the unavailability of fuel.

3.12 Tubewell owners in project areas with farms of less than 2 ha were running their wells only 30 percent as much as owners with 10 or more ha; in nonproject areas, the figure was 15 percent. Unless these smaller well owners were realizing massive rents on the water they sold, the return on their investment was greatly inferior to that of larger operators. As the next section shows, an increase in irrigation costs is associated with a switch to high-value crop production.

4. Production, Income, and Equity

4.1 As chapter 3 has shown, inequities in the pattern of tubewell ownership and use remained after the SCARP Transition Pilot. The impact evaluation set out to discover whether farmers who could not afford private tubewells were the most seriously affected, as the IDA feared they would be. The survey used agricultural and financial monitoring indicators (annex 2) to determine whether the welfare of non-tubewell owners, who are exclusively smaller farmers, suffered after the transition to private ownership. The findings were mixed but showed that, across the board, tubewell owners did better than water buyers, who in turn did better than farmers who relied solely on rainwater and canals. Economically, the data parallel the finding described in chapter 3, which showed that the increase in private tubewells was approximately the same with and without the project. Economic data suggest that the most cost-efficient way to make the transition to private tubewell ownership is to do it without project intervention. Whether equity is best served by this method remains an open question.

Agricultural Production

4.2 Earlier studies in the Punjab had suggested that tubewell owners were doing much better than water buyers. Freeman, Lowdermilk, and Early's 1978 study showed that owners and water buyers had higher yields than farmers who depended on canal water and rainfall alone. However, the increase in wheat and cotton yields for tubewell owners was double that for water buyers; for rice, it was 27 percent higher. The WAPDA's 1980 study found that tubewell owners had higher cropping intensities, grew more crops that require substantial amounts of water, and had higher yields for wheat, rice, sugarcane, and vegetables than water buyers. Renfro's 1982 study looked at the water use, cash inputs, cropping intensity, and gross income (per ha) of the two groups. Cash and labor inputs of water buyers were as high as those of tubewell owners, yet cropping intensities and gross income per ha were, like those of farmers who relied solely on canal water, lower than those of well owners. Renfro concludes that "tubewell owners can exert more control over water supplies, with favorable impacts on productivity."

4.3 Recent studies, however, have not confirmed these earlier findings. In their 1994 study of Fordwah and Eastern Sadiqia, Strosser and Kuper concluded that tubewell owners achieved higher cropping intensities than nonowners but added, "The analysis of crop yields . . . did not show any clear difference between groups of farmers characterized by different degrees of control of the irrigation water supply."[17] Meinzen-Dick, reviewing the literature, noted, "The differences in cropping patterns between tubewell owners, water purchasers, and non-users of

17. Data were as follows:

		Sole Owner	Jointly Owned	Nonowner Buyer
Wheat yield	[MT/ha]	2.2	2.1	2.0
Cotton yield	[MT/ha]	1.7	1.5	1.7
Cropping intensity	[%]	171	145	137
Area cropped	[ha]	19.0	8.0	5.0

tubewell water are not as clear in the International Food Policy Research Institute (IFPRI) sample villages as in the WAPDA (1980) and Renfro (1982) studies." The same is true of yields and income. Shahid and Khan (1995) found no significant differences among project farmers, nonproject farmers, tubewell owners, and water purchasers for the majority of the agricultural and irrigation monitoring indicators. The amount of irrigation and fertilizer used and the timing involved were similar in project and nonproject areas and among different types of water users over a whole range of crops.

4.4 The next sections look first at the cropping changes that took place between 1989 and 1994 and then at how these cropping changes related to tubewell ownership status at the time of the 1994 survey.

The Benchmark (1989) and Evaluation (1994) Surveys

Cropping Patterns

4.5 The surveys' findings showed that shifts in cropping patterns in both the project and the nonproject areas were much more modest than expected. The appraisal had anticipated possible incremental intensification of cropping as a result of shifts to high-value crops. In both the project and nonproject areas, however, wheat and rice remained the predominant crops at about the same levels. The primary shifts were to fodder and sugar cane (table 4.1). The other quantitative shifts were small, although shifts to high-value crops like vegetables were significant in value terms.

Table 4.1: Changes in Cropping Patterns (percent of cropped area, by season)

	Project Area			*Nonproject Area*		
Crops	*1989*	*1994*	*Difference*	*1989*	*1994*	*Difference*
Winter (rabi)						
Wheat	76.4	75.4	-1.0	78.0	75.6	-2.4
Rabi fodder	21.1	22.8	+1.7	18.3	23.1	+4.8
Vegetables	0.9	1.5	+0.6	0.5	0.3	+0.2
Oilseeds	—	0.1	+0.1	1.9	1.0	–0.9
Gram	—	0.1	+0.1	—	—	—
Melon, watermelon, other	1.6	0.1	-1.5	1.3	—	-1.3
Summer (kharif)						
Rice	77.8	73.5	-4.3	66.5	56.5	-10.0
Kharif fodder	16.4	19.5	+3.1	23.8	23.8	—
Sugarcane	3.3	5.4	+2.1	6.6	9.6	+3.0
Kharif oilseeds	1.5	0.8	-0.7	1.1	2.4	+1.3
Vegetables	1.0	0.8	-0.2	—	—	—
Sesame, other	—	—	—	2.0	0.2	-1.8

Source: Shahid and Khan 1995, Table 3.9, p. 30.

Fertilizer Use

4.6 Incremental fertilizer use may be a proxy for intensification. The survey results showed that preproject fertilizer use on wheat was modestly higher in the project than in the control area; by 1994, the reverse was true. Preproject fertilizer use on rice was similar in the project and nonproject areas in both 1989 and 1994, although the later survey showed that the increment was slightly higher in the project area (Shahid and Khan 1995, Table 3.11, p. 34). There was no evidence of significant differential intensification.

Crop Yields

4.7 Incremental crop yields are another possible proxy for intensification. The survey results showed that preproject yields were modestly higher in the project than in the control area (table 4.2). By 1994, yields had increased in both areas (except for paddy in the project area), but they had increased more in the control area, with the exception of the small but lucrative vegetable crop.[18] While the area planted with vegetables was small, the net benefit was high and had a significant effect on overall results.

Table 4.2: Changes in Crop Yields and Gross Value

	Project Area			*Nonproject Area*		
Crop	*1989*	*1994*	*Difference (%)*	*1989*	*1994*	*Difference (%)*
			(Mt/ha)			
Wheat	2.05	2.33	14	1.87	2.54	36
Paddy	2.34	2.18	-7	1.97	2.38	21
Sugarcane	32.8	35.9	9	30.5	38.2	25
			(PRs/ha)			
Rabi fodder	5,953	11,629	95	5,496	12,718	131
Vegetables	9,633	16,119	67	7,553	9,263	23
Kharif fodder	2,426	4,970	105	2,240	5,607	150

Source: Shahid and Khan 1995, Table 3.12, p. 36.

The Effects of Tubewell Ownership Status on Cropping

4.8 Breaking down the figures to account for farm size gives an indication of the project's effects on individual farmers. Preproject data were not disaggregated to show these differences, but postproject data were. The results, while mixed, are revealing. Specifically, cropping patterns and yields were higher for those with access to tubewells (whether they are owners or water buyers) than for those relying solely on rainwater and canals. In this last group, those in the project area had no access to the public tubewells that were still available to the control group.

18. The three evaluation surveys were based on farmer recall, not on crop cutting. Because farmers do not think of fodder or vegetable production in terms of weight per area (quintals or maunds/acre) and were generally unable to give accurate information on yields of these crops in physical terms, the surveys collected more reliable data on gross value of output per unit cropped. These figures capture both physical increases over time and price increases. The price increases are a mix of real increases and of inflation. Percentage changes in PRs/ha are not comparable to those in MT/ha.

Variations in Cropping Patterns

4.9 The surveys provided no real evidence of marked differences in cropping patterns between water users and water buyers. But the 3 percent of farmers in the project area who depended entirely on rainfall and canal water grew significantly more fodder and far less wheat and rice than well users (table 4.3). The differences in cropping patterns between well owners and water buyers in both groups were minor.

Table 4.3: Variations in Cropping Patterns (percent of area)

	Project Area			*Nonproject Area*		
Crop	*Well Owners*	*Water Buyers*	*Nonowners/ Nonbuyers*	*Well Owners*	*Water Buyers*	*Nonowners/ Nonbuyers*
Rabi (winter)						
Wheat	76	75	60	77	73	72
Fodder	23	21	34	21	28	28
Vegetables	1.0	3.7	5.6	0.4	—	—
Other	0.2	0.7	—	1.3	—	—
Kharif (summer)						
Paddy	75	67	51	62	60	33
Fodder	18	23	49	26	21	49
Sugarcane	6.0	5.0	—	9.0	20.0	19.0
Vegetables	0.5	1.5	—	—	—	—
Oilseeds	0.3	4.0	—	3.0	—	—
Other	0.2	0.1	—	0.4	—	—

Source: Shahid and Khan, 1995, Table 5.1, p. 74.

4.10 The major difference across groups was the tendency for farmers who do not use tubewells to grow less paddy in the summer, replacing some of it with fodder and oilseeds. These farmers grew a third less paddy than well owners and more than twice as much fodder. Water buyers also grew less paddy, but the difference was much smaller (only a little over 10 percent). Water buyers may have been affected by the irrigation patterns of well owners. Because paddy uses large quantities of water and is sensitive to drought stress, irrigating it may require a tubewell's full capacity during certain seasons. In this case, owners used water for their own crops first rather than selling to other farmers.

4.11 There were also differences between tubewell owners and nonowners in cropping patterns for high-value items such as vegetables and sugarcane. In some instances, water buyers—and even farmers without access to tubewells—gave these water-sensitive crops a bigger place than well owners did. This difference may have been a function of farm size, with smaller farmers choosing to devote their abundant labor to small areas of labor-intensive crops such as vegetables. Tubewell owners got much higher returns from these crops than nonowners (especially non-tubewell users) and were thus able to devote a smaller proportion of their land to them.[19]

19. Because crops such as vegetables need water in small, frequent doses, they do not tolerate the large infrequent doses the canal system delivers, nor the unpredictable doses from SCARP tubewells in the nonproject area.

Crop Yields

4.12 Data on crop yields provided more precise information on how farmers fared after the project (table 4.4). Farmers who did not use well water got lower paddy yields (by around 20 percent) than well owners and water buyers. Although water buyers in the project area had lower yields as well, the difference was only 5 percent; in the control area, it was 13 percent. Fodder and vegetables were a different matter, however. Well owners' fodder yields were much higher than those of all nonowners. The gross value of the fodder/ha (which serves as a proxy for yields) of nonusers is a little over half the value of well owners' yields in the project area and slightly more outside it. For water buyers, the differences are 39–46 percent in the project area and 19–21 percent outside it.

4.13 The data on cropping patterns suggested that the higher fodder yields tubewell owners enjoy released land that was then used for high-value crops such as vegetables. In the project area, owners grossed PRs 15,438/ha from their vegetables, 79 percent more than the PRs 8,645/ha of the farmers who bought water. This difference suggests that owners were giving themselves better irrigation service than they were giving their water purchasers—an outcome that clearly shows one of the benefits of tubewell ownership.

Table 4.4: Relationship of Crop Yield and to Tubewell Ownership Status

	Project Area			*Nonproject Area*		
	Well Owners	*Water Buyers*	*Nonowners/ Nonbuyers*	*Well Owners*	*Water Buyers*	*Nonowners/ Nonbuyers*
			(MT/ha)			
Wheat	2.33	2.14	1.97	2.47	2.59	2.10
Paddy	2.19	2.07	1.85	2.37	2.06	1.94
			(PRs/ha)			
Fodder						
Winter	21,726	13,173	12,249	19,982	15,808	12,632
Summer	8,060	4,523	3,211	10,769	8,699	7,440
Vegetables	15,438	8,645	—	18,525	—	—

Source: Shahid and Khan, 1995, Table 5.1, p. 75.

Cropping Intensity

4.14 Cropping intensity was significantly higher for well owners than for farmers relying on rainwater and canals (around 25 percent in the project area and 13 percent outside) (table 4.5). But well owners had only slightly higher cropping intensities than water buyers—2.5 percent for the project area and 3.3 percent for the nonproject area.

Table 4.5: Cropping Intensity by Tubewell Status (percent of area per year)

Project Area			*Nonproject Area*		
Well Owners	*Water Buyers*	*Nonowners / Nonbuyers*	*Well Owners*	*Water Buyers*	*Nonowners/ Nonbuyers*
168.7	164.5	127.1	163.8	158.5	143.5

Source: Shahid and Khan, 1995, Table 5.1, p. 74.

4.15 The effect of well ownership on cropping intensity is clearer when the data are disaggregated by farm size (table 4.6). On average, the farms of tubewell owners, water buyers and nonbuyers differed in size, and farm size had an impact on cropping intensity. Farmers with less land used it more intensively, while those with more land were under less pressure to farm to full capacity. And it was the farmers with smaller holdings who *increased* cropping intensity the most, both in the project area and outside of it. Nevertheless, when the data are adjusted for farm size, well owners did marginally better than water buyers.

Table 4.6: Cropping Intensity by Farm Size (percent of area per year)

	Project Area			*Nonproject Area*		
Farm Size Category	*1989*	*1994*	*Increase*	*1989*	*1994*	*Increase*
(ha)			*(%)*			*(%)*
0-2	167	198	18	152	163	7
2-5	167	170	2	148	162	10
5-10	158	160	1	132	147	11
>10	142	149	5	128	129	1

Source: Shahid and Khan, 1995, Table 3.10, p. 32.

Farm Income

4.16 *Incremental net farm income* generated by the project is the best indicator of changes in participants' economic welfare. This indicator incorporates changes in cropping patterns and use of inputs, as well as higher yields resulting from project intervention. But it omits some sociological factors, such as risk aversion and the division of labor by gender. In the project area, the 1989 benchmark survey showed that the average annual net farm income before the project was PRs 995 per ha (table 4.7). Five years after the project began, it was PRs 1,158, an increase of 16 percent or PRs 163/ha. In the nonproject area, the average annual net farm income per ha was PRs 820 in 1989 and PRs 921 in 1994, an increase of 12 percent or PRs 101/ha (Shahid and Khan 1995, Table 3.15, p. 41). In annual terms, incremental net farm income attributable to project intervention was PRs 163 minus PRs 101, or PRs 62 per ha per year.

4.17 *Net farm income* is the best single proxy for the success of farming operations.[20] For this indicator, outcomes were roughly as expected at appraisal. However, nonproject farmers achieved similar benefits *without* the project, rendering the farm benefits quite modest. Further, when the figures were corrected for inflation to 1994 prices, they showed a decrease in real terms of 28 percent (PRs 445/ha) for the project area and 30 percent (PRs 400/ha) for the nonproject area. While project farms still fared better than nonproject farms, the overall project benefits were small.

4.18 Tables 4.7 shows net farm income disaggregated for farm size. The table shows not only that the income gains from the proliferation of private tubewells were small but that they were relatively uniformly distributed.

20. Net farm income is the difference between gross farm income and the sum of cash costs, inputs of family labor, rent of land and depreciation and interest on capital items.

Table 4.7: Net Annual Farm Income, by Farm Size (PRs/ha)

	Project Area			*Nonproject Area*		
Farm Size (ha)	*1989*	*1994*	*Increase*	*1989*	*1994*	*Increase*
			(%)			*(%)*
0–2	852	988	16	753	988	13
2–5	921	1,079	17	837	934	12
5–10	1,035	1,198	16	800	906	12
>10	1,205	1,410	17	845	958	14
Overall	995	1,158	16	820	921	12

Source: Shahid and Khan 1995, Table 3.15, p. 41

4.19 Table 4.8 correlates tubewell ownership and net farm income distribution in 1994. Tubewell owners did better than water buyers, who did better than farmers without access to private tubewell water. The differences here stemmed partly from differences in farm size and partly from the fact that well owners had the best access to water.

Table 4.8: Net Farm Annual Income Distribution, by Tubewell Ownership Status

	Project Area			*Nonproject Area*		
	Well Owners	*Water Buyers*	*Nonowners/ Nonbuyers*	*Well Owners*	*Water Buyers*	*Nonowners/ Nonbuyers*
PRs/ha	1,309	1,161	961	1,050	981	803
PRs/household	21,270	16,278	12,080	21,025	15,300	11,700

Source: Shahid and Khan 1995, Table 5.1, p. 75.

4.20 The project had a positive impact on the share of *net cash household income* going to small farmers (table 4.9). In 1989, small farming households (less than 5 ha) in both the project and nonproject areas received about 27 percent of total household income. By 1994, their share in the project area had increased to about 34 percent. Among the large farmers, the project had a greater impact on equity by reducing their share by 22 percent, compared with 15 percent in the nonproject area. Overall, the modest gains from the development of private tubewells were marginally greater in the project area than in the nonproject area.

Table 4.9: Share of Total Net Cash Household Income, by Farm Size (percent)

	Project Area			*Nonproject Area*		
Farm Size (ha)	*1989*	*1994*	*Increase*	*1989*	*1994*	*Increase*
0–2	10	13	+34	9	13	+38
2–5	17	21	+22	17	19	+11
5–10	28	30	+9	24	26	+ 8
>10	45	36	-22	50	42	-15
Total	100	100	—	100	100	—

Source: Shahid and Khan 1995, Table 3.18, p. 46.

5. The Economics of the SCARP Transition

5.1 Economic analysis shows that while the returns to the SCARP Transition Pilot investments were satisfactory, they derived primarily from savings to the government. Actual on-farm returns were negligible and would have been losses without the elimination of government subsidies for public tubewells. In the light of this finding, the evaluation asks whether there is a more cost-effective way to produce the same results. And given that market imperfections and some farmer dissatisfaction remain, the evaluation examines two alternatives to the system promoted under the SCARP Pilot.

Economic and Financial Returns

5.2 Assuming that the sample farms have fully adjusted to the transition from SCARP tubewell irrigation to private tubewell irrigation, the modest net incremental on-farm benefit—PRs 62/ha/year—is the financial benefit to project beneficiaries. Converted to economic prices and adjusted for public savings (the amount of SCARP subsidies the government did not have to pay), net of subsidies paid to private tubewell operators, it becomes the stream of economic benefits.[21]

5.3 The project's ERR—the return to Pakistan—is based on the impact evaluation's findings (annex 3). The principle project benefits are the savings to the government from shutting down the public tubewells in the project area and not investing in electrification. While the project's on-farm benefits are negligible, these savings led to an acceptable ERR of 18 percent on the resources invested in the project.

5.4 While the project was a satisfactory investment from this point of view, the impact evaluation survey shows that there is a lower-cost path to the same results—that is, that substantially the same farming results can be reached without such a project. The project's electric grid (and free power connections), canal improvements, technical assistance, administration, training, and monitoring and evaluation were, in retrospect, not needed to stimulate investment in private tubewells. It should be possible, after appropriate notification, simply to discontinue SCARP tubewells in fresh groundwater areas without such interventions and to achieve the same result. This fact was not obvious when the SCARP Transition Pilot began. In demonstrating it, this pilot project served its purpose.

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21. The Region recommended that the economic analysis take account of the subsidized cost of water provided by SCARP tubewells in the nonproject area because this would increase nonproject on-farm benefits thus reducing net incremental benefits attributable to the project. OED's analysis computes net incremental benefits on the basis of with-without agricultural performance in which water is only one component. Indeed, removing the effect of SCARP subsidies would nullify the without project comparator which is the SCARP project. Even if we wished to evaluate the effect of subsidies, this could not be done with the data available. The average amount paid for irrigation water in the project area and nonproject area was collected as part of the ex-post surveys, and it is clear that farmers in the nonproject area paid much less than project area farmers. However, there are insufficient data to determine how far the amount paid for water is affected by water subsidies. Other factors affecting the amount paid for water in the nonproject area compared to the project area include the changing mix of canal, public and private water supplies between benchmark and ex-post surveys, significantly different cropping patterns during the Kharif, different and unknown private tubewell technologies and power sources that affect water cost, and the imbalance of canal supply and demand that would decrease the volume of water and hence the amount paid for water

Fiscal Returns

5.5 Fiscal returns to the project were obviously high. The government captured more than 70 percent of the project's net present value (NPV) for a return on the investment of more than 50 percent (annex 3). Dispensing with the investments that made up the project's off-farm costs (and which were in fact unnecessary) would have raised this figure still more. In fresh groundwater areas, for instance, the government could simply have given appropriate advance notice, withdrawn its tubewell services, and removed its pumps to saline groundwater areas.

Financial Returns

5.6 With the government realizing such a large share of the net benefits, is there anything left for farmers? OED's audit found groups of small farmers who had invested in tubewells and were finding it hard to pay the cost of pumping. These farmers cursed the IDA and the withdrawal of the highly subsidized SCARP tubewell service.[22] Group ownership and operation do impose costs on the participants, as forming a group and keeping it running is not easy (see Olstrom 1992; Tang 1992). But the evidence suggests that returns to these tubewells should have been sufficient to allow the owners to cover their costs (see the section on group-owned wells below).

5.7 To assess the returns to well investments, the impact evaluation used not only data gathered for the survey but data collected in the Faisalabad District by the International Irrigation Management Institute (IIMI) and the International Food Policy Research Institute (IFPRI) (Meinzen-Dick 1995). These data present a forward-looking picture of private tubewell investments, since the actual costs to SCARP Transition Pilot farmers in 1986–92 are outdated. Economies of scale have developed over the intervening years, and smaller, more efficient diesel motors are now available. Meinzen-Dick found that the average annual investment cost for tubewells was PRs 8,852 (US$354) for electric wells and PRs 5,544 (US$222) for diesel tubewells. Electric-powered wells cost PRs 667 annually to repair and maintain, diesel-powered wells PRs 895. Using elaborate multiple-regression analysis, the study established the following annual incremental gross margins for private tubewell use: PRs 5,365 (US$215) when canal irrigation is not available, and PRs 15,326 (US$613) when it is.[23] On this basis, without canal water, an electric pumper gets a return of 6 percent on land, labor, investment, and experience and a diesel pumper 12 percent. When farmers have access to canal irrigation and use their tubewells to supplement it, an electric-powered pumper gets a return of 24 percent, a diesel pumper 46 percent.

22. OED Report 14769 of June 30, 1995, para. 4.17, p. 61.

23. Diesel and electric pumps generate equal irrigation. Manifestly, pump irrigation has a much higher average value when it is the "peaking power" and canal irrigation the "base load."

5.8 Based on these calculations, most SCARP Transition Pilot tubewell investors should have made good returns on their investments. Almost all were served by canal irrigation, though the supply was sometimes problematic at the tail ends of the canals. Smaller farmers complained about the cost of operating tubewells, a reflection of their anger at the withdrawal of the subsidies and the difficulties of successfully budgeting for the resulting increase. But the reason for the small net incremental on-farm benefit attributable to the project is not that farmers in the project areas did not do well, but that nonproject farmers did just as well.

Alternatives to the SCARP Pilot

5.9 Given the inequities discussed in chapter 4, the evaluation team asked if there is a more cost-effective solution that would generate approximately the same agricultural results and improve equity (or at least not create further inequities). Seen in the context of other research in Pakistan and of development experience in India, the survey results suggest that there may be.

Water Markets

5.10 Clues to potentially superior solutions lie in the markets that have developed for irrigation water in Pakistan.[24] These markets permitted 15 percent of the farmers in the project area (five-sixths of non-tubewell owners) to share the benefits of the investments of their neighbors. Tubewell owners with more water than they could use on their land were able to sell the excess water and improve their returns. In contrast to studies in the late 1970s and early 1980s, Shahid and Khan (1995) show that water buyers are not exploited by their well-owning neighbors but share in the benefits of those investments, doing almost as well agriculturally as well owners.

5.11 The impact survey's analysis stops there, but work in the same area by IIMI and IFPRI provides further insights.[25] Because the price of tubewell water is the O&M costs of the pump that delivers it, costs are highest for tractor-powered pumps and lowest for the electric variety. On average, the cost is PRs 32 (about US$1) per hour, a price that does not vary with the season or with shortages or surpluses. When pumps reach capacity during the summer, pump owners simply stop selling to water buyers. Meinzen-Dick (1995) reports that for Faisalabad, "there are numerous occasions on which tubewell water is not available to water buyers at any cost, despite their demand for it."

5.12 Meinzen-Dick, a sociologist, seeks the cause of these market imperfections. Most transactions take place among neighbors. The practical limit for water sales is a radius of 300 m around the well, unless the channels are lined, in which case sales may extend more than one kilometer from the well.[26] In the Faisalabad area, buyers are likely to be relatives and

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24. The evaluation surveys reveal a market for private tubewell water. Strosser and Kuper (1994) reveal that canal water is also traded illegally at 10–15 times the official rate.

25. Most prominently, Meinzen-Dick (1995), Malik and Strosser (1993), and, covering a nearby area of the Punjab, Strosser and Kuper (1994).

26. For a review of evidence on benefits and costs of canal lining, see OED's impact evaluation of Pakistan Credits 1163, 1239, 1487 and 1603 (Report 15863-PAK, 1996).

transactions highly personal. Apparently, this fact engenders high transaction costs for the seller, who is unable to charge his own long-run cost to his relatives.[27] Buyers benefit by getting water more cheaply than they could have through their own tubewell investments, but the service is less reliable because it can be cut off.

5.13 Whatever their cause, these market imperfections have three important effects. First, water buyers get lower-quality irrigation than well owners, even though buyers would probably be willing to pay more for water at critical times. Second, most well owners are not able to fully exploit their investments because they sell water below cost. And third, there are more wells and pumps—more investment—than there would be in a perfect market.

5.14 With a perfect market, the investment cost for a specified level of irrigation would be lower, buyers willing to pay for the same service as owners would receive it, and owners would sell water at a price that gave them a return to their investment. Such a market would resolve the problems discussed here.

5.15 Shah (1991) has argued that groundwater markets are becoming less personal over time. Groundwater markets seem to be improving in Gujarat and in the Pakistani Punjab, accounting for the differences in the findings of the studies conducted in the 1970s and early 1980s and those of the more recent studies cited here. Groundwater markets are a relatively recent phenomenon and have developed independently of government intervention (and often illegally). Their potential as a solution to problems of access and equity argues for their inclusion in the formulation of future irrigation policy.

Group Ownership

5.16 The utilization rate is higher for group-owned than for individually owned tubewells. For the Fordwah/Eastern Sadiqia, where the IIMI has specifically studied water markets, individual tubewells averaged 616 hours of operation per year. Group-owned wells averaged 816 hours, or 32 percent more (Malik and Strosser 1993). Group ownership, while sometimes problematic, benefits not only the group but society. Using the Fordwah/Eastern Sadiqia example, the same irrigation could be achieved with 25 percent fewer wells and pumps, thanks to higher capacity utilization, at a cost savings (net of the cost of forming the groups and keeping them operating) of 25 percent.

5.17 These returns could be even better, for two reasons. First, group ownership is more efficient than the still-imperfect water markets. As chapter 3 showed, water buyers, who purchase water below cost, do remarkably well agriculturally. But they still do not do as well agriculturally as owners, because the service is less reliable. Group ownership eliminates this problem. Moreover, since water buyers and group owners tend to have smaller farms than sole well owners, group ownership also promotes equity.

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27. An alternative explanation would be that overinvestment in wells and pumpsets (inspired by the prestige attached to owning one) is such that small farmers, without enough land of their own to fully use their investments, are desperate to sell water, even at less than cost. This hypothesis, however, is not consistent with a stable year-round price. Owners who have behaved irrationally by investing in more pumping capacity than they can use would be irrational not to sell water, even when it is scarcest and most in demand on their own farms.

5.18 Second, almost lost in the above discussions of efficiency and equity are the environmental issues raised above and discussed in chapter 6: the dangers of uncoordinated pumping by thousands of independent well owners, of insufficient pumping (leading to waterlogging), and of excessive pumping (leading to a drop in water tables below the operating depth of centrifugal pumps, unproductive investments , exaggerated pumping costs, and excessive salt buildup in soils and groundwater). A system that includes private wells but also has a high proportion of group-owned wells would probably also be easier to regulate when it is in the public interest to do so. Like water markets, group ownership has the potential to ease problems of equity and access and should be considered in future policy decisions.

6. Sustainability

6.1 The 1994 impact evaluation survey found that a third of the farmers in both the project and nonproject areas believed that the SCARP Transition Pilot had made the condition of their soil and water worse (Shahid and Khan 1995). Investigations show that about a quarter of the wells are in fact still brackish. And while farmers have managed to control the salinity of the soil thus far, the problems go well beyond the project, with potentially severe environmental consequences. This chapter discusses these issues and the related problem of unregulated pumping, all of which need to be addressed if Pakistan's irrigation system is to be privatized and remain viable.

Water Tables and Water Quality

The Water Table

6.2 To evaluate fluctuations in the water table resulting from the SCARP Transition Pilot, PERI collected data from the commands of ten SCARP tubewells that had been shut down and compared them with 1989 data for the same sites at the same time of year. The 1994 water-table depth varied from 3.3 m to 5.5 m; the average was 4.7 m, with a standard deviation of 1.0 m. Compared with a 1989 average of 4.4 m, the water table had fallen an average of 0.3 m. As the 1994 survey report says, "The lowering of the water table depth is a positive development of the project" (Shahid and Khan 1995). Had the water table been raised or lowered substantially, the impact would have been negative.

Water Quality

6.3 The 1994 survey asked farmers' opinions on the quality of their private tubewell water. The results for the project and nonproject areas did not differ significantly (44 and 52 percent, respectively), but over one-third of farmers in both areas reported that their private tubewell water was brackish or unfit for irrigation.[28] To determine the exact nature and likely cause of the problem, PERI retested the water quality from 40 previously tested tubewells. All 40 samples passed electroconductivity and sodium absorption ratio tests, as well as sodium, calcium and magnesium tests, but eight were found to have levels of residual sodium carbonate slightly higher than the permitted level, and two had levels over 80 percent higher. Altogether, 25 percent of the samples were pronounced unfit, even if most of them were only marginally so.

6.4 These results were an improvement on the preproject situation, when water from 90 percent of the tubewells registered as unfit. Electrical conductivity had declined by 39 percent on average and residual sodium carbonate by 88 percent. Though the sodium absorption ratio had, on average, increased by 61 percent, it was still within acceptable limits in all cases. The survey did not test water quality in wells outside the project area.

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28. Asked how they knew tubewell water was having adverse effects on their soil, 80 percent of the farmers said they could see it, and the rest cited the results of soil or water tests. When asked the nature of the adverse effect, most farmers mentioned the white salt that appeared on the surface when the soil was dry, and/or soil hardening. See Shahid and Khan 1995.

Soil Quality

6.5 Given the area's semi-arid conditions, salt and exchangeable sodium buildup in soils is a problem, as there is not enough rainfall to leach the salt out. With private tubewell irrigation, farmers should be able to recognize, diagnose and solve this problem by applying enough water to leach salts down to levels that will not result in too much crop damage—at least if the tubewell water itself is not too salty. To see whether the farmers were correct, the impact evaluation survey collected and analyzed soil samples from the commands of 41 wells, analyzed them, and compared measures of salinity, sodicity, and alkalinity with 1989 preproject readings. In 85 percent of the samples, soil alkalinity, salinity and sodicity were within acceptable levels. The other 15 percent were saline, and half were sodic as well. But the tests also revealed that salinity (as measured by electrical conductivity) had increased by 82 percent on average, sodicity (as measured by sodium absorption ratio) by 13 percent, and alkalinity (as measured by pH) a modest 5 percent. At one test site the soil was saline and sodic enough to inhibit growth.

6.6 The survey findings show that except for the one saline/sodic plot, farmers were letting salts build up, but not to the point of seriously affecting farming, and were using tubewell water to leach the salts when the concentration became too high. They also show a sharp increase in the percentage of cultivated land that farmers considered saline, from 0.6 percent in 1989 to 18 percent in 1994. Private tubewells have apparently improved the farmers' ability to cope with salinity: they cannot get rid of it, but by leaching with private tubewell water, they can keep it under control.

6.7 These results do not touch on a far more serious problem, however. Even in the "fresh groundwater" area where the project farms are located, water from the shallow aquifer, which shallow tubewells tap, is more saline than canal water from the Indus system. Because salt is not absorbed by the plants and does not evaporate, soil salinity rises as shallow pumping increases.[29] Leaching it out of the root zone only returns it to the aquifer, where it once more contributes to the salinity of the groundwater. While the SCARP Transition Pilot farmers apparently were able to manage the salt levels of their soil well, the salinity is part of a much more widespread problem that shallow private tubewells cannot solve—and which they may actually make worse.

6.8 The environmental consequences of secondary salinization are potentially devastating, but cost-effective solutions are available. The government is tackling the problem of salinity caused by brackish tubewell water by providing subsidies for the use of gypsum. Returns from gypsum application to rice-wheat rotation far exceed its cost in Pakistan (Siddiq 1994), and a similar subsidized program was very successful in the Indian Punjab.[30]

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29. For a global view of Pakistan's salinity problem, see Mulk 1993. World Bank (1994) includes a 28-page summary.

30. Some critics maintain that subsidies should be stopped, however, arguing that the PRs 100 million spent on the program in 1991 could have been used to finance campaigns to increase the awareness of the benefits of gypsum application and to fund extension services to ensure that it was used efficiently. See Pakistan: Economic Policies, Institutions, and the Environment. Report 15781-PAK, World Bank, 1996.

Unregulated Pumping

6.9 The SCARP Transition Pilot area is now well drained, and the water table has not yet fallen to levels at which pumping becomes prohibitively expensive or centrifugal pumps can no longer reach the water table. But with thousands of pumps operating independently without coordination or planning, can this result be maintained? The Khankah Dogran area is close to major supply canals and difficult to pump down, but the same is not true for all the Punjab. Unregulated shallow tubewell development treats groundwater as a free public good, allowing farmers to pump as much as they like. This condition, especially when combined with the problem of salinity, argues against sustainability.

6.10 If there is a case for regulation in the public interest to ensure the supply of a precious natural resource and prevent environmental damage, there is also a case on the grounds of economic efficiency. As the survey shows, without regulation, private individuals and groups have invested in many more tubewells and pumps than are necessary to irrigate the area. Overall tubewell capacity use in the project area was 7 percent in 1994, but only 4 percent for the smallest farmers.[31] Until the optimal capacity-utilization figure is determined, it remains at least the 13 percent achieved by the larger farmers.[32] The optimal figure will probably be somewhat higher, but even so, private tubewell capacity in the project and control areas is currently twice what it needs to be to deliver the irrigation results now being achieved.

6.11 These calculations compare full development to what the more efficient private farmers are already achieving, not to the much higher efficiencies of large public SCARP wells, which averaged 70 percent utilization in 1960. Even in 1985, when the system was reeling from poor maintenance, they averaged 45 percent (Malik and Strosser 1993). While private tubewell development is effective, it is clearly not the least-cost solution to the irrigation problem, even if it does minimize social and transaction costs.[33] But direct regulation also may not be the most effective way to control groundwater demand.

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31. IIMI's study in the same area found an average utilization rate (also based on 20 hrs/day) of 9.4 percent with 55 percent of the wells below 5 percent (Malik and Strosser 1993). At Fordwah/Eastern Sadiqia, IIMI found a utilization rate of 10 percent (Strosser and Kuper 1994).

32. Capacity utilization of 7 percent does not mean that there is 14 times (the reciprocal) the installed capacity needed to irrigate the command. Even if the marginal cost were zero, it would not be useful to run tubewell pumps 20 hours/day on average. Circumstances vary. In Khankah Dogran, to use an electric power analogy, rainfall and canal water form the base load, and private tubewell water is the peaking capacity. Tubewell use and water sales peak in July–October for kharif, with a smaller rabi mode in January–March. Strosser and Kuper (1994) show a similar situation on five watercourses in Fordwah/Eastern Sadiqia. Even relatives farming a large area with an electric pump and paying a flat rate for electricity (and thus with the financial incentive not to economize) averaged only about four pumping hours/day (20 percent utilization factor). They used the pumps to full capacity only when rain and canal water was insufficient for the paddy crop. Farmers farming more than 10 ha in the evaluation sample and control averaged 13 percent capacity utilization (Shahid and Khan 1995). The optimum capacity utilization according to these calculations should be around 15 percent.

33. For similar findings on the high cost of private groundwater development in India's Ganga Plain, see OED's audit of India—Second Uttar Pradesh Public Tubewells Project (Credit 1332, approved March 1983), OED Report 14732 of June 29, 1995. The IDA's current policy favors such private groundwater development in India.

Water Pricing Policy and Sustainability

6.12 Water pricing policy profoundly affects the utilization of water investments and the efficiency of fresh water resource use, thus affecting waterlogging and salinity. This fact was ignored when the SCARP transition project was being prepared, although pricing policies subsequently had a major impact on farmers' selection of pumping equipment (para. 3.11).

6.13 Pakistan's economic policies on environmental management do not include pricing incentives to conserve water. The subsidy for canal water accounts for more than 50 percent of O&M costs and is much higher if measured in terms of the opportunity cost or the cost of tubewell water. Underpricing water and basing charges on the area irrigated rather than on the actual quantity applied have eliminated incentives to use water efficiently and aggravated waterlogging and salinity (Ahmad and Kutcher 1992). Underpricing discourages not only water conservation but also private investments aimed at making irrigation more efficient, such as the lining of on-farm watercourses and drip or trickle irrigation. Not surprisingly, despite the large number of on-farm water management projects implemented since 1978, only about half the conservation savings envisaged in the government's RAP have been achieved.[34]

6.14 Further, tubewell drilling and electricity are still subsidized, and tubewell drilling is not restricted, even though tubewell water is traded at a price several times higher than canal water. In areas where groundwater is limited, then, there is no way of regulating groundwater use. The standard response to this problem is to regulate installed capacity, either by issuing licenses or restricting tubewell density. But such regulation has proved not only ineffective but inequitable, for several reasons (Johnson 1992). First, the certification process is open to manipulation by both farmers and officials. Second, because most wells are drilled privately, they are difficult to monitor.[35] Third, controlling installed capacity tends to formalize existing inequalities governing access to groundwater supplies, because the richer farmers own the bulk of the existing wells. Controlling tubewell density would only shut out small farmers altogether. And even if the controls could be made effective, they would not guarantee that water supplies were properly regulated, since there would be few price incentives to induce conservation.

6.15 Economic policy also distorts tubewell water use. Recent research on the effect of water pricing on use in the SCARP I Lager distributary in 1988–89 clearly shows a strong inverse relationship between price and volume used (Johnson 1992) (fig. 6.1).

6.16 Electrical power tariffs promote the overexploitation of groundwater resources. Data from Johnson (1992) and Meinzen-Dick (1996) show that while the cost differential between flat-rate electricity and diesel costs has narrowed between 1988–89 and 1991–92, electrically powered wells are still the cheaper option (fig. 6.2). Even then, the way in which electricity is billed also has a marked effect on the volume of groundwater pumped. Those with metered billings pay by the kilowatt-hour used, so that the amount they pay is directly tied to the volume pumped. Those paying a flat rate pay the same irrespective of the volume pumped and thus have no incentive to conserve. In the Lagar command of SCARP, for example, for farmers with holdings of comparable size, flat-rate electric wells pumped almost twice as much as their metered counterparts and almost four times as much as nonelectric wells (Johnson 1992).

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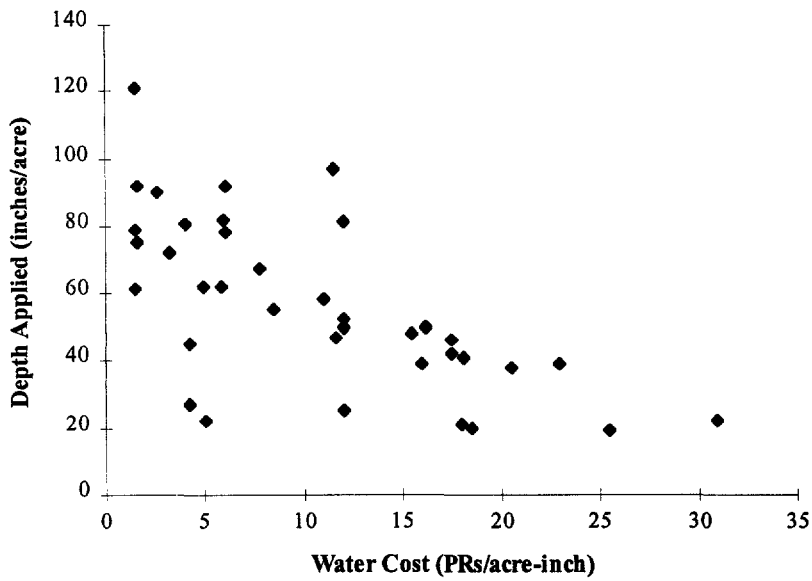
34. OED, Report 15863-PAK 1996.

35. Even the official survey for the SCARP transition project seriously underestimated the number of private wells.

Figure 6.1: Kharif Water Use and Tubewell Water Cost



Source: Johnson 1992, Figure 7, p. 17.

6.17 Developing this argument further, Johnson (1992) argues that if the money invested in the SCARP transition pilot project had been invested differently, there could have been substantial equity and environmental benefits. He estimates that 13,000 diesel-power tubewells could have been installed instead of the 2,100 SCARP transition pilot wells. Even better, if the pilot project had invested only in drilling boreholes and installing tubewells, leaving farmers to provide the pumps, almost 20,000 boreholes could have been installed. Even though the numbers are large, current practices indicate that farmers would have relied on tractor pumping, at least initially. Given the high cost of water that tractor pumping entails, there would have been a marked conservation effect.

6.18 Inattention to the effects of underpricing water and of subsidies on the proliferation of private tubewells can have a major impact on the sustainability of groundwater-based irrigation. Johnson's study (1992) shows that the safe yield of the aquifer is being exceeded by more than 35 percent, and OED analysis for Pakistan as a whole shows a modest mining of groundwater in freshwater areas but a continued rise in groundwater levels in saline water zones (table 6.1).

6.19 Water pricing policy could be a powerful tool to ensure sustainability. Increasing the cost of canal water would lower overall water use and thus the volume of seepage that replenishes fresh groundwater areas. In fresh groundwater areas, a further decline in the water table would gradually reduce both groundwater losses from evaporation and concentrations of salts near the surface. If full-cost pricing of groundwater were effective, the increased depth of the water table would also increase the cost of tubewell water and induce farmers to use water more efficiently.

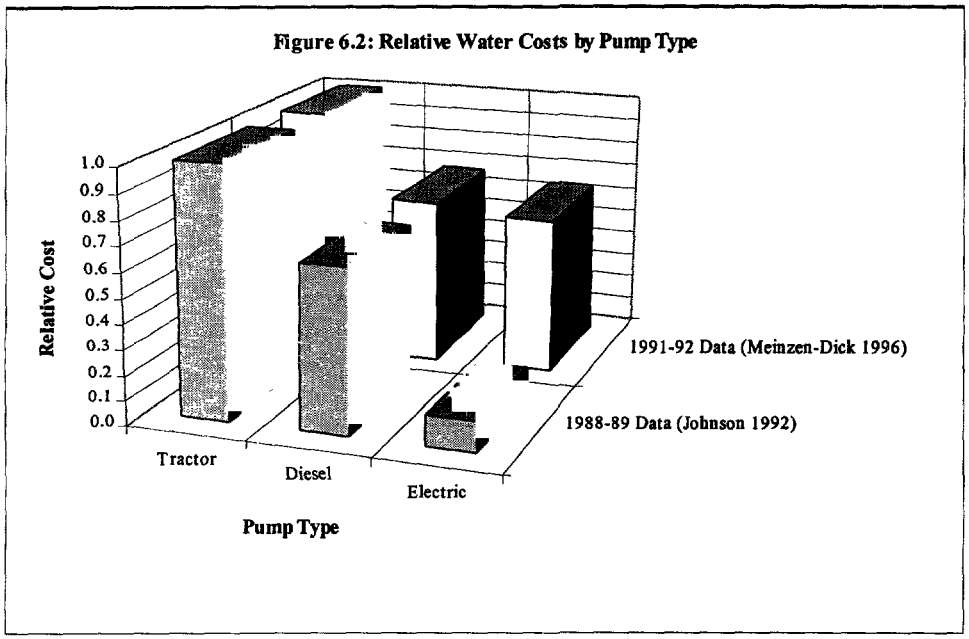


Table 6.1 Groundwater Balance for Pakistan (million acre-feet)

	Fresh	*Saline*	*Total*
Inflow			
Rainfall	1.2	0.8	2.4
Tubewell water	9.8	0.0	9.8
Canals	13.4	8.4	21.8
Watercourses and fields	16.8	14.9	31.7
Rivers	-1.0	-0.3	-1.3
Total Inflow	40.5	23.9	64.4
Outflow by tubewells	38.9	0.0	38.9
Balance	1.6	23.9	25.5
Evaporation from groundwater	4.5	11.2	15.7
Balance after evaporation	-2.9	12.7	9.8

Source: OED Report 15863-PAK World Bank, 1996, Table B.1.

6.20 Clearly, at some point rising groundwater costs would force farmers to reduce pumping so much that their private tubewells would no longer provide sufficient drainage. Thus, there are sound economic arguments for the differential pricing of canal water and the elimination of flat-rate pricing of electricity. In saline areas, where farmers need to increase their drainage capacity and reduce seepage by lining watercourses, raising the price of canal water could generate the revenue to pay for such measures and induce conservation. Conversely, in fresh groundwater areas, lowering the price of canal water would maintain seepage inflows and recognize that private tubewell owners are providing a public good in using vertical drainage. On balance, a robust policy for water pricing could eliminate the need for measures to directly regulate private sector access to groundwater.

7. Conclusions

7.1 The SCARP Transition Pilot achieved its objectives: to transfer responsibility for pumping fresh groundwater from the public to the private sector, and to increase agricultural production and farm incomes (especially for small farmers) through the improved use of surface and groundwater supplies. Farmers installed their own wells and were able to bear the costs themselves. The improved irrigation service has generally been sufficient to provide acceptable returns on these investments. Productivity gains from higher yields and cropping intensities and shifts to high-value crops have been sufficient to offset the additional costs, although the increases have not been as great as appraisers hoped. The water table has not been disturbed or the soil harmed, and water quality has improved. And despite expectations to the contrary, the transition has had a modest but positive effect on income distribution.

7.2 The project outcome is satisfactory and its sustainability likely, despite some long-term doubts. Institution building in the private sector was substantial, including groups of well owners and a market nexus of owners willing to sell water and nonowners willing to buy it. Most projects with such ratings would be worth repeating, but the SCARP Transition Pilot is not, as the same results were achieved at far less cost in similar areas without the project's interventions. The impact evaluation survey shows that the project's achievements were part of an upsurge in investment in private tubewells that was already taking place when the project began and that continues in fresh groundwater areas all over the Punjab.

A "Demonstration Effect"?

7.3 Proponents of the SCARP Transition Pilot argue that the achievements outside the project area were the result of the project's "demonstration effect" and ought to be claimed as benefits.[36] The survey's control group was changed in response to complaints that the control was tainted by the proximity of transition. Even after the changes, however, some believe that the control merely captured more of the project's benefits.

7.4 Can the critics be correct? If they are, several factors could have stimulated the "effect." The removal of eight SCARP pumps in November 1, 1987, signaled that the government of Punjab was serious about abandoning SCARPs in fresh groundwater areas. The project and the IDA's support for it may have offered the government of Punjab the courage it needed to take this step. But the upsurge of private tubewell investment has been so geographically widespread that it seems implausible to attribute all or even much of it to this pilot scheme.

7.5 Ultimately, however, whether the SCARP Transition Pilot was indirectly responsible for the increase in private tubewell investment outside the project area is merely an interesting historical question. Far more important is the question of what should be done now, given what has been learned from the pilot.

7.6 When the preliminary findings of the impact evaluation survey first became known, an OED mission visited the Provincial Irrigation Department (PID) to ask whether the tentative

36 . In a similar situation, supporters of Malawi's Lilongwe Rural Development project claimed benefits outside the project area when the without-project outcomes turned out to be identical to project results.

results seemed to ring true. The officials confirmed that the private tubewell investment phenomenon was widespread and, most likely, just as intense outside the project area as within it. The most appropriate way to achieve the project objectives throughout Punjab's fresh groundwater areas, the PID officials suggested, was the "do-nothing mode." Arguably, they are right, but considering the potential environmental and sustainability problems involved in unregulated private tubewell development (chapter 6), simply letting things take their course may not be sufficient.

Plans for the Future

7.7 In preparing the follow-on Privatization of Groundwater Development project, both the IDA and the borrower are mindful of the lessons of the SCARP Transition Pilot project and of the tentative lessons of its on-going sequel, the Second SCARP Transition project. General subsidies for private tubewell investment have been eliminated as unnecessary, as have electricity subsidies, which skew the choice among diesel, electric, and tractor-powered pumping (most farmers opt for diesel). The project under preparation recognizes the ineffectiveness of SCARP Transition Pilot's efforts to promote group ownership. However, the restructured Second SCARP Transition project community organization's efforts have led to installation of 1500 tubewells in Punjab and Sindh in just two years. The new project is expected to focus its promotional efforts exclusively on community-owned tubewells. Investment assistance would be provided to cover the costs of forming and maintaining groups. But the assistance will be geared toward promoting a small number of intensively used community tubewells rather than a large number of underutilized individually owned tubewells, because the community wells will provide the greatest social benefits.

7.8 This effort would break new ground in Pakistan. It has parallels in India, however. In the Ganga Plain, uncoordinated sinking and pumping of private tubewells has led to serious depletion of the aquifer in many locations. The authorities have forbidden further groundwater development in some areas (known as "black zones") and regulates it tightly in others ("gray zones"). As in Pakistan, the traditional public tubewell system is in disarray. Attempts to improve it with tubewell systems engineered to design around the problems were initially declared successful. Subsequent examination has shown that these efforts failed miserably in Uttar Pradesh and in Bihar. [37] In West Bengal, however, the package was further modified and is succeeding.[38] A small Indo-Dutch project in eastern Uttar Pradesh with similar characteristics is also succeeding.[39] What these successful adaptations have in common is (a) public identification and fostering of community groups; (b) public construction or rehabilitation of groundwater systems to high standards;[40, 41] and (c) community ownership and operation of the systems.

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37. OED Report 14732 of June 29, 1995, the audit of India—Second Uttar Pradesh Public Tubewells Project (Credit 1332-IN); Report 14409 of April 28, 1995, the Implementation Completion Report of India—Bihar Public Tubewells Project (Credit 1737-IN).

38. See Report 14677 of June 26, 1995, the Implementation Completion Report on India—West Bengal Minor Irrigation Project (Credit 1619-IN).

39. For more information, see discussion in OED Report 14732, cited above, especially chapter 6 and annex B.

40. Notably a design duty of 3.3 times that of the failed systems of Uttar Pradesh and Bihar.

Similar measures are being proposed under the Privatization of Groundwater Development project. Based on the findings of this impact evaluation, this fact alone is grounds for optimism.

41. The Region states that rehabilitating SCARP tubewells is not an option for Pakistan. The tubewell technology is too complex, and SCARP tubewells, being deeper than private tubewells, tap poorer quality groundwaters.

Revised Economic Analysis

1. The analysis of costs in the Project Completion Report (PCR) includes major benefits from cost savings to the government from shutting down the SCARP public tubewells in the project area. This analysis is confirmed, with one exception. The PCR's assumption of operation and maintenance (O&M) costs for large irrigation canals without the project (PRs 5,200 million at full development) as opposed to much lower with-project costs (PRs 1,325 million) is not reasonable.[1] As it stands, this difference represents a major project benefit. In fact, there is no reason to believe that project expenditures on canal improvement lowered O&M costs, and certainly not to one-fourth of what they would have been in the absence of the project. This alleged benefit has been eliminated.

2. The PCR's adjustments from prevailing (financial) to national (economic) prices are confirmed.[2]

3. The PCR's analysis of net farm benefits,[3] which admittedly never had an empirical basis,[4] has been discarded in favor of a calculation based on the findings of the impact evaluation survey: a net incremental on-farm benefit of PRs 62/ha. This figure is *not* adjusted to economic prices because (a) the net adjustments are minor, as the PCR shows; and (b) the on-farm benefits are so small that such adjustments would not materially affect the economic rate of return (ERR). The PCR has correctly reported the size of the affected areas and the numbers of new tubewells installed per year. It has been assumed that no production is lost in the switch from public to private tubewells, that no gains are realized in the year of the changeover, and that an additional one-fifth of the full-development increment of PRs 62/ha is realized in each of the subsequent five years as the farmer adjusts to his new resource. This assumption may be conservative but, like price adjustments, it does not materially affect the ERR because on-farm benefits are already so small.

4. The ERR—18 percent—is principally the savings to Pakistan of not operating SCARP tubewells in the project area, of not having to spend PRs 40,000 million on power supply improvements in 1987–88, and of not having to replace the project area's SCARP tubewells in 1987–92. The analysis assumed that, without the project, these expenditures would have been made.

5. Agricultural production did not fall when SCARP tubewells were removed, thanks to private tubewell investment and O&M. As the impact evaluation surveys have shown, however, the project's expenditures (installing the electric grid and hookups, improving canals, technical assistance, and training) had little to do with generating this investment, which occurred at the

1. See PCR, Annex Tables 8 and 9, pp. 28 and 29.

2. PCR, Annex Tables 5 and 6, pp. 25 and 26.

3. See PCR, Annex Tables 2, 3, 6 and 7, pp. 22, 23, 26, and 27.

4. See PCR, para. 6.5, p. 6.

same level and speed in similar areas in the absence of a project. Therefore, the same benefits (stable farm production, no cost from SCARP tubewells) could have been achieved at less cost.

Table A.1: Project Economic Benefit and Cost Streams (Constant 1991–92 PRs million)

Year	*Private Tubewells* *Invest*	*O&M*	*Electric (Net)*	*Canal Improve-ments*	*Other Project Costs*	*SCARP Replace Avoided*	*SCARP O&M Avoided*	*Net Farm Benefits*	*Net Benefit*
1986–87	-2.2	—	-4.3	-9.3	-3.2	0.0	28.4	—	9.4
1987–88	-4.7	0	28.5	-13.6	-2.8	7.6	26.0	0	41.0
1988–89	-2.9	-0.2	-98.1	-8.0	-11.4	7.0	25.7	0.2	-87.7
1989–90	-13.8	-0.3	-33.4	-8.8	-7.4	9.9	26.2	0.4	-27.2
1990–91	-12.0	-0.6	-24.1	-8.1	-6.2	8.9	25.3	0.8	-16.0
1991–92	-6.2	-1.0	-21.8	-1.0	-5.2	8.3	25.6	1.6	.3
1992–93	—	-1.1	-5.0	—	-0.9	—	25.6	2.5	21.1
1993–94	—	-1.1	-5.0	—	-0.9	—	25.6	3.2	21.8
1994–95	—	-1.1	-5.0	—	-0.9	—	25.6	3.9	22.5
1995–96	—	-1.1	-5.0	—	-0.9	—	25.6	4.4	23.0
1996–97	-2.2	-1.1	-5.0	—	-0.9	—	25.6	4.5	20.9
1997–98	-4.7	-1.1	-5.0	—	-0.9	—	25.6	4.5	18.4
1998–99	-2.9	-1.1	-5.0	—	-0.9	—	25.6	4.5	20.2
1999–2000	-13.8	-1.1	-5.0	—	-0.9	—	25.6	4.5	9.3
2000–2001	-12.0	-1.1	-5.0	—	-0.9	—	25.6	4.5	11.1
2001–2002	-6.2	-1.1	-5.0	—	-0.9	—	25.6	4.5	16.9
2002–2006	—	-1.1	-5.0	—	-0.9	—	25.6	4.5	23.1

Note: Undiscounted NPV=PRs 328.3 million. ERR=18 percent (because the cumulative net benefit stream changes sign twice, from positive to negative in year 3 and from negative to positive in year 10, this ERR is not unique).

Fiscal Analysis

Table A.2: Project Fiscal Benefit and Cost Streams (1995 PRs million)

Year	*Electric (Net)*	*Canal Improvement*	*Other Project Costs*	*SCARP Replace Avoided*	*SCARP O&M Avoided*	*Net Benefit*
1986–87	-3.444	-7.416	-2.54	0.0	22.723	9.323
1987–88	24.388	-11.797	-2.389	6.528	22.325	39.055
1988–89	-90.024	-7.296	-10.487	6.424	23.578	-77.805
1989–90	-31.866	-8.366	-7.075	9.445	25.023	-12.839
1990–91	-24.556	-8.272	-6.358	9.069	25.786	-4.331
1991–92	-23.197	-1.013	-5.631	8.831	27.196	6.186
1992–2005 (average)	-7.294	—	-1.313	—	37.35	28.743

Note: undiscounted NPV=PRs 333.2 million; NPV @ 50%=PRs 3.0 million. ERR>50% (because the cumulative net benefit stream changes sign twice, from positive to negative in year 3 and from negative to positive in year 8, this IRR is not unique).

FAX MESSAGE

NO. 2(32)ECA/84-VII
GOVERNMENT OF THE PUNJAB
PLANNING & DEVELOPMENT DEPARTMENT

Dated Lahore, the 19th May, 1997

To

The Joint Secretary(Banks),
Government of Pakistan,
Economic Affairs Division,
I S L A M A B A D

SUBJECT: SCARP TRANSITION PILOT PROJECT (CR. 1693-PAK) IMPACT EVALUATION REPORT

Kindly refer to World Bank, Washington letter dated April 21, 1997 from whereby a copy of above mentioned report has been forwarded by them.

2. We generally agree to the contents/conclusion of the report. However, following comments are offered:

i) The project has been completed in the recent past and its effect would be visible only after a period of at least 10 years.

ii) The Water table level and soil salinity should be observed by Agriculture and Irrigation Departments regularly.

iii) The mode of installation of private tubewells was expensive and concept of equity was lost with project implementation due to the installation of individual farmers owned private tubewells because water of SCARP tubewells was flowing in the water courses and was available to all beneficiaries but now it is being used by farmers who have installed their own private tubewells.

3. Comments of the Project Director SCARP Transition Project would follow. It is requested that above mentioned comments may be forwarded to World Bank.

(NADEEM HASAN ASIF)
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No. PD/PPGD/97/289-80-114/97
Dated 27/05/1997

To:

Mr. Usman Qamar
Projects Advisor
IDA Resident Mission
The World Bank
Islamabad.

Subject COMMENTS ON (DRAFT) IMPACT EVALUATION REPORT
SCARP TRANSITION PILOT PROJECT.

Ref: Telephonic talk dated 27.5.1997.

I am enclosing comments on Draft Impact Evaluation Report Scarp Transition Pilot Project. These were received from Project Manager of Punjab Groundwater Consultants on the evening of 26th May, 1997. I am enclosing the comments part only and I am withholding "major differences from Pilot Project and Punjab Private Sector Groundwater Development Project and lessons for policy changes". These will be referred to the concerned Departments of Government of Punjab for seeking their comments.

It may be treated in supersession of my fax (unsigned) on the same subject on dated 24.5.1997.

Mian Hafizullah
Project Director

cc: Mr. C. Maloney, Project Manager, PGC Consultants
89-A/I, Township, Lahore.

C. Maloney and PGC staff

Comments on (Draft) Impact Evaluation Report: SCARP Transition Pilot Project

dated 20 March 1997

1. Institutional Development

Objective of the Project was "to develop a replicable package of technical and institutional components."

The *Impact Evaluation Report* stated "project provisions to foster group ownership were ineffective" (Exec. summary 17).

Despite this, the *Evaluation* rated institutional achievement as "fully achieved" (Exec Summary 15) and "substantial" (p. 16), because the project was intended, not to build but to **destroy** the public institution promoting SCARP tubewells (p. 27 fn.).

Then it says that the idea that WUAs would take over the SCARP tubewells did not work out (2.11).

The Conclusion rated institutional development as "substantial" for a different reason: "groups of well owners and a market nexus of owners willing to sell water and non owners willing to buy it" (7.2). In fact, the Pilot Project did not create water markets, which were there long before the project, and moreover farmers buying and selling water cannot be defined as an "institution".

OED agrees water markets were present before the project—see paras. 5.10, 5.11, 5.15.

The following points are evident:

1) There was no institutional development in the project in the sense of sustainable farmer groups or WUAs. There is no evidence that the project produced more or stronger groups.

OED agrees. See paras. 3.1, 3.2, 3.3.

2) In project implementation, as far as is evident, there was no real effort at building up sustainable institutions for water management by water users, and no staff assigned to that task.

OED disagrees. See paras. 3.6, 3.8.

3) The people conducting this *Evaluation* themselves had little idea of what institutional development means, as their interests were in water technology, agronomy, and economics, without input of social science.

OED disagrees.

Probably that is why PPSGWDP has been designed differently, with a heavy component addressed specifically to institutional development.

2. Group Ownership and Equity

Though the *Evaluation* says that group ownership is more effective than water markets (5.17), it says nothing about development or growth of farmer groups. It states that group ownership promotes 1/3 higher capacity utilization of water, and concludes that the project therefore promoted equity (4.15). This is largely because the groups consist of small farmers (having under 5 ha). The mechanism is not shown, except that small farmers are said to be under more pressure to use their resources more efficiently.

In this respect the *Evaluation* supports the policy of PPSGWDP to focus on irrigation needs of small farmers and to pursue equity as an issue.

3. Point of View of Farmers?

The *Evaluation* states that it "assesses the project's impact from the point of view of the beneficiaries rather than the government" (1.22).

This is not true because both ERR and institutional development were judged to be successful purely because of effect on government! And the fact that the word "beneficiaries" is used here shows that the authors had little professional idea of how to actually look at the project from the point of view of the farmers, except to collect statistics on crops and profits.

OED disagrees. PERI's surveys of farmers' views were the basis for the evaluation. Private sector development was successful, see para. 3.8.

4. Social, Psychological, and Time Costs of Farmers to Organize

The authors of the *Evaluation* relegated this exceedingly important point to just a footnote (3.3 fn.), suggesting lack of understanding of the process and costs of forming WUAs.

This has perhaps been corrected in planning PPSGWDP.

5. Over-capacity of Tubewells

The *Evaluation* found clear evidence that there was over-capacity of private tubewells in some places, because utilization declined and also price of water was falling below cost (pp. 41-43).

This may have important implication for PPSGWDP, demand for community tubewells may not be nearly as much as anticipated in project documents.

6. Water Markets

Earlier studies in Pakistan grossly underestimated or ignored indigenous water markets—sale of tubewell water, sale/exchange of waranbandi turns, etc. The market rates are 6 to 10, or even 15 times the official rate (p. 59 fn.). The Pilot Project also underestimated it (1.12, 3.5). The over-capacity of pumps in some places now is affecting the price.

Yes, but this omission was picked up by the evaluation surveys.

PPSGWDP is taking note of water markets in its Watercourse Assessment Survey, as part of prioritization for subsidy for tubewells.

7. Lining of Watercourses

The Pilot Project did some lining in 182 watercourses, and collected not 70% as expected but 36%, and 15 watercourse works were left incomplete.

In view of the poor organizational efforts of the Pilot Project, it is surprising that even 36% was collected from the farmers.

8. Lining of Canals

The Pilot Project lined 32 km of canals. The *Evaluation* does not say that the farmers paid any part of this cost (2.13).

It does. See para. 2.13.

PPSGWDP is expected to organize farmers (in 3 tiers?) on 26 distributaries in saline areas with the intent to collect from them half the cost of the lining. There is no evidence from the Pilot Project (or any other sources) that farmers will organize just for that. The issue involves reorganization of the entire government policy about distributary canal management and its economics.

OED agrees that there are few incentives for farmers to organize to pay canal lining costs. See Chapter 5 of OED's Pakistan Impact Evaluation (Report No. 15863-PAK, June, 1996) which examines on-farm water management issues.

9. Capacity of Tubewells and Additional Construction

The Pilot Project shows that farmers often preferred to install over-capacity pumps for water security—they installed more 1 cu pumps and fewer 1/2 cu pumps than expected. But they did not want to pay for sumps, pumphouses, concrete floors, etc. (3.10).

This suggests to PPSGWDP may find the same preferences.

10. Credit

The Pilot Project found that in only 10% of cases did farmers need credit to install PTWs (3.10).

This is in line with our understanding of field conditions, and is why in PPSGWDP not much importance is given to this issue, though networking for credit will be done when necessary.

11. Electricity, Diesel, or Tractor Power

The *Evaluation* contains mixed and contradictory suggestions about preferences and costs of electric as against diesel pumps (3.5, 3.11, 5.7). The main objection to electricity is not so much cost, as power cuts.

OED disagrees. The evaluation statements about the relative merits of diesel and electrically powered pumps are not contradictory. Para. 3.5 does not even raise the issue. Para. 3.11 generally concludes that farmers prefer diesel; para. 5.7 (quoting Meinzen-Dick 1995) says that in the trade-off between capital costs and long-term operations and maintenance costs, diesel powered wells do better.

This suggests that the preference expressed in PPSGWDP documents for diesel over electricity may not remain true. This depends much on government pricing policies. Generally electricity is more efficient, and also cheaper, and we may expect the farmer preference in PPSGWDP to eventually move to preference for electricity.

OED disagrees with this conclusion. Para. 6.16 and figure 6.1 demonstrate that cheaper power (electricity) promotes excessive water use.

12. Cost of Electrification

The Pilot Project invested heavily in **dedicated** electric lines for pumps. This was despite IDA finding that in Uttar Pradesh, Bihar, etc., the idea that there should be power lines dedicated to irrigation pumping was not successful (1.12 fn.).

OED disagrees. The Indian examples quoted were implemented at the same time as this project and the finding that dedicated power lines were not successful emerged only after the SCARP Transition Pilot was closed.

PPSGWDP omits this component, expecting that more farmers might prefer diesel, but that may well change, and then the issue of electric lines will come up again. And if so, the idea of dedicated power lines should be resisted even if there is partisan interest that these should be built.

13. Farmer Income

Incremental income of farmers increased only Rs. 62/ha/year, which is less than inflation and therefore was a decrease of income, both in project and control areas (4.7, 4.16-17).

This raises the question, whether PPSGWDP can succeed if incremental income will be so low. The first point is that Impact Evaluation of such a small difference is not likely to be reliable. The larger point is that PPSGWDP is not viable if justified just by a presumption of increased income, without institutional and policy changes about wider water management.

Farm prices have been kept depressed not just by irrigation factors but by government pricing/food control policies, and if increased production and better water management are expected of Punjab farmers, they may need to get rid of controls and let the market determine prices, whatever the political cost.

14. Expectation of Shift to High Value Crops

The Pilot Project expected significant shift by farmers to "high value crops" which would justify project costs. But cropping patterns did not change much. There was some shift to fodder and vegetables (4.5). This has a benefit not shown in the *Evaluation*: better nutrition (proteins through milk products and vitamins through vegetables).

OED agrees, but measuring the health impact of the incremental production is exceedingly difficult and fraught with methodological problems.

If increase in fodder and vegetables happens in PPSGWDP, we may consider factoring in this in project benefits/costs especially if there is a women's component emphasizing these products.

15. Data collection

The *Evaluation* data seem to have been collected largely by "enumerators" using questionnaires. This resulted in an apparent 8% error in one case (p. 40 fn.) and probably accounts for numerous others of the statistical uncertainties.

Given the statistical basis of the sampling program (see para. 1.22) questionnaires were applied to the large number of randomly selected respondents. OED reported this 8 percent anomaly (footnote 13) for reasons of transparency.

This suggests to PPSGWDP that impact evaluation should not rely so much on "enumerators" with questionnaires but on fewer and more experienced professionals.

16. Project Served Its Purpose Well?

The *Evaluation* is clear that as regards agricultural production and farmer profit, there was practically no result from the Project, and that any changes in this respect would have

appeared without the project. The Project had no impact on wider water or groundwater management. Yet, the *Evaluation* says that the " Pilot Project served its purpose well and may have proved that such projects are unnecessary"!! (3.1).

OED disagrees. The follow-on projects to expand privatization of groundwater were one of its major impacts. See para. 7.7.

We would hope that PPSGWDP would have a more forthright evaluation conclusion than that!

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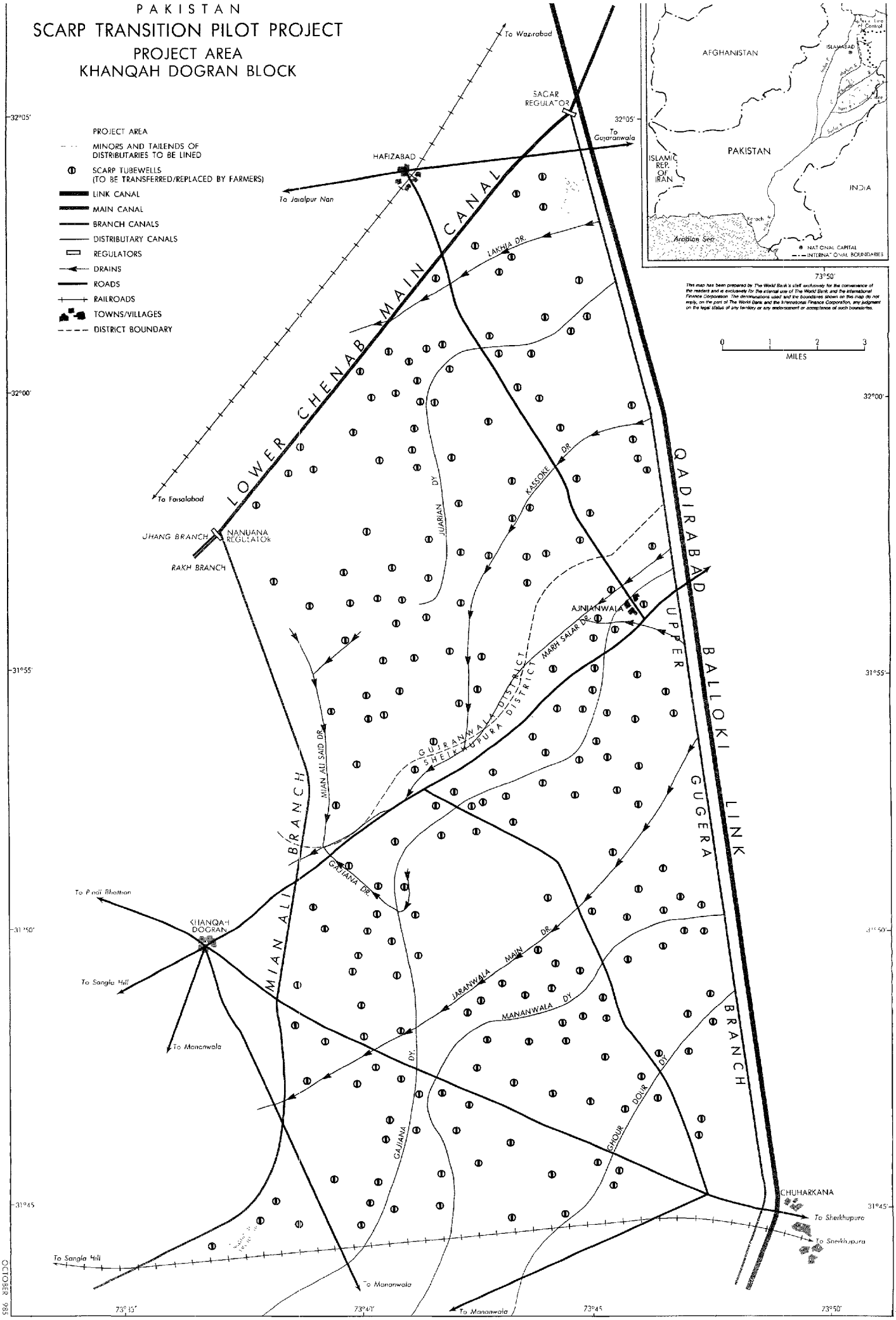
MAP SECTION



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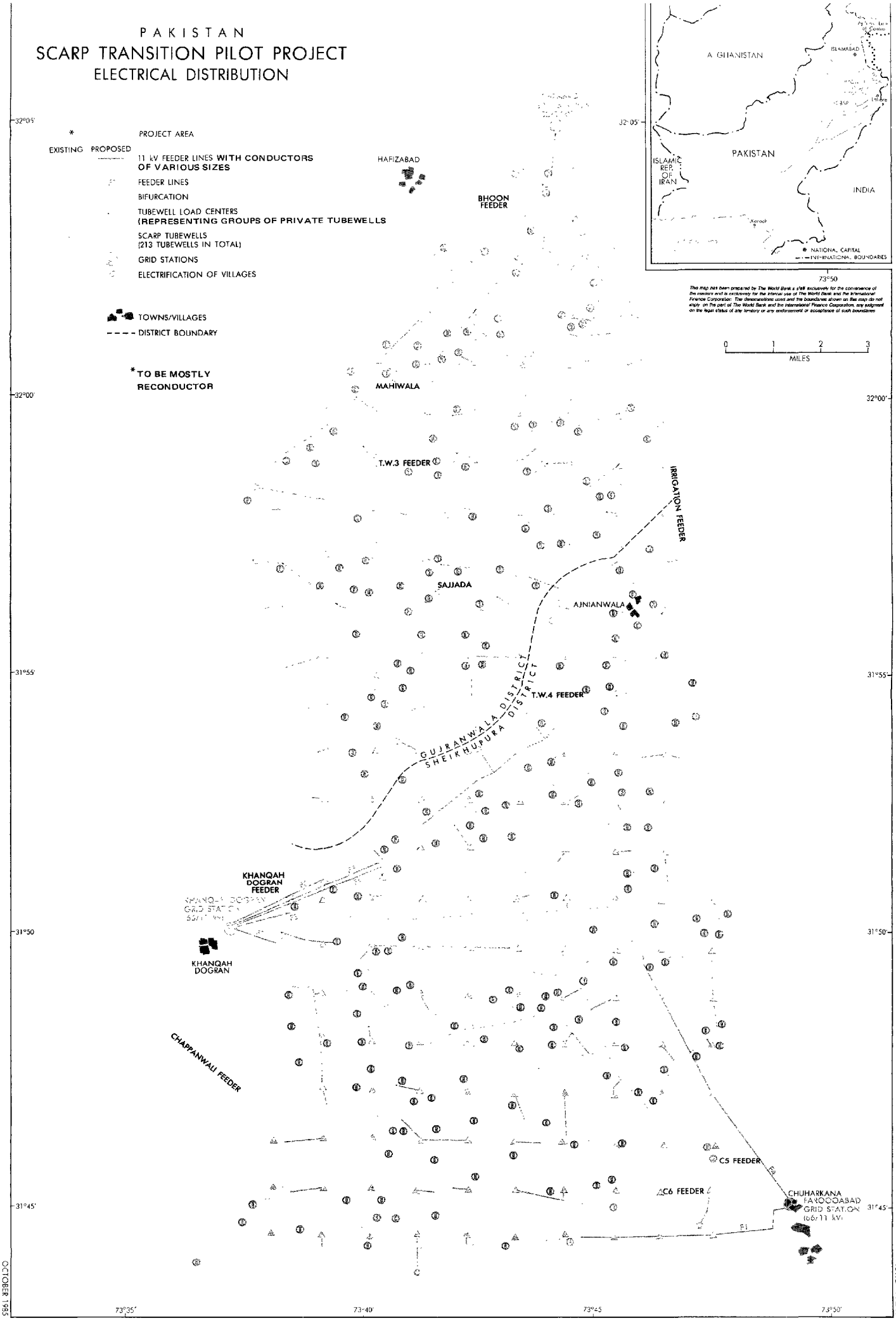

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