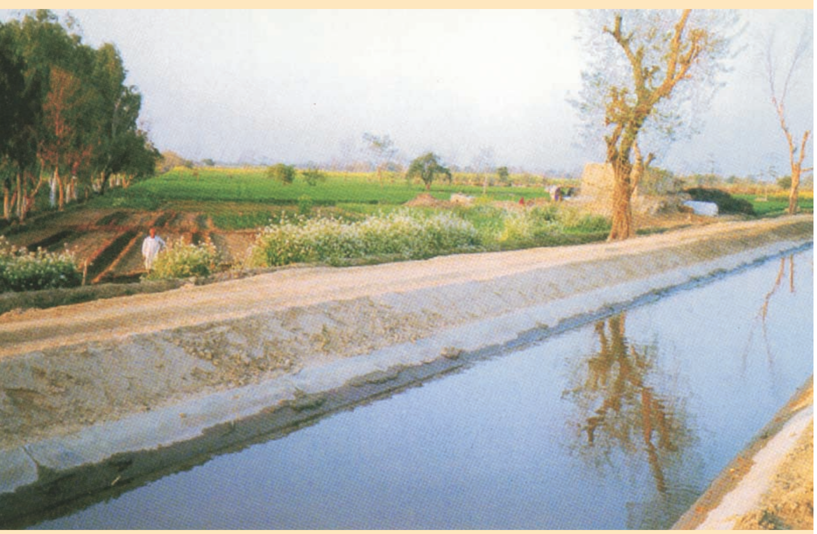
WORKING PAPER 4

Irrigation Management in Pakistan and India: Comparing Notes on Institutions and Policies



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International Water Management Institute

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IWMI gratefully acknowledges the financial support for its research work from the following Governments, Development Banks, Agencies, and Foundations: Australia, Brazil, Canada, China, Denmark, France, Germany, India, Iran, Japan, Netherlands, Norway, Pakistan, South Africa, Sweden, Switzerland, Taiwan, Turkey, European Union, United Kingdom, and United States of America; African Development Bank (AfDB), Asian Development Bank (ADB), and World Bank; Agricultural Engineering Research Center (AERC), Council of Agriculture (COA), Food and Agriculture Organization of the United Nations (FAO), and International Fund for Agricultural Development (IFAD); Chi-Seng Water Management and Development Foundation, Environment Greening Foundation, Ford Foundation, Taoyan Irrigation Research and Development Foundation, and Tsao-Jiin Memorial Foundation for R&D for Agriculture and Irrigation. The Governments of India, Iran, Mexico, Nepal, Pakistan, Sri Lanka, and Turkey also provided program support for IWMI-related activities in these countries.

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The authors gratefully acknowledge comments on this paper provided by Chris Perry, Hammond Murray-Rust, Mehmood ul Hassan, S. A. Prathapar, Wahid uz Zaman, D. J. Bandaragoda and Douglas Merrey.

Shah, T.; Hussain, I.; Saeed-ur-Rehman. 2000. *Irrigation management in Pakistan and India: Comparing notes on institutions and policies.* Colombo, Sri Lanka: International Water Management Institute (IWMI). 21p. (IWMI working paper 4).

ISBN: 92-9090-426-7

/ irrigation management / productivity / privatization / irrigated farming / equity / water distribution / groundwater management / economic aspects / tube wells / price policy / electricity supplies / pumps / India / Pakistan /

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Contents

Glossary

abiana	irrigation water charge
chak	an outlet command area
Lambadar	a person, representing landowners, appointed by the Revenue Department at the village level to collect state revenues (including abiana) and to perform other administrative duties.
Lambardari	institution of the Lambadars
mistry	mechanic
moga	outlet
patwari	Revenue Department official responsible for keeping land records and assessing abiana
warabandi	a rotational method of water distribution among farmers
wari	irrigation turn
Zamindaars	big landholders

Units

1 acre		=	0.4047 hectare
PRs	Pakistan rupee: US$1.00	=	PRs 55.00.
InRs	India rupee: US$1.00	=	InRs 43.00

Abstract

These notes present the impressions gathered by a team of Indian and Pakistani economists on contemporary issues in irrigation management in these two countries. The authors suggest that the two countries can learn important lessons by comparing notes on several issues: [a] what would work best in ensuring equitable access to irrigation—physical rehabilitation being tried out in Pakistan Punjab with the help of the army under the military rule offers interesting possibilities in terms of scale and impact as does the Andhra Pradesh model of irrigation reform, [b] the experience in both countries so far defies the uncritically accepted premise that under farmer-management, irrigation systems will be more equitable, [c] why farmers in Pakistan Punjab have to use 16-20 horsepower (hp) diesel engines to pump groundwater from 25-40 feet while north Indian farmers have been doing the same with 5 hp engines—if it is because of compulsion of habit, appropriate policies can save Pakistan substantial diesel fuel per year, [d] India needs to ask why diesel engines in Lahore cost only 40-50 percent of the retail price they command in Lucknow or Ludhiana—we suggest allowing free imports of Chinese pumps will do away with the need for pump subsidies that keep diesel engines over-priced in India, [e] both Pakistan and India need to pay serious attention to promoting simple pump modifications that can increase fuel efficiency of their pumps by 40-70 percent, [f] India and Pakistan need to compare notes on their rich experience of electricity pricing policies to achieve viability of electricity supply to farmers and to achieve important goals of groundwater management and policy.

Irrigation Management in Pakistan and India: Comparing Notes on Institutions and Policies

Tushaar Shah, Intizar Hussain, and Saeed ur Rehman

Introduction

These notes are based on fieldwork undertaken by a team of Pakistani and Indian researchers of the International Water Management Institute (IWMI) exploring the water productivity variations in irrigated agriculture in these two countries of the subcontinent. Pakistan and north India share a great deal in terms of their socio-ecology, history and culture. Yet, there are notable variations in the manner in which irrigation institutions and policies have evolved in the two countries. Comparative analysis of the irrigation management institutions and policies of these countries throws up interesting questions. This paper outlines five areas of policy relevance that promise a useful opportunity for comparative institutional analysis and policy research in the water resources sector of India and Pakistan.

Irrigation Management Transfer (IMT)

Indian discussion on irrigation reform is abuzz with Andhra Pradesh Chief Minister Chandrababu Naidu's statewide program of transferring management of surface irrigation systems to Water User Associations (WUAs). The scale and speed with which these changes have been implemented have attracted worldwide attention. Assessments of the program—laudatory as well as critical—are already available. But it will be some time before we will know whether the WUAs will sustainably carry out operation and maintenance (O&M) activities and what will be the ultimate effects of the reform on irrigation productivity, equity of access, and irrigation cost recovery.

The Punjab Irrigation and Drainage Authority (PIDA) of Pakistan recently announced a large irrigation reform program in the Lower Chenab Canal (LCC), and some pioneering experimental work done by IWMI in organizing water users in Hakra-4R distributary in Harunabad district of Pakistan Punjab has provided useful inputs in the conceptualization of the IMT program of LCC. In Hakra-4R, a farmer organization (FO) was set up with facilitation from IWMI back in 1997; but it took 3 years of long protracted negotiations with the Irrigation Department for the "turn over" to take place. As it happens, the actual "turn over" amounts to considerably less than what farmers had expected, and the relationship between the newly created PIDA and the FO is yet to mature. Even so, when we met them, the FO Board members were upbeat about the prospects. To understand the dynamics of irrigation management transfer (IMT) in Pakistan, we carried out some fieldwork in Hakra-4R in July 2000.

Hakra-4R, on the Indus system, has over 48,000 acres in its command, 123 outlets, and 4,690 farmers (Bandaragoda et al. 1997). In the 3-tier federated FO facilitated by IWMI, each outlet had an elected committee with 3-7 members and a chair. These were federated into 5 subsystem water user organizations (WUOs). Five members from each subsystem went to a system-level Water Users Federation (WUF), which has a five-member executive committee, one of them elected as the WUF president. Under the new Water Law, PIDA has created a new structure with Water Course Representatives at the outlet level and a 9-member system-level Executive Committee, with a president. The IWMI-facilitated organization has now collapsed into the PIDA-mandated FO design and this underwent irrigation management transfer (IMT) in April 2000.

PIDA has now announced a much larger IMT program for the Lower Chenab Canal (East) covering a huge area in 4 districts, somewhat similar to the program in Andhra Pradesh. An Area Water Board is constituted for the entire command and distributary-level organizations—such as that we find today in Hakra-4R—are proposed. Lessons learned from Hakra-4R can be immensely useful in designing and implementing new larger institutional reforms.

The "organizing protocol" that IWMI evolved in creating the Hakra-4R FO and the model created by the Institute of Resource Development and Social Management (IRDAS) in Andhra Pradesh are exemplars. Both involved a graduated, stage-wise process in which the idea of farmer management was first introduced; local opinion leaders were co-opted, credible "champions" were sought out and invited to lead the process of organizing, norms were evolved, and finally a structure was erected (Bandaragoda et al. 1997). The approach in creating the models in both the cases was thus "process and time intensive" but it promoted dialogue and therefore resulted in a FO with strong grassroots linkages. Following the successful model, Andhra Pradesh swiftly enacted a law and created over 10,000 WUAs in the state over a short period of one year. PIDA is about to do the same. Working on a much larger area, PIDA may be under pressure to move fast and cut corners with the "process." This may compromise the results of the intervention. There seems to be a role here for IWMI in conceptualizing its "organizing protocol," refining it and engaging with PIDA in upscaling it.

Another aspect of study is the organization design of the FO. The IWMI-facilitated design at Hakra-4R was bottom-heavy, unwieldy and slow, but it ensured broad-based participation by all farmers and communication across the membership. The PIDA-mandated structure is leaner, faster and cheaper but may run the high risk of ending up as an "oligarchy" of *Zamindaars* (big landholders) who may run the distributary as a private fiefdom.[1] Moreover, without large-scale allegiance and support of a majority of farmers, the leadership of such an oligarchic FO may not be able to do much of significance. Even in the more participatory IWMI design at Hakra-4R, the governance of the FO

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[1]This danger is greater in Pakistan than in Andhra Pradesh because of the greater inequality of landholdings in the former. Even the IWMI-created FO had a strong oligarchic propensity. The average landholding in Hakra-4R is less than 10 acres, but the Social Organization Volunteers, the initial mobilizers used for organizing the FO at the water course outlets, had holdings averaging 35 acres (Bandaragoda et al. 1997:34). The average landholding increased systematically as one moved up the hierarchy of the FO: the average for water course level nominees was 58.7 acres; for the Water User Federation members, it was 72.4 acres; and for WUF office bearers, it was 71.1 acres (ibid: 63), the average for all 100 leaders surveyed being 58.7 acres. Less than 10 percent of the 125 FO leaders had landholdings comparable to the population average of 9.2 acres (ibid: table 13, p 64).

seemed heavily tilted towards large landowners and frustration with “domination by the bigwig” emerged repeatedly as an important theme in our interviews with tail-enders and small farmers. In our judgement, even if oligarchic, the governance structure of an FO may deliver better with strong member control ensured by the IWMI design than with little or no member control as is likely under the PIDA design. This transition from high member control to low member control seems evident in Hakra-4R itself. For example, under the IWMI design, the FO Board was able to organize a massive participatory maintenance campaign involving all members. But it is doubtful if it would be able to do so under the PIDA design, which, in effect, recognizes in its formal working only 124 of the several thousand irrigators in the distributary command.

Member willingness to support a FO is generally contingent upon the degree of control they perceive they can exercise over it when necessary. In Hakra-4R, the Executive Committee and the President of the FO have demonstrated a high level of enthusiasm and drive, but the primary membership has not displayed the same level of enthusiasm. As a result, there is no resource generation even to pay normal management costs, and the FO Board members have had to meet the substantial transaction costs of leadership roles from their personal resources. This has also meant that only resourceful members gravitate into leadership positions. Now, even these resourceful Board members are feeling restless and wonder how long they can continue to bear the transaction costs of leadership roles and are exploring ways of recouping their investments.[2]

A critical issue on which greater clarity is needed is the value-adding role the WUAs are to assume. According to the Hakra-4R FO Board, the main benefit of the FO is the elimination of rent-seeking, estimated at PRs 2,500,000-2,800,000[3] per year for the distributary as a whole. This amounts to about PRs 1,500-1,800 per hectare, over 7-9 times the *abiana* (irrigation water charge) assessment, which seems a great deal but is not implausible. Fragmented trade in canal irrigation turns at the tail end, at PRs 2,000 per hour for 45 weeks in a year and PRs 150-200 per hour for a single turn, indicate the high value assigned to canal irrigation at the tail end. The Vice-President of the Hakra-4R FO auctioned a 2-hour turn assigned to his village for the entire year at PRs 10,000 last year, and at PRs 17,000 in the current year. These suggest the high economic value of canal irrigation in Punjab. It can mean either of two things: a smart FO can generate considerable resources for development through sound management of canal water supplies; or the FO can replace the existing spoils system by a new one. That the second is more likely to happen is indicated in five items on the immediate agenda of the Hakra-4R FO Board after the IMT occurred: a) Lobbying for flat rate for abiana; b) Replacing *Lambardars* by Water Course Representatives in abiana collection (we discuss this further below); c) Entrusting to *patwaris* of the FO the task of abiana assessment; d) Ensuring that Water Course Representatives get 5 percent of the total collection per water course as commission, provided abiana

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[2]One solution the Hakra-4R Board has found is to replace the traditional *Lambardars* by Outlet Representatives in the role of *abiana* (irrigation water charge) collection for which they get a commission of 5 percent of the total collection. The Board believes that this might be one way of compensating the 124 FO leaders for the transaction costs they have to incur in their leadership roles. Several new activities proposed—such as fertilizer and agrochemical supply—are to be undertaken, not as FO services to members but as income generating activities for leaders.

[3]US$1.00 =PRs 55.00.

collection is 100 percent; and e) Starting fertilizer distribution and other agro-services by getting dealerships for FO Board members or other members. Thus some of the issues being raised about IMT in Andhra Pradesh—about rent-seeking by members of ruling political party, apathy of WUA members, control by local elite—are all likely to play themselves out as Pakistan's IMT story unfolds.

The Institution of *Lambardari*

In India, Sri Lanka, and many other countries around the world, the inability of government to ensure irrigation cost recovery is the most important problem IMT is designed to solve. In Sri Lanka, the canal water charge is zero. In India, the assessed water fee is a small proportion of the cost of O&M and what is collected is often less than 20-30 percent of that assessed.[4] In Pakistan, the situation on this front is different and better; according to information provided by some experts at IWMI-Pakistan, the total assessment for canal irrigation for Punjab in 1999 was PRs 1.72 billion and the total fee collection was PRs 1.25 billion or 72 percent of the assessment. The present government has stipulated that irrigation charges per acre will increase at a rate of 10 percent per year, compounded; which means that the total collection might cover O&M costs in 5-7 years, especially with the current ban on recruitment of new staff in PIDA—with staff costs being over 80 percent of O&M costs. Thus the financial burden of O&M in Pakistan's surface systems does not seem to be as unresolvable an issue as in other South Asian countries.

Moreover, Pakistan Punjab has what no other South Asian country has: a well-established institution of *Lambardari*. Lambardari existed mainly in Punjab and NWFP (North West Frontier Province), but was never adopted in Sindh. A *Lambardar* is an unofficial link between the landowners in his village and the government officials. He represents landowners and not the government. While he is appointed by the Revenue Department (Revenue Collector), he does not hold any formal office in Pakistan government services.[5] Hereditary claim, good family background and ownership of land

[4]Bhatia, Rogers and de Silva (1999), for instance, estimated that in India "a farmer pays (for surface irrigation) US$3.3 per hectare (ha) as irrigation charges against an estimated expense of US$26 per ha of water supply. This resulted in a total subsidy of US$800 million during 1993-94." Similarly, B N Navalawala (1999), Irrigation Advisor to India's Planning Commission, lamented: "In 1945-46, just before Independence, profit from irrigation schemes was Rs 7.92 crores on an investment of Rs 149 crore, i.e., 5.30%. [But] financial losses [in government-managed irrigation schemes were] Rs 4,246 crore in 1995-96" [p.6]. A committee appointed by the Government of India in 1992 to examine irrigation pricing estimated total losses (including interest on investment) in the surface irrigation sector to be InRs 20,286 crore during the 8th Five Year Plan period. According to India's Central Water Commission, during 1991-92, gross receipt of irrigation charges per hectare was InRs 82 and working expenses of irrigation systems was InRs 1,032. Irrigation fees have not been revised in most states in 20 years. According to Navalawala, some InRs 1,000 crore of assessed fees remain uncollected; in Assam, collection is less than 1 percent of O&M costs; in Bihar, collection is 25 percent of assessment; and in Uttar Pradesh, it is 40 percent.

[5]However, the appointment procedures, duties and powers of the Lambardar are well defined in the Land Revenue Act 1967 and Land Revenue Rules 1968. Under Section 47 of the Canal and Drainage Act (Act VIII of 1873), a Lambardar

within the same village are important considerations for appointment as a Lambardar. According to Land Revenue Rules, the principal duties of a Lambardar include: [a] Collection of all land revenue recoverable from landowners within his village and payment of the same into treasury, and acknowledgement of any payment received by him in the books of the landowner and tenant; [b] Assisting all officers of the government in execution of their public duties within the village, assisting in functions such as crop inspections or surveys carried out in his village, and supplying the required information and generally acting for and on behalf of the landowners, tenants and residents of the village.

In the context of irrigation, the Lambardar is specifically responsible for: [a] Collecting and paying into the treasury irrigation water charges from farmers in his village; [b] Helping the *patwari* to register or correct irrigation records; [c] Reporting to and helping irrigation staff and revenue department staff investigating cases of water theft, and breaks and cuts in canals. For performing these services, the Lumbardar is provided 12.5 acres of land and receives 5 percent of the assessed abiana as remuneration. Lambardars are subject to a penalty if they fall short of a certain threshold level of collection. Every village has one or more Lambardars, and on a 5 percent commission, this steelframe of Pakistan Punjab's abiana collection system is also a low-cost mechanism for abiana collection. In many Indian irrigation systems, the cost of water fee collection exceeds the revenue collected. The institution of Lambardars ensures that the abiana collection performance in Pakistan is better than that in many other countries in the region. If improvement is required, it would probably be at the assessment stage. Here comes the IWMI case for a flat rate for irrigation charges, which eliminates the power of the patwaris.[6]

We received conflicting messages about the social role of Lumbardars. One viewpoint was that they are influential local leaders, are widely respected and often serve as change agents and opinion leaders but are generally not very large landowners. Another vi ewpoint was that they are trouble-

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is employed to collect state revenue and to perform other administrative duties under the Act. The government places serious reliance on any information or certificate given by the Lambardar.

[6]After an in-depth study and extensive debate, IWMI's Pakistan office has recently recommended to the Government of Pakistan that instead of crop-based canal irrigation charges, it would be better, cheaper and administratively easier to set a flat abaina per hectare of land commanded. In fact, a flat rate was recommended a century ago by some official of the Colonial Government, and then Prime Minister Z.A. Bhutto took up the suggestion and implemented a flat irrigation tariff in Sindh. However, this was withdrawn a few years later; it is not clear why. One viewpoint is that it was not convenient for the powerful landed gentry who could manipulate the crop-based water fees to their advantage. But it would be useful to understand the experience gained and why that policy was abandoned. Another aspect worth exploring is why the *warametric* water charging experiment that was piloted in Haryana in the 1970s and which offered great promise did not enter IWMI's recent debate on abiana. From what little we understood, the *warametric* method of irrigation charge collection has all the advantages of the flat rate but still creates some incentives for water productivity. Basically, *warametric* pricing involves putting a price per hour of a *wari* which is fixed for all farmers on an outlet, and weighing it by the size of the inflow to the outlet. This might show promise if, under the institutional reforms in progress, abiana assessment and collection is to be decentralized to distributary level FOs.

making exploiters who, with the patwaris as cohorts, mess around with the abiana assessment. The reality is obviously somewhere in the middle but nobody we talked to questioned their effectiveness in collecting the assessed abiana and, in some ways, this is no mean achievement, considering the widespread failure of government machinery to perform this task effectively in other countries of the region. Overall then, even if not ideal, Lambardari may well be a useful institution; many countries that are thinking of outright privatization of irrigation systems might eventually evolve similar or worse institutional arrangements.

One problem that Pakistan Punjab faces in its IMT program—that Andhra Pradesh in India does not face—is that, as conceived now, it may well do away with the Lambardars, or vice versa. The new Lower Chenab Canal initiative proposes that the task of abiana collection as well as the 5 percent commission may be handed over to the Water Course Committees—which, if implemented will seal the fate of the Lambardars. In Hakra-4R, the Board wants Lambardars replaced by the 124 Water Course Representatives. They want the abiana to be collected by Water Course Representatives and the commission paid to them. This may amount to replacing one class of agents by another. But before all this can happen, it is very likely that the influential and elite class of *Lambardars* will probably try their best to frustrate the IMT initiative.

Moga Modification Program

A major issue in the Indus system—as in most South Asian systems—is that of equity in access to irrigation, especially, inequity that causes the tail-enders' woes. Without much evidence in support, the irrigation management literature implicitly assumes that this, and many other problems of canal irrigation, will get resolved with IMT, which has almost assumed the stature of a gospel. Pakistan has witnessed a refreshingly new response to the problem of inequity in canal irrigation access. Soon after military rule was established, the government took an unusual decision to clean up and rehabilitate the canal system, distributary downward, with the help of the army. This involved a massive effort in cleaning and desilting and, most crucially, rebuilding the outlets (*mogas)* to deliver their originally designed discharge. Nearly half of the distributaries in Punjab has been "rehabilitated" thus; the rest will be taken up next year. The *moga* modification program hit the nail on its head! Head-tail inequity in the Indus system—as in all South Asian canal irrigation systems—is caused largely by gradual enlargement of the outlets by farmers at the head and middle reaches. The impact of this physical intervention has been dramatic and far reaching because it has upset the long-established "seating arrangement on the deck." For the first time in many years, large areas in the tail ends of the system have been brought under irrigation. If a group of farmers we interviewed are to be believed, in Hakra-6, 15-20 *murabba*s (1 *murabba* = 25 acres), and in Hakra-7, some 22-25 murabbas of new land got irrigation at the tail. In Hakra-4R itself, some 500 acres in the tail got irrigation for the first time. One Board member of Hakra-4R FO lamented: "After the Military's *moga* modification program, the Hakra-4R distributary, which is designed to carry 300-325 cusecs of water, developed an over-grown tail carrying 150 cusecs of water!" Naturally farmers at the tail are uniformly and supremely happy and those in the middle and head are uniformly and extremely unhappy. The severity of the sting seems to be proof of the significance of the impact of redistribution of the moga modification program.[8] Farmers at the head lamented that the head-tail inequity is not reduced but *reversed*.

In many other South Asian countries, farmers would probably have frustrated such an intervention by razing the modified outlets even before the cement dried;[9] in Pakistan, farmers in the head and middle fumed and blew hot and cold but attempts to change the modified mogas appear few and far between, except those made with the connivance of the local bureaucracy. It is not clear why. Possible reasons are the tight administration by the present government, the prohibitively high penalty attached to tinkering with public property, and the fact that, since half or more canal irrigators have holdings of 25 acres or more, most mogas can be identified with specific farmers and this reduces the monitoring costs greatly. In many Indian systems, an outlet serving a *chak* (an outlet command area) may serve up to 50 farmers and so it is difficult to find the culprit; but in Pakistan, it may be easier. But the most important reason might be strong peer pressure because of a reasonably well-functioning *warabandi* system.

How would farmer organizations react in such situations? In Hakra-4R, head- and middle-reach farmers raised an uproar because the army intervention apparently reduced their water share far less than their original entitlement, and this became the major drive for creating the FO. To redress this grievance, PIDA re-modified the mogas redistributing water from head to tail. Even this did not seem to satisfy the farmers; so the first thing the FO did after the distributary was 'turned over' was to carry out one more round of moga modification, very nearly restoring the original, long-established seating arrangement on the deck!

Groundwater Economy of Punjab

Groundwater irrigation is extremely important in Punjab, Pakistan's granary, and yet there is little formal research in the way the groundwater economy functions. Around 80 percent of Punjab's farmlands are under the Indus system. Of Punjab's total geographical area of 51 million acres, a little over 40 million are under the Indus system and, of these, 31 million acres are under wheat (personal communication with Mr. Bhatti of National Engineering Services of Pakistan [NESPAK, Lahore]). Punjab also has 0.5 million of Pakistan's 0.58 million tubewells; tubewells contribute more to Punjab's agriculture than is generally imagined. According to Mr. Bhatti, of the total surface water supplies of 55 million acre feet released to Punjab, 30 end up at the farm gate, and the remaining 25

[8]Another indirect evidence is the bribes many farmers paid to irrigation overseers to restore their mogas to their original size. Farmers we interviewed suggested a rate of PRs 20,000 per moga for a bribe. In some distributaries, many farmers got their mogas rehabilitated at this going rate. If this is true, then the welfare impact of the army intervention probably got considerably reduced, and the canal engineer emerged as the primary beneficiary.

[9]In India's Indira Gandhi canal in Rajasthan, for instance, farmers frustrated all efforts to introduce water measurement devices at the outlet level that would serve some 80 smallholders. Tushaar Shah participated in a function to inaugurate one such fancy structure in Bajju area of Bikaner district in December 1989. Next morning, it was found vandalized and razed.

disappear as either evaporation or seepage. Farmers supplement these canal supplies by 31 million acre feet of groundwater irrigation pumped by 0.5 million tubewells (62 acre feet per tubewell per year). To the society, groundwater irrigation is far cheaper compared to surface water irrigation. According to the above source, Punjab's surface system is worth US$150 billion in capital cost and all its tubewells have cost of US$0.5 billion; yet, both deliver the same amount of water at the farm gate. But what tubewells gain in capital cost, they lose in their operating cost. The annual operating cost of the tubewell sector is US$8 billion whereas the O&M cost of the surface system is US$40 million. Wheat, Punjab's mainstay, is grown with an irrigation delta of 3 feet; of these, 1 foot is contributed by surface irrigation, 1 foot by tubewells and 1 foot by rainfall. This calculus is likely to be representative of the situation in much of canal-irrigated India.

A critical issue for groundwater irrigation in Pakistan is salinity. The big problem that the Salinity Control and Reclamation Project (SCARP) was designed to address—waterlogging and salinity—is still present today, unresolved and in some ways more serious, long after the original SCARP program[11] ended. However, farmers in many areas have begun doing what the SCARP tubewells were supposed to do. Under a new SCARP Transition Project, a subsidy of PRs 20,000 is provided on capital cost to a group of farmers in the canal command to pump groundwater to augment the canal water flows in the water course. These tubewells are commonly used for conjunctive use of surface water and groundwater. During their canal irrigation turns, farmers pump the tubewell water into the canal to augment supplies to their fields. In Sargodha district, we talked to farmers who use a cluster of 5-10 strainers to capture the canal seepage from shallow depths and pump it to mix with canal water for irrigating orchards. Farmers realize that they cannot pump for long periods at a time because brackish water would bet pumped out after a long period.

Whether they merely skim canal seepage from a level close to the ground surface or pump brackish groundwater from 25-30 feet, tubewells in Pakistan Punjab are mostly fitted with 16-20 horsepower (hp) diesel engines and delivery pipes of 5-inch diameter. These seem large considering that pumping depths are barely 25-40 feet in Punjab. In north India, where farmers pump groundwater from 25-40 feet, the most common diesel pump one comes across is of 5 hp, with a 4-inch delivery pipe. The 16 hp pump uses 1.9-2.2 liter/hour of diesel as opposed to 0.9-1.1 liter/hour that the 5 hp engine uses. Why does the Pakistani farmer need a 16 hp diesel engine to pump water from 30 feet while the north Indian farmer has carried on jolly well with a 5 hp engine all these years? If the Pakistani farmer does not really need the 16 hp engine, there might be important opportunities for huge gains in fuel efficiency by reducing the size of the prime mover.

One plain explanation was in terms of comparative advantage: Pakistan's diesel prices as well as diesel engine prices today are lower in real terms than India's. A 16 hp Chinese diesel pump at PRs 14,000 in Lahore is over 30 percent cheaper than a 5 hp Kirloskar in Lucknow at InRs 17,500 (US$1.00 = InRs 43.00 = PRs 55.00); similarly, at PRs 13.5 per liter, diesel is also 30 percent cheaper in Pakistan than India's price of InRs 15.6 per liter. No wonder then that the Pakistani farmer has a

[11]This was a large program to set up public tubewells expressly to pump groundwater in waterlogged areas directly into canals or field channels with the twin purpose of providing vertical drainage and augmenting canal flows to tail ends. India too tried a similar strategy in the Satlaj-Yamuna canal.

preference for diesel pumps, and big ones at that. The argument against this is that the Pakistani farmer's preference for 16 hp engines is 25-30 years old and it is unlikely that engine and diesel price ratios between India and Pakistan have always been the way they are today.

Another common explanation we encountered was that of compulsion of habit. Until the Chinese pumps arrived in Pakistan over 20 years ago, farmers in Pakistan Punjab were used to huge, unwieldy black oil engines. Because of this 'Big is Beautiful' tradition, Pakistani farmers took to high-powered Chinese engines; and once the trend started, the "Microsoft Windows" phenomenon probably began to operate. Since a majority of farmers use 16-20 hp engines, new buyers too tended to gravitate to these because they as well as *mistrys* (mechanics) were most familiar with them, spare parts are easily available locally, and dealers stock these most. In general, the 16 hp engines became the industry standard in Pakistan as much as the 5 hp became the standard in India. If this is true, then an interesting research and policy issue is how to get Pakistani farmers to use more fuel-efficient pumping plants just as India should explore how to get farmers in eastern India to start using 2 or 3 hp engines rather than using 5 hp engines as their speed of pumping is tied down by lower than optimal water levels. Between the two countries, this could mean savings of billions of liters of diesel per year.

Messers Gohar and Bhatti of NESPAK suggested that farmers need high discharge from their tubewells because these are commonly used for conjunctive irrigation. Under the *warabandi* system, the farmer gets less than half an hour per acre of canal irrigation a week. During this period, he wants to mix as much groundwater as possible with canal water. This requires that his machine works during the *wari* (irrigation turn) but also that it provides a high discharge. This makes sense. Mr. Gohar also suggested that the farmer does not worry unduly about energy losses because after the first 2-3 minutes of operation, the 16 hp diesel engine any way settles down to an effective 6-7 hp output and uses only that much fuel as it needs to do that much work. This means that although its rated capacity is 16 hp, it in effect works as a 6-7 hp engine most of the time.

Yet another explanation offered was in terms of the differences in average landholding sizes. In Pakistan Punjab, at 4.5 ha, the average holding size is significantly larger than in north India. So although they pump from comparable depths, Pakistani farmers need higher discharge rate compared to the Indian farmer. Moreover, Indian farmers using diesel pump irrigation invariably use flexible rubber pipes for conveying water, which reduces seepage but also make it possible to convey water for long distances. In Pakistan, pumped water is normally conveyed through irrigation canals or field channels; these require sizeable discharge to provide for 30-40 percent conveyance losses and for water to reach some distance.

To construct a quick test of our hypotheses, we surveyed 25 diesel pump owners in Sargodha district of Pakistan Punjab and compared the results with a 1994 study of 40 diesel pump owners carried out by IWMI (IIMI 1994). The results, presented in table 1, seem to reverse our hypotheses: it suggests that the 5 hp diesel engines used in north India seem over-sized when compared to the large engines in use in Pakistan Punjab. For a liter of diesel, the Pakistani tubewells seem to do more work than the north Bihar ones. The former uses less than twice the diesel per hour used by the latter, but lifts more than 2.5 times the discharge and that too over twice the head of the north Bihar pumps. It is not surprising that Indian experiments on improving fuel efficiency of diesel pumps have found reducing the RPM (resolutions per minute) to be an effective way of reducing fuel consumption without sacrificing the discharge (Reidhead 1999).

Table 1.

Comparison of diesel pumps in Pakistan and north India.

	Pakistan	North Bihar
Sample size	25	40
Average hp	17.3	5
Pipe diameter (inches)	5	4
Depth of the bore (feet)	115	66
Head range (feet)	33	16-24
Average fuel consumption (l/hr)	2.03	1.03
Discharge (l/s)	23	9.2

Note: All values in the table are averages of respective variables. Pakistan data are based on a survey carried out by IWMI in July 2000. Indian data are from an IWMI study of groundwater use in north Bihar (IIMI 1994:60-66).

Electricity Pricing for Tubewells

Another exciting sequence of change in Pakistan's irrigation is the experimentation that WAPDA (Water and Power Development Authority) and NEPRA (National Electric Power Regulatory Authority) have engaged in with electricity pricing for tubewells over the past decade. Because of salinity problem, Pakistan needs to devise ways of providing spatially differentiated incentives or disincentives for groundwater withdrawal in order to produce the same results that the famous SCARP tubewell program was designed to do. So far, the government has been trying to provide such incentives under the SCARP Transition Project through a capital cost subsidy on diesel pumps and tubewells. But it can be argued that private electric tubewells offer a more powerful option; the present program increases the density of diesel tubewells but can do little to stimulate total withdrawal per tubewell. With electric pumps, it is possible to stimulate both the density as well as average pumpage in areas where it is necessary to do so, as in parts of the Chaj Doab (region between Chenab and Jhelum rivers) in Punjab.

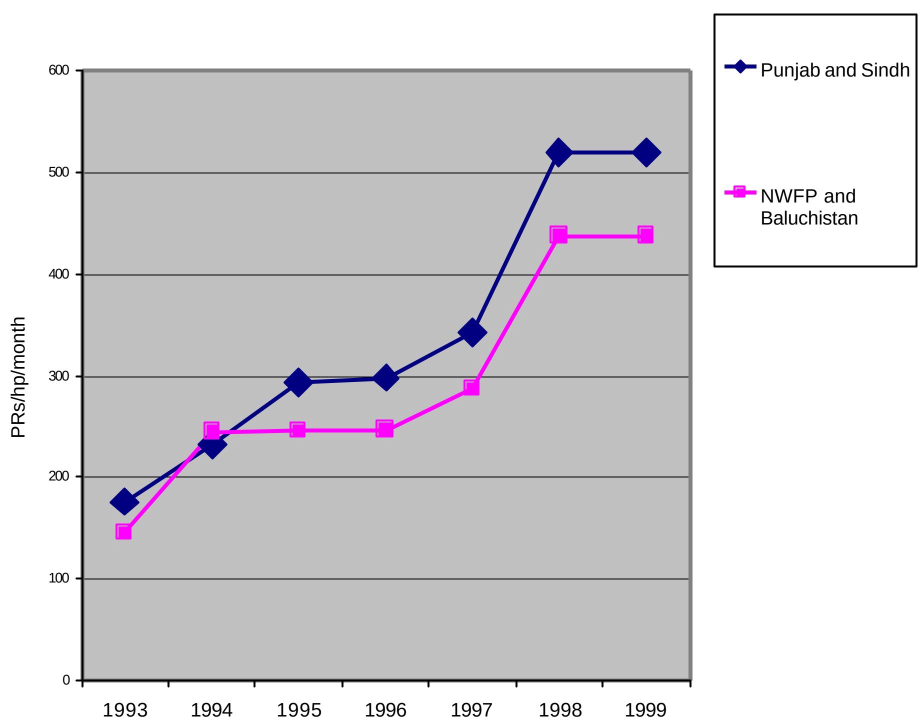
The electricity pricing policy in Pakistan during the past decade, however, has been dictated entirely by the economics and the logistics of power supply. Until 1991, Pakistan had metered electricity tariff at around PRs 0.65 per unit. According to farmers and pump dealers we interviewed in Lahore, a very large proportion of tubewells in Punjab—over 80 percent according to some, which seems unlikely to be true—used electric motors as prime movers. Circa 1991, the Government of Pakistan changed to flat tariff for much the same reason as many of the Indian states did during the mid-1970s. Metering costs were high, pilferage of power was extensive, and farmers regularly complained about the highhandedness and arbitrariness of WAPDA's meter readers. Flat rate (FR) was seen as a one-stroke answer to the problem of metering costs as well as of reducing the hassle. Most Indian states changed to flat electricity tariff for similar reasons in the late 1970s, and witnessed major consequences, beneficial and deleterious. Years later, Pakistan is going through the same cycle.

In Indian discussions on groundwater markets during the 1980s, it was argued that, besides being simpler and cheaper to administer, flat power tariff is a powerful means of improving poor farmers' access to groundwater irrigation (Chambers, Saxena and Shah 1987; Shah 1993). Much evidence was presented to show that the switch from metered to flat power tariff resulted in immediate and substantial decline in the prices of pump irrigation in informal water markets, expanded groundwater trade, enhanced capacity utilization of tubewells, and stimulated irrigated farming by pumpless smallholders who depend upon water markets for their irrigation needs. This analysis anticipated that flat tariff calculated on the basis of prior average power consumption per tubewell would result in losses because flat tariff would stimulate greater pumpage; but it argued that social benefits of flat tariff would remain invariant with respect to the *level* of flat tariff, and therefore recommended progressive increases in flat tariff to cover power supply costs. Flat power tariff, however, got discredited in India because state governments used it to subsidize power, leading many state Electricity Boards to bankruptcy; they also used it indiscriminately regardless of the groundwater potential of different regions. Throughout eastern India, where flat electricity tariff can produce massive welfare, their actual effect was nearly the opposite; it resulted in progressive de-electrification of rural areas forcing farmers to switch to diesel pumps for irrigation on a massive scale.

Unlike the Indian states, however, Pakistan raised its flat tariff several times to reflect increasing power consumption per tubewell under FR as shown in figure 1. As the FR increased, the incentive to

Figure 1.

Progressive increases in flat electricity tariff in Pakistan, 1993-2000.



cheat WAPDA increased too. As a result, a new business of fitting electric motors with plates of smaller than their actual rated capacity flourished. In any case, it was very difficult to get WAPDA to approve a high load; so it became common to install 15 hp motors, when the sanctioned load was 6-7 kw, and stick a plate of 5 hp so that the FR is charged at 5 hp. As part of its irrigation reform agenda, the military government imposed heavy penalties on those who cheated on their electricity bills in industry as well as agriculture. Many farmers went behind bars and many more had to pay arrears on electricity bills since 1991—which pushed some out of business. Most importantly, a massive process of dieselization of tubewell irrigation started; farmers disconnected electric pumps on a large scale and replaced them by diesel engines. In March 2000, the government introduced a "flat-cum-metered tariff" all over again. Unlike in India, farmers were not given the option to choose either flat tariff or metered tariff. Flat-cum-metered tariff is the only option and the rates are:

Tariff/month in Punjab and Sindh = 82*kw + {110.4[0.49+0.75+0.63]} kWh

And

Tariff/month in NWFP and Baluchistan = 72*kw + {110.4[0.34+0.75+0.63]} kWh

Where the first component of the variable charge is energy charges, the second is Fuel Adjustment Surcharge and the third is additional surcharge, and the last is "hydel" (hydroelectricity) surcharge at 10.4 percent levied on the total variable charge.

Our discussions with pump dealers and mistrys in Lahore suggested that farmers have again begun turning to the electric tubewells. This trend may get a further impetus if the government reduces the variable charge further as is being suggested in some quarters. The recent surge in electricity connections to tubewells is very likely restricted to farmers who already had connections earlier but had disconnected them and changed to Petter engines.[12] This is because it is very costly to change from diesel engine to electric motor in Pakistan since the farmer has to bear the capital cost of drawing the cable from the line to the tubewell, which involves PRs 25,000 for a 25 kv transformer, PRs 10,000 per pole and additional charges for cable. In India, this cost is borne by State Electricity Boards (SEBs), and it makes electric connections attractive. Be that as it may, as of today, over 90 percent of private tubewells in Pakistan Punjab use 16-20 hp diesel engines as the prime mover. And the case is similar in much of eastern India. The policy of flat electricity tariff has resulted, in both countries, in progressive dieselization of tubewell irrigation. WAPDA's intent clearly is to woo farmers back to electric tubewells. And in these efforts, some micro-economic analysis could usefully supplement the present experimental approach being tried out.

During the 1960s, a major consideration under the pricing of electricity tubewells in India was to maximize power use per tubewell. The Electricity Board, which invested heavily on drawing lines to the wellhead and installing transformers was concerned that each electrified tubewell used enough power for it to recover its fixed costs over 5-7 years. So, besides a fixed component as in the present

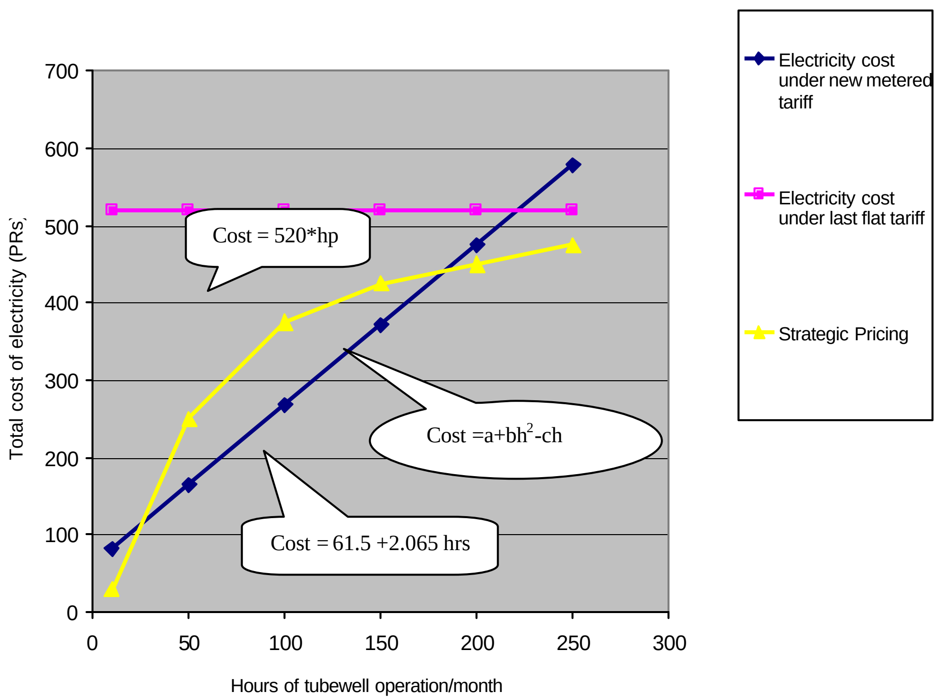
[12]Diesel engines are commonly called "Petter engines" in Pakistan, probably after the famous brand name of a British engine manufacturer of a bygone era.

WAPDA formula, Indian SEBs charged for metered power use along 3-4 slabs at declining rates; farmers using tubewells sparingly had to pay a penal pro-rata rate, but beyond a threshold level they paid a significantly lower rate. This encouraged tubewell owners to offer irrigation to neighboring farmers; and this is how water markets first started. In figure 2, this scheme is shown by the curved function. Our hypothesis is that under the present WAPDA pricing scheme, tubewell owners will charge higher prices and sell less pump irrigation than under the one implicit in figure 2 under the curved function because the latter will induce tubewell owners into expanding the pumpage to claim the low pro-rata tariff at high levels of power use.

The upshot of this discussion is that while in surface irrigation a growing consensus is that prices do not matter, in tubewell irrigation, prices—of both pumps as well as fuel—matter a great deal. Pakistan's decade old experimentation with electricity prices and farmers' response to it provides strong evidence in support of two hypotheses that have been in currency in South Asian discussions:

Figure 2.

Alternative electricity pricing strategies for tubewell irrigation in Pakistan.



[a] levels of flat tariff strongly influence the population of electric tubewells; and [b] the levels of pro-rata tariff strongly influence the average operating factor of electric tubewells. In the flat-cum-prorata electricity pricing systems in use in Pakistan now, this means that, other things being equal, low fixed component and high pro-rata component would encourage more electric tubewells but produce low average operating factor.[13] Conversely, high fixed component and low pro-rata charge will discourage electric tubewells but induce surviving electric tubewell owners to achieve a high "operating factor." The lesson we learn is that in India and Pakistan—two of the world's largest groundwater using countries—electricity pricing for irrigation certainly needs to ensure viability of the electricity industry; but doing only that is sacrificing a potentially powerful toolkit of policy instruments for promoting sustainable management of the groundwater resource.

Summary and Conclusions

This paper discussed an assortment of issues in irrigation management in India and Pakistan and identified several areas of policy relevant to comparative research in the water resources sectors of the two countries. India and Pakistan can learn important lessons by comparing their experiences in irrigation management transfer, water charge collection, interventions to reduce head-tail inequities, and electricity pricing for groundwater management. Against the generally unimpressive results of irrigation management transfer programs in many parts of Asia, the Pakistan experiment of moga-rehabilitation program offers an interesting contrast as an approach to improving head-tail inequity. The institution of Lambardari in Pakistan Punjab may well explain Pakistan's superior performance in abiana collection. IMT programs as designed today pose a major threat to Lambardari; and it will be interesting to watch whether IMT compromises Lambardari or it is the other way around. At the conceptual level, it is interesting to ask whether periodic moga rehabilitation, tightly run warabandi, and Lambardari together do not offer a superior institutional compact compared to IMT.

Equally interesting are issues in groundwater management. Our discussion on the Pakistani farmers' penchant for large diesel pumps compared to north Indian farmers' preference for 5 hp pumps remains inconclusive. However, we believe the issue to be important enough for both countries to deserve further scrutiny. Moreover, in view of the preeminence of diesel pumps in the Indus as well as the Ganga basins, ongoing experiments in improving fuel efficiency of diesel pumps are of great significance to both countries. In improving poor people's access to groundwater irrigation, India has operated myriad schemes of diesel pump subsidy; however, comparative analysis of India and Pakistan suggests that these subsidies have only inflated diesel engine and pump prices. Our conclusion is that dismantling the subsidies and opening up the imports of Chinese pumps and engines will drastically reduce Indian diesel engine and pump prices even below the present subsidized prices. Finally, both India and Pakistan have experimented with electricity pricing for tubewells but neither has yet found a formula that protects the viability of electricity supply and also helps sustainable groundwater management. However, the fact that electricity prices pinch is the proof of its power to influence the behavior of millions of pump users in the two countries. We commend a more reflective approach to the ongoing experiments in electricity pricing.

[13]Operating factor = number of hours of tubewell operation/8,640.

Literature Cited

Bandaragoda, D. J.; ul Hassan, Mehmood; Mirza, Zafar Iqbal; Cheema, Muhammad Asghar; and uz Zaman, Waheed. 1997. *Organizing water users for distributary management: Preliminary results from a pilot study in the Hakra 4-R Distributary of the Eastern Sadiquia Canal System of Pakistan Punjab Province*. Lahore, Pakistan: International Irrigation Management Institute.

Bhatia, Ramesh; Rogers, Peter; de Silva, R. 1999. *Water as an economic good: How to use prices to promote equity, efficiency and sustainability*. Unpublished paper for the World Water Forum, The Hague.

Chambers, Robert; Saxena, N. C.; and Shah, Tushaar. 1987. *To the hands of the poor: Water and trees*, Delhi, India: Oxford IBH Publishing Co.

IIMI (International Irrigation Management Institute). 1994. *Farmer-managed groundwater irrigation within the Eastern Gandak Irrigation Systems in Bihar, India*. Colombo, Sri Lanka: IIMI.

Navalawala, B N. 1999. *Financial viability of water resources sector*. Paper presented at the International Conference, Water Asia-1999, New Delhi, January 19-21.

Reidhead, Paris William. 1999. *Efficient pumpsets and efficient policy: Towards sustainable agricultural energy use in India*. New Delhi, India: International Development Research Center (unpublished).

Shah, Tushaar. 1993. *Water markets and irrigation development: Political economy and practical policy*. Bombay, India: Oxford University Press.

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