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Future of Irrigation and Drainage in Pakistan

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The future of Pakistan's agriculture depends on the future of its irrigation and drainage system, which currently faces major problems. Increasing water logging and salinity, over-exploitation of fresh groundwater, low efficiency in delivering and use, inequitable distribution, unreliable delivery, and insufficient cost recovery are some of these problems. These problems, however, are only symptoms of a deeper problem—the treatment by the government of irrigation water as a public good. Such a treatment has caused inefficient pricing of water, misallocation of resources and widespread rent-seeking behaviour.

The future strategy for irrigation and drainage will require a major change in the public sector's approach. An efficient self-sustaining irrigation and drainage system can be achieved only by promoting market-determined incentives for improved management of the irrigation and drainage services and giving the private sector a greater stake in the system. The process could begin by developing commercially-oriented public utilities on a canal-command basis, developing suitable farmer organisations around distributaries/minors, formalising water rights, developing autonomous provincial water authorities, and developing provincial regulatory bodies for regulating public utilities, water rights, and groundwater resources.

Public utilities at the canal command level—which are large enough to capture any scale economies in administration and yet small enough to be responsive to users—would play the leading role in the management of the system until user groups matured and were able to take over. Farmer organisations would have to be fostered to provide structure on the demand side. Such organisations would make a unique contribution to the welfare of farmers and to the development of Pakistan's irrigation and drainage by providing a counterbalance to the monopoly of the public utilities, by facilitating water market development, and by reducing administrative and O&M costs.

In the long term, farmer organisations would thus play a larger role. Because of the underdevelopment of farmer organisations so far, public utilities will have to play the leading role in the short run. The interim role of the public utilities should not impede eventual takeover by the farmer organisations and other local groups with valid interests in area water resource management. As the farmer organisations expand and become stronger, they are expected to become more involved in the work of the public utility through greater representation on its board.

The total period required for transition to the new system depends on the acceptance of new institutional structure and the speed with which farmer organisations are developed.

Irrigated land accounts for 76 percent of total agricultural land and more than 90 percent of the value of agricultural production. Irrigated land area increased at the rate of 1.5 percent a year during the period 1950–95. The increase in irrigated area was most

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significant before 1980. Since the 1980s increases in irrigated area have come from groundwater tubewells and the area irrigated by canals has remained unchanged. Because the development of water resources is approaching its limits, there is little potential for further increase in irrigated areas.

THE LIMITED PROSPECTS FOR INCREASING WATER SUPPLY AND THE NEED TO IMPROVE SYSTEM EFFICIENCY

At present canal diversions to about 106 million acre feet annually, the level at which they have remained since 1980. Prospects for major increases in water supply to canals appear limited. River flows are fully utilised, except during the flood period in *Kharif*. The Water Apportionment Accord of 1991 allocated 117.35 million acre feet of water among the provinces, an increment of about 12 million acre feet. Incremental water above the current level of diversions is available for a short duration only, and is not sufficient to mature a full crop. Canal capacities permitting, a limited quantity (about 2 million acre feet) can be used for relieving water stress in existing cropped areas. The utility of the flood water is thus very marginal unless additional storage is provided to lengthen the supply period. Providing more storage in the system could increase water captured by 15 million acre feet (14 percent) over the current level of diversions. However, additional canal capacity, which could be acquired either by remodelling the existing system or by building new canals, would be required to utilise these flows. Such investments would be very expensive and relatively uneconomic.[1]

Prospects of extending irrigation outside the Indus Basin are limited. About 2.2 million hectares of land are located outside the Indus canal commanded area, scattered in relatively small parcels with water coming from open wells, tubewells, lift pumps, karezes, springs, and small diversions; water sources for perennial irrigation outside the Indus system are largely exhausted. Some extension in partial irrigation is feasible by using flood flows and water harvesting and about 16,000 hectares could be brought under irrigation by harnessing the hill torrents on the right bank of the Indus. These schemes are costly, however, and water supplies are not reliable for high-yielding crops.

Groundwater use, which has been major source of growth in agricultural production in Pakistan over the past two decades, also seems to be reaching its upper limit. Currently more than 300,000 private tubewells supply about 40 percent of total irrigation water in Pakistan. As a result of increasing extraction from the aquifers, the groundwater table in most fresh groundwater areas is falling, limiting the potential for further groundwater development.

[1]Water Sector Investment Planning Study (WSIP) estimates a net benefit-cost ratio of 1.6 at 12 percent for storages in the Indus system; the benefit-cost ratios for command area extension projects are estimated at 7.0 for the Dajal Branch Extension, 1.0 for the Greater Thal Canal, and 0.4 for the Rainee Canal projects.

Water supply (and hence agricultural growth) could be expanded greatly by improving the efficiency of the existing system. Investments in improving efficiency, thus have high economic returns. Benefit-cost ratios of irrigation system rehabilitation and on-farm water management investments range from 2.5. to 6 at 12 percent. Major reforms are needed just to sustain the current system, which faces serious problems (as outlined in the next section).

Institutional reform should be the main focus of development of irrigation in Pakistan in the future. Increasing efficiency of the irrigation system will require substantive improvement in water management as well as increased water supply and will demand better financial, managerial, and technical planning. The performance of the sector will depend on redefining the roles of the public and private sectors and enhancing the capabilities of both sectors.

MAJOR PROBLEMS OF THE EXISTING SYSTEM

Rigid system design and inadequate drainage, low delivery efficiency and inequitable distribution of water, waterlogging and salinity, and over exploitation of groundwater in fresh areas represent major problems in Pakistan's irrigation system.

Rigid System Design

Although the development of barrages, reservoirs, and link canals has provided more control over distribution, the irrigation system is operated on historic canal diversion patterns that in many cases no longer correspond to water requirements. Inefficient reservoir capacity combined with the highly seasonal pattern of river flows—which provide roughly 85 percent of water during the summer—result in inadequate water availability at the beginning and end of the summer and during the winter. This mismatch between water supplies and water requirements constrains agricultural production.

Each watercourse is a miniature irrigation system, with channels up to 10 miles long. Watercourse commands range from 200 to 700 acres, with discharges of 1 to 3 cusecs. Each command is divided into 25-acre squares, each of which has access to the public watercourse at a single point and includes a network of farm channels. Because the average farm is much smaller than 25 acres and parts of the farm are not cropped each season, channels can take up as much as 8 percent of the square's area. A better-organised square would allow for more cropping area and less water loss. Improved layouts of farm land with shorter and fewer farm channels could also improve on-farm delivery efficiency. Redesign of farm layout would require land consolidation or integration, however, which is difficult in Pakistan because of poor land records. More efficient designs could easily be adopted in new areas, however.

Inadequate Drainage

Flat topography and lack of well-defined natural drainage in the Indus Plain create a surface drainage problem, which has been compounded by the construction of roads, railways, flood embankments, and irrigation systems that obstruct natural drainage flows. Since the 1960s efforts have been made to provide drainage in the irrigated areas and several large drainage programmes are ongoing. Out of the gross canal commanded area of 16.7 million hectare acres about 6.5 million hectare acres requires drainage, of which about 1.86 million hectare acres are covered under ongoing projects (Table 1). Providing drainage to such a vast area is a large undertaking. An area of about 2.38 million hectare acres is estimated to have a water table of less than 5 feet. The government considers such areas disaster areas gives them high priority for drainage. On-going projects cover only 0.85 million hectare acres of designated disaster areas.

Table 1

Scope of Drainage Requirements in Pakistan

Area	Gross Area (Mha)	Share (Percent)
Gross Area	16.67	100
Total Area Requiring Drainage	11.46	69
Area under Completed Projects	5.85	35
Area Requiring Drainage in Future	6.50	39
Under On-going Project	1.86	11
Remaining Area	4.64	28
New Area	3.75	22
Under Completed Projects Requiring Drainage	0.89	5
Area with Water Table Less Than 5 Feet in April/June 1989-90	2.39	14
Under On-going Projects	0.85	5
Under Completed Projects Requiring Drainage	0.51	3
Remaining Area	1.03	6

Provision of drainage is essential for maintaining the agriculture sector resource base: disposal of drainage effluent in the rivers, canals, and evaporation ponds will not be feasible in the long run. An outlet to the sea with link drains from the rest of the basin will be required to carry highly saline effluent to the sea. Drainage investments are highly viable, with rates of return close to 20 percent.[2] The absence of natural drainage and the continuous nature of the Indus Plain groundwater system requires that all drainage infrastructure be developed in an integrated manner. Independently developed local schemes may be in danger of being overwhelmed by neighbouring undrained areas with high water tables and becoming ineffective. Because of the large scope of the investments and cross linkages, balanced development in the drainage sector requires

[2]The EER of SCARPIV was estimated to be 19 percent; the actual EER was 18 percent for SCARP Mardan and Left Bank Outfall Drainage.

integration of local area drainage needs and such infrastructural developments as outfall drains for the conveyance of drainage effluent from larger tracts.

Low Delivery Efficiency and Inequitable Distribution

As a result of age, overuse, and poor maintenance, canal delivery is extremely inefficient. Average delivery efficiency is 35–40 percent from the canal head to the root zone, with most losses occurring in watercourses. The loss of such a large proportion of surface water reduces water available for crops and contributes to waterlogging and salinity.

In many irrigation systems with drainage, excess water and water lost in irrigation return to the river, to be used again downstream. The loss in efficiency to the river basin is thus lower than the loss to any single scheme.

Inequitable distribution represents another serious problem. Because of poor efficiency water does not reach users at the tail end of the system — at least not at the rate intended in the system's design. Illegal pumping from canals exacerbates the inequitable distribution of water.

Water-logging and Salinity

Soil salinity may be robbing Pakistan of about 25 percent of its potential production of major crops [World Bank (1992)]. In an environment like the Indus Basin (flat topography, poor natural drainage, porous soils, semi-arid climate with high evaporation) irrigation without adequate drainage will inevitably lead to rising water tables and salinity. The increase in the diversion of river flows for irrigation and seepage from canals, watercourses, and irrigated areas has meant a gradual rise in the groundwater table. By the 1960s a series of SCARPs were initiated. Despite these efforts, however, about 30 percent of the gross commanded area is waterlogged, of which about 13 percent is considered highly waterlogged. About 8 percent of the gross commanded area is estimated to be severely affected by salt; another 6 percent is believed to be moderately affected.

Over-exploitation of Groundwater in Fresh Water Areas

Groundwater use has contributed to increased agricultural production since the late 1970s. Groundwater tubewells not only supply additional water but provide flexibility to match surface water supplies with crop water requirements. The explosive growth in groundwater use by the private sector (6 percent annual growth in number 2 private tubewell) may cause saline water to contaminate freshwater aquifers by excessive lowering of water tables in fresh groundwater areas. Furthermore, in many canal commanded areas, where canal water is not sufficient because of inequitable distribution, farmers depend on tubewells and tend to overexploit groundwater. In the

absence of adequate leaching and effective conjunctive use of surface and groundwater, excessive pumpage introduces salinity in the root zone.

PROBLEMS CAUSED BY INADEQUATE PLANNING OR SUPERVISION BY THE GOVERNMENT

Inadequate Operation and Maintenance (O&M)

Pakistan's irrigation and drainage system has been deteriorating because of deferred maintenance and utilisation beyond design capacities. Under Bank Projects Provinces agreed to maintain the 1988 levels of expenditure on surface irrigation and subsurface saline drainage facilities in real terms. Actual expenditure fell far short of 1988 levels in all provinces except the North West Frontier Province (NWFP): overall the gap is more than 24 percent, with gaps as high as 37 percent in some regions (Sindh). Privatisation of groundwater tubewells has proceeded more slowly than planned and in Punjab and Sindh, where most of these tubewells are located, O&M requirements are twice as high as estimated. Had O&M requirements of publicly owned tubewells been included the financing gap would thus have been even larger.

Inadequate Cost Recovery of O&M Expenditure

In the past capital costs of irrigation development were recovered from users. In recent years, however, water and drainage charges have been intended to cover only O&M. The figures are available only upto 1992-93 and these figures shows that the gap between O&M expenditure and recoveries through water charges has been increasing, reaching 44.4 percent in 1992. In Punjab and Sindh the gap is about 30 percent, and would have risen to more than 60 percent if expenditures on public tubewells had been included; relative to recoveries, the overall gap would have been 57 percent. In NWFP and Balochistan the gap is as high as 80 percent.

Inadequate O&M is largely the result of inadequate institutional capability and lack of funding. Operating under a structure and set of rules formulated more than 100 years ago, Provincial Irrigation Departments (PIDs), resist any form of institutional change, modern technology, or management practice. Emphasis on technical performance is declining, along with the PIDs'ability to enforce statuary provisions of the Canal and Drainage Act, the foundation of good irrigation practice.

Funds allocated to PIDs by provincial governments are insufficient for proper O&M. The shortfall stems from low water rates and inadequate assessment and collection of charges. Water charges in Pakistan apply only to surface water supply and are imposed on a crop acreage basis that varies with the type of crop grown. Rates are currently set significantly below the level needed to recover O&M expenditures. Revenue collection and implementation of O&M are undertaken buy different agencies

and revenue does not go directly to the PIDs, thus eliminating incentives to improve water delivery and the collection of charges.

The Price of irrigated water grossly understates the true value of water to agricultural producers. Based on actual prices paid by farmers in private sales the value of water to users is as much as ten times higher than current official charges. The difference between the cost and the value of water represents a hidden gain, or rent , to water users and distorts the use of the system, causing a breakdown in system discipline and unequal distribution as users struggle to capture this rent (through illegal pumping or breaking the *mogha* or the *warabandi*).

Farmers willingly make informal payments to irrigation system officials to obtain additional water. Yet they are unwilling to pay even the current low O&M charges because they are seen as unrelated to any water deliveries or O&M services they may receive from the PIDs. At the same time, PID budgets are unrelated to water charges, making them independent of (and indifferent to) user requirements (although they may be responsive to individual users as part of rent-seeking).

Poor Investment Planning

Investment planning for irrigation and drainage is conducted at three levels in Pakistan. Sectoral plans establish a medium- to long-term framework for sectoral development, five-year plans are used for short-term planning, and yearly allocations are made by the Annual Development Programme (ADP). In the past much effort has gone into sectoral planning. Plans such as the Revised Action Programme (RAP) and Water Sector Investment Planning Study (WSIPS), prepared with foreign assistance, take a comprehensive look at sectoral requirements and objectives. These plans are rarely incorporated wholly into either five-year plans or the ADP, however, and institutional and policy recommendations are often ignored. Instead, the tendency is to invest in poorly planned civil works packages.

Inadequate Project Preparation and Lack of Project Ranking

No identifiable rational process for identifying and prioritising investments in irrigation and drainage exists in Pakistan. Project approval follows guidelines issued by the Planning Commission in the 1960s and feasibility reports contain insufficient information on which to implement projects successfully. Moreover, provincial and federal agencies are unable to prepare projects effectively: projects prepared by the government often use cost estimates that are distorted by out-of-date rate schedules and designs that use obsolete techniques and guidelines, and interproject and intersectoral linkages are generally not considered.

Because of the inability of the government to prepare projects feasibility plans for

externally assisted projects are usually prepared by consulting firms, which help the agencies in planning and development. Few domestic consulting firms are qualified to undertake these assignments, however, and ambiguous regulations, unfair hiring practices, and the complexity of hiring consultants limits their use.

Project approval is slow and often based on affordability and social benefits rather than on economic criteria. Projects are approved as they are proposed, thus facilitating the politicisation of the process. Moreover, even if a project is economically viable it is unlikely to be approved if it is not included in the current five-year plan. Finally, no process exists for evaluating and ranking potential projects.

These shortcomings were among the major constraints affecting performance during the Seventh Five-Year Plan and the Eighth Five-Year Plan (1992). By and large each project is revised time and again in terms of cost, schedule, and benefits, disturbing the investment plan and adversely affecting policies and targets. The need for proper planning, project preparation, cost estimation, and monitoring during implementation for each water development and drainage project is critical. Continuous monitoring and periodic reviews are necessary for corrective action to complete the project within the envisaged time and cost.

Declining Investment Financing and Inadequate Capital Cost Recovery

Pakistan's irrigation and drainage system has been almost entirely funded by the public sector. Given the political climate and the state of the banking system in Pakistan the costs of establishing the infrastructure to achieve economies of scale could not have been met by the private sector. Subsequent tubewell irrigation investment did involve substantial private sector investment, and indication of the ability and willingness of the private sector to finance further development.

Since the mid-1980s public spending on irrigation has been declining by about 4 percent a year in real terms. Completion of projects underway has been delayed and there has been a tendency to start new projects without ensuring the availability of funds, further delaying completion. Funds available for project implementation have been severely reduced because of the high rate of interest charged to the project during construction because of the prolonged implementation period. One major reason for the shortage of development funds is the failure to recover capital costs from users. In the past some capital costs were recovered under provisions of the Canal and Drainage Act. Land previously classified as waste (uncultivated) was sold to farmers upon irrigation development. Privately owned land that was farmed was also subject to "betterment charges" following irrigation from a public system (USAID 1984). Water charges, too, included a component for capital cost recovery. In 1972-73 and 1973-74 revenue receipts were higher than the total O&M expenditure by 13 and 25 percent. Revenue

receipts fell below the O&M expenditure for the first time in 1974-75 and capital cost recovery has lapsed since then, with water charges set with the aim of recovering O&M costs only. (The single exception is the On-Farm Water Management programme, in which about 30 percent of the cost of some materials is recovered.)

THE SOURCE OF THE PROBLEM:WATER AS A PUBLIC GOOD

Waterlogging and salinity, overexploitation of fresh groundwater, low efficiency in delivery and use, inequitable distribution, unreliable delivery, and insufficient cost recovery are not the causes of Pakistan's inadequate irrigation system but symptoms of a deeper problem—the treatment of irrigation water as a public good. In fact, water is a private tradable good, for which markets can operate (as they currently do informally). Lack of well-defined individual property rights and the banning of the sale of surface water severely constrain informal irrigation water markets.

Rather than addressing the roots of the deficiencies of the system the government has continued to treat water as a public good, causing inefficient pricing of water, misallocation of resources, and widespread rent-seeking behaviour. The problems of the system have been compounded by inadequate public sector investment in drainage, unsatisfactory management of public expenditure, and deteriorating institutional capability. Without the introduction of the right incentives, economic efficiency in the delivery of water cannot be achieved and the system cannot be sustained financially.

Efficient Pricing of Water

Creating water user rights and legalising water trading can be expected to provide a transparent market value for water and its opportunity cost, promoting more efficient use of the resource through equalisation of the marginal value product of water in its alternative uses. In the long run, efficient allocation of water is achieved when the marginal value product of water is equal to the marginal cost of supplying it. If demand for water cannot be satisfied in the short run by charging marginal delivery cost a capacity constraint exists and an optimal allocation is achieved when the marginal value product of water in one use reflects the (opportunity) cost of foregoing its use in the best alternative activity—that is, when marginal value products are equalised.[3] In an ideal irrigation system, in which the water utility has the flexibility to supply water in response to user demand, the market price for water will distribute the resource optimally, since irrigators will bid up the price of water until marginal returns are equalised. If the price does not reflect opportunity costs, overconsumption and wastage occur.

Because the Indus Basin system operates at its capacity limit the opportunity cost of one unit of water (its marginal value product in agricultural use) overestimates the

[3]An equalisation of marginal value products assumes that delivery costs are equal. If substantial divergences in transportation costs exist, net rents are equalised (marginal value product minus marginal cost of obtaining it).

short-run marginal cost of running the system. The system was designed to deliver water in proportion to landholdings. If all farms had the same agricultural production function and were equipped with the same inputs of other factors (such as labour, fertiliser, and tractors) such a system would result in efficient use of the limited resource [Rhodes and Sampath (1988)]. In fact, there is substantial variation in water efficiency across regions and across crops that cannot be explained by diverging transportation and delivery costs. The average financial return to water is Rs 700 per acre foot, but ranges from Rs 0 to Rs 2,000, suggesting significant variations in marginal returns to water. Since water, not land, is the constraining factor in agricultural production, the average and the marginal productivity of water can be expected to move together. Prices in informal local water markets reveal huge variations.

Privately pumped tubewell water prices range from Rs 100 to Rs 400 per acre foot; informal water sales that take place along a watercourse range from Rs 100 to Rs 700 per acre foot. External impacts occurring after the cropping decision make equalisations of the marginal returns to water impossible. But the large divergence in returns and prices signals high potential output gains that could materialise if available water were allocated more efficiently.

Data constraints make it difficult to determine actual long-run marginal costs for individual users and to disaggregate the individual categories of marginal costs. Practical billing necessities often render detailed long-run marginal cost pricing uneconomical. For political reasons unified regional or provincial rates might have to be adopted. Irrigation agencies often supply water to remote areas, where marginal costs outweight opportunity costs. In such cases the government could pay the agency the difference between the delivery cost and the O&M charge prior to actual delivery (that is, the cost of implementing the social programme). Such programmes divert the agency from its basic objective of cost-effective delivery of irrigation water, however, and cause a breakdown in user discipline as more and more users seek preferential treatment, expanding the beneficiary group until the programme become a severe financial burden to the public sector.

Unlike on-farm drainage, off-farm drainage is a public good, because it is not possible to exclude individuals from the area-wide drainage benefit of lowering the water table. Thus, off-farm drainage should continue to be provided by the government. The underlying problem of inappropriate institutional framework will require reforms that will ensure autonomy, transparency, and accountability within the current institutional set-up.

Sustainable Cost Recovery

Replacement of PIDs with public utilities, coupled with development of water markets based on water property rights, facilitates both efficient water pricing and sustainable cost recovery. Cost recovery should reflect the full O&M charges of

delivering a unit of water, including the costs of the provincial and federal water authorities; it should not cover past capital expenditures. All future investment costs, however—for additional and replacement capture, storage, and delivery — should be fully recovered, through delivery charges, the sale of rights, or both. Long-term development planning must take these charges into account in estimating future demand for irrigation and these costs must be made explicit by utilities in delivery contracts with user organisations.

Delivery charges that cover the full cost of O&M costs would not be burdensome for users. Current O&M charges represent only 5 percent of either costs of production or farm income and cover 70 percent of total O&M charges. Full recovery of current O&M charges would require that the rate charged be doubled. With no increase in delivery efficiencies, the increased charge amounts to Rs 40 per acre foot at the *mogha* and Rs 70 per acre foot in the field—still much lower (but higher than the lower end of informal market price) than the financial marginal value of water of Rs 700 per acre foot, the informal market value of Rs 100 — Rs 700 per acre-foot, or private tubewell water prices of Rs 100–Rs 400 per acre foot. To the extend that farmer organisations take over O&M at the distributary level and improve delivery efficiency these charges would be reduced. Significant efficiency gains below the *mogha* could also be made through farmer organisations.

Pricing of delivery services by public utilities must be regulated to prevent market imperfections leading to discriminatory pricing practices and misstatements of costs in establishing the basis for cost recovery. A commonly used yardstick of financial viability is the potential to earn an acceptable return on assets (such as net operating income) as a fraction of net fixed assets plus working capital [Munasinge (1988)]. An upper limit to returns imposes a restriction on average water charges. Regulated in this way the system would give priority to achieving the financial objective of self-sustainability. Possibilities of following more closely the long-run marginal cost pricing approach (that is, charging different blocks of buyers a fixed connection charge and attempting to price the unit of water at its marginal cost while taking into account possible future investment projects) could also be explored.

Regulation to ensure adequate investment in system expansion appears unnecessary. Although the presence of a monopolist utility might appear to imply underinvestment in the water supply, competition from basic water rights holders (totalling about 75 percent of captured water), groundwater, and other utilities would ensure that appropriate investment was made in the long run. In development of new storage the utility would face competition from federal and provincial governments, other public utilities, and the larger, more advanced farmer organisations. The monopoly of the public utility thus extends only to the delivery of diverted water and regulation should be confined solely to this area.

A NEW APPROACH TO ADMINISTERING THE SYSTEM

The future strategy for irrigation and drainage will require a major change in the public sector's approach. The goals of establishing an efficient self-sustaining irrigation and drainage system can be achieved only by promoting the use of market-determined incentives for improving the management of the irrigation and drainage services and giving the private sector a greater stake in the system. The process could begin by decentralising the management of irrigation and drainage systems by developing commercially oriented public utilities on a canal command basis, developing suitable farmer organisations around distributaries/minors, formalising water rights, developing autonomous provincial water authorities, and developing provincial regulatory bodies for regulating public utilities, water rights, and groundwater resources. The structure proposed here approximates the current provincial structure in order to minimise disruption. The functions of the PID would be divided horizontally between the public utilities and a provincial water authority. A provincial regulatory authority would be required for the utilities and user organisations. The role of the federal authorities would remain unchanged.

Public utilities at the canal command level—which are large enough to capture any scale economies in administration yet small enough to be responsive to users—would play the leading role in the management of the system until user groups matured and were able to take over. Farmer organisations would have to be fostered to provide structure on the demand side. Such organisations would make a unique contribution to the welfare of farmers and to the development of Pakistan's irrigation and drainage by providing a counterbalance to the monopoly of the public utilities, by facilitating water market development, and by reducing administrative and O&M costs.

Institutional Structure

The proposed institutional structure provides a greater role for the private sector and autonomy for public sector agencies. Federal institutions would continue to be responsible for overall assessment, coordination, and development of interprovincial water resources and works. An administratively autonomous provincial water authority would be responsible for coordinating all planning and development of water resources within the province and would handle distribution of irrigation water to financially autonomous independent public utilities at the canal command level. At the production face a farmer organisation would distribute water among its members. A provincial regulatory commission would regulate the O&M charges of the public utilities and adjudicate farmers' disputes.

Federal Government and Agencies

The role of the federal institutions would change only slightly. Development

of appropriate legislation to establish water rights, develop water markets, and regulate public utilities would be the responsibility of the Ministry of Water and Power. WAPDA and the Chief Engineering Advisor would continue to work as executive arms of the Ministry of Water and Power and would assume responsibility for the following functions:

- Assessing and allocating water resources among sectors in the light of demand patterns and efficiency in use.
- Making hydrological measurements; investigating, planning, and monitoring water above the rim stations; and managing watersheds.
- Monitoring and controlling groundwater aquifers.
- Developing and implementing criteria and programmes for monitoring and enforcing standards for water quality in rivers and groundwater aquifers.
- Assessing and forecasting water availability and preparing basin-wide operational plans in coordination with the provincial water authorities and public utilities.
- Delivering water to the provincial water authorities.
- Coordinating flood control works and flood management.
- Planning, developing, and operating and maintaining large dams, interprovincial link canals, and outfall drains (in response to long-term needs identified by the provincial water authorities and/or public utilities with full cost recovery for such services.
- Recovering O&M and capital costs of federal infrastructure through water charges, sales of water, or revenue installments.

Indus River System Authority

The Indus River System Authority (IRSA) was created in 1992 to oversee the implementation of the Provincial Water Accord by the provinces. Its role would not change under the new set-up. IRSA would lay down the basis for regulation and distribution of surface water among provinces according to the allocation policies agreed to in the Provincial Water Accord, review the reservoir operation, settle any disputes between provinces relating to distribution of river and reservoir waters, and evaluate the availability of water for all new projects.

Provincial Water Authority

An administratively autonomous Provincial Water Authority (akin to the federal WAPDA) would be responsible for delivering water to public utilities. These deliveries might consist of the basic water rights of public utilities and water captured by the provincial water authority, or water traded among different public utilities.

Total water use in each province would be determined according to shares allocated under the Provincial Water Accord. The provincial water authority would recover O&M costs for the delivery of the basic rights volume; any incremental water captured by the Provincial Water Authority would be auctioned off.

The Provincial Water Authority would be responsible for the O&M of link canals, barrages, and other provincial facilities distributing water to public utilities (although implementation could be contracted out) and would plan and develop new facilities on behalf of public utilities to improve water delivery efficiency, regulate water within the province, and facilitate sales among public utilities. The cost of these activities would be recovered through the sale of water or revenue installments. Transaction fees would be charged to recover costs involved in facilitating trading among public utilities. The Provincial Water Authority would also be responsible for developing, operating, and maintaining main and/or tributary drains; receiving drainage effluent from the farmer organisations within the province; and handling flood control and protection works and flood management within the province.

Provincial Regulatory Commission

A Provincial Regulatory Commission would oversee the financial affairs of public utilities, register water rights, and adjudicate local water distribution disputes. The commission would comprise two wings. The regulatory wing would oversee the financial aspects of public utilities operations, including reviewing and registering allocation of basic water rights and regulating public utility charges for delivery of basic water rights volumes. All water distribution disputes, including disputes among the members of a farmer organisation, would be adjudicated by the arbitration wing.

Public Utilities

Public utilities are a key interim element in the proposed institutional structure. The public utility would need to be a self-sustaining autonomous body with a hard budget constraint. Services would be provided on a commercial basis. The public utility would comprise two wings, operations and technical assistance. Although a public utility could cover several canal commands it would be desirable for accurate water accounting for a canal command not to be split among more than one public utility. The main function of the operational wing of the public utility would be to take delivery of water from the provincial water authority and to allocate it among farmer organisations. Where contracted to do so by the provincial water authority, it would undertake development, O&M, and collection of charges for drainage and flood protection systems within its command area or elsewhere. The technical assistance wing would be responsible for helping farmers develop farmer organisations and making decisions about technical options. To do so the public utility could hire services of consulting

firms, NGOs, or other agencies with expertise needed by the farmer organisations. As the farmer organisations matured the activities of the technical assistance wing would be scaled down. Revenue of the public utility would come from recovery of O&M cost (including O&M costs charged by WAPDA) and the Provincial Water Authority for delivering water established as farmer organisation's basic right, sale of nonbasic rights water to farmer organisations or other public utilities, and transaction fees for facilitating water trade between different farmer organisation). The public utility would not get involved in disputes among members of the farmer organisation as long as the farmer organisation paid its water charges. If the farmer organisation did not pay its water charges the public utility would be empowered to stop supplying water.

The major functions of the public utility would include the following:

- Operating and maintaining irrigation and drainage facilities in its command area.
- Collecting water delivery charges from the farmer organisations and collecting drainage service charges as contracted for by the provincial water authority and federal agencies. (Drainage costs should also be shared by the industries that dispose their effluent into the drainage system. The cost of flood protection and management should be also shared by all beneficiaries.)
- Passing on the provincial and federal share of fees collected to the provincial water authority and federal agencies.
- In coordination with the farmer organisation, determining the delivery point at which the farmer organisation would receive water from the public utility. During transition, the delivery point may be at the head of a watercourse. As the farmer organisations mature and expand their management capabilities, the delivery point should move higher up the system. The system should have built-in incentives for encouraging greater participation of the farmer organisations in the distribution of water.
- In coordination with the farmer organisation, determining basic water rights at the delivery point based on the following criteria:
  - The volume of water based on the approved water allowance at the water course head and the designed capacity factor for the distributary would form the lower bound for the water right.[4]
  - The volume estimated, based on an average capacity factor during the post-Tarbela period, would form the upper bound.
  - In determining actual water rights consideration would be given to soil and

[4]At the design stage it is assumed that when operational the distributary will run full—that is, all watercourses on the distributary will draw their authorised water allowances. The capacity factor determines the number of days the distributary will run. The guidelines require that a distributary be operated for a block of time at least 8 days to ensure that all users on a watercourse receive their share and losses are minimised.

groundwater conditions, delivery losses within the farmer organisation area, land distribution/farm size within the farmer organisation, and the location of the delivery point.

- Specific water rights would be negotiated between farmer organisations and public utilities, and approved and registered by the Provincial Regulatory Commission.
- Groundwater rights would be allocated following allocation of surface water property rights.
- Water would be procured from the provincial water authority as available (in addition to the basic water rights) for sale to farmer organisations. Excess water would be sold to other public utilities and trading between farmer organisations would be facilitated (for which the public utilities may charge a transaction fee).
- Field drains in the farmer organisation's areas and drains connecting the areas to the provincial drainage system would be developed and maintained as contracted for by the provincial water authority or the farmer organisations.
- Commercial investments in system development would be initiated to increase water use efficiency, and fee-based technical assistance would be provided to farmer organisations on O&M of irrigation and drainage systems.

Drainage and Flood Protection

Because drainage is a public good the primary responsibility for provision and O&M of drainage and flood protection services rests with the public sector, at both the federal and provincial level. The delivery agency (the public utility) has the opportunity to play a unique role, but steps will have to be taken to avoid unnecessary monopolies.

A three-tier drainage system is proposed. Responsibility for interprovincial drains and flood protection would remain with the federal authorities. The Provincial Water Authority would be responsible for development and O&M of provincial drainage and flood protection. As monopoly suppliers of canal water public utilities have a unique ability to collect drainage cost recovery charges on behalf of the provincial water authority together with irrigation water charges. The provincial water authority could also contract with public utilities to carry out drainage O&M within their own CCA. To preserve competition, however, all provincial water authority contracts for drainage construction, contract management, and O&M should be awarded through competitive bidding. Farmer organisations may develop local area drainage schemes through contracts with public utilities or private contractors. Farmer and other user organisations may internalise collection of drainage charges or use the utilities' collection facilities.

An optional two-tiered system would charge the public utilities with responsibility for providing all off-farm drainage needs and recovering costs, which could be tied to irrigation water charges. Such charges would come under the regulatory oversight of the Provincial Regulatory Commission. The Provincial Water Authority would likely remain responsible for overall planning and coordination of provincial drainage development in addition to its other responsibilities.

Farmer Organisations

If Pakistan's farmers have managed their own watercourses for decades without formally organising why should they do so now? Pakistan's irrigation system was built to serve fewer farmers holding larger acreage than they do today. Migration and land fragmentation have put great pressure on already scarce water resources [Government of Pakistan (1988)]. In the process discipline has broken down, theft has become increasingly common, and inequity has grown [Bandaragoda and Firdousi (1992)]. Real O&M expenditures have fallen markedly over the past few decades so that less water now reaches the *mogha*. Flows through watercourses are subject to leakage and theft, and water reaching the tail (when it does so at all) is inadequate. Given the government's fiscal constraints an alternative O&M financing strategy must be pursued. The preferred course is to transfer greater control of the irrigation system to organisations of water users. Because traditional methods of decision-making among irrigators have not proved to be sufficient to shoulder these new responsibilities, cooperation among users (not just within but among farmer organisations) will be required to transfer greater O&M control from the government and to enable water markets to function effectively.

To realise the full potential of water markets maximum flexibility and control must be afforded to the buyers and sellers of water. Farmers could arrange the sale of water among individual users located at the lower end of the system, something that would be prohibitively expensive for a public agency to do. Formation of farmer organisations, initially at the distributary/minor level, would reduce the O&M burden of the public sector, enhance farmer participation in the distribution of water, and provide a market in which the true value of water would be transparent. The farmer organisations would likely be cooperatives and thus subject to oversight and regulation by provincial government agencies responsible for cooperatives. In most provinces specialised enabling legislation would be required before such organisations could be established.

Ensuring accountability of monopolies (public or private) is crucial and is best achieved through a combination of regulation (service standards, reporting requirements, and so forth) and consumer rights. Consumers—acting collectively and individually to protect their rights, and reinforced by legislation—help ensure accountability. Farmer organisations must play a central role in ensuring that public utilities are accountable for service delivery, maintenance of physical structures, and assessment of charges.

Farmer organisations must also help bring user discipline to water distribution. The fact that *warabandi* on a watercourse, which is implemented by the farmers themselves, is rarely violated shows that the farmer organisations can improve operation of the system. Their role should thus be expanded to the highest possible level in the system—at least to the distributaries and minors.

In the short term, the main functions of a farmer organisation should include the following:

- Determining a suitable delivery point from which to receive supplies from the public utility, assess basic water rights, and determine the share of each farmer organisation member.
- Distributing water and facilitating trade of water among members.
- Estimating and forecasting water needs for the farmer organisation area and negotiating with the public utility to acquire incremental water or arrange sale of excess water to another farmer organisation or public utility.
- Carrying out O&M of both the irrigation and the drainage systems within the farmer organisation area.
- Planning and developing the irrigation and drainage system within the farmer organisation area by improving the distributary/minor, setting up control structures to make the system flexible for trading among farmer organisation members, installing meter flumes or other suitable water measuring devices for water accounting, redesigning watercourses and their layout, and/or laying out farm land, on-farm drainage, and connections to the public utilities drainage system.
- Developing groundwater to meet water needs.
- Estimating total O&M cost, including public utility charges, collection of water charges or other fees from its members, and payments to the public utility.

In the long term farmer organisations would play a larger role. Development of farmer organisations in Pakistan is currently inadequate to support operation of more than a watercourse; even at this level, despite substantial effort by the World Bank, results have fallen short of expectations. Because of the underdevelopment of farmer organisations, public utilities will have to play the leading role in the short run. The interim role of the public utilities should not impede eventual takeover by the farmer organisations and other local groups with valid interests in area water resource management. As the farmer organisations expand from the watercourse level, through amalgamation at the distributary and minor levels and through a federation to the entire canal command, they are expected to become more involved in the work of the public utility through greater representation on its board. Eventually, formation of long-run

business policy should be well within the capabilities of the farmer organisation and the farmer organisation federation would be expected to try to rationalise other productivity-related agricultural matters, such as land consolidation and technology transfer.

Transition Arrangements

The total period required for transition depends on the acceptance of the new institutional structure and the speed with which farmer organisations are developed. Total transition is expected to take about fifteen years, with completion of all four phases expected within twenty years. The structure outlined here will require adjustments to suit the specific conditions at the different canal command areas. A phased approach is therefore desirable, as shown in Table 2.

Table 2

Phasing in the Restructuring of the Irrigation and Drainage System

Phase	Restructuring Steps	Responsibility for O&M	Assessment of Water Charges	Collection of Water Charges
Phase I: Formation of Institutions Period 1-2 Years	Enabling legislation, allowing formation of public utilities, farmer organisations, sales of water, establishing water rights and revision of *warabandi* to include delivery losses.			
	Linkage of the Annual Development Programme with the Commercialisation of Irrigation and Drainage systems (I&D).			
	A pilot public utility is formed converting at least one canal command. At the same time the Provincial Regulatory Commission (PRC) is formed. Public utility announces the revised rules of *warabandi* in the project area.	As currently (i.e., farmers below *mogha* and public utility above *mogha*).	Water rates are crop based but revised to recover full O&M cost of public utility.	By public utility either directly from farmers or from functioning farmer organisation.
	Formation of farmers organisations is encouraged and the technical assistance wing of public utility assists farmer organisations in organising and making technical decisions.			

Continued–

Table 2—(*Continued*)

Phase	Restructuring Steps	Responsibility for O&M	Assessment of Water Charges	Collection of water Charges
Phase II Institutional Building Period 2-3 Years	Farmer organisations are formed, water rights of the farmer organisations are determined jointly by the farmer organisation and public utility, and approved and registered by the Provincial Regulatory Commission. To expedite formation of farmer organisations incentive packages and technical assistance will be offered to potential farmer organisations. In the farmer organisation areas, the system is remodelled wherever necessary and water is delivered to the farmer organisations on volumetric basis at the delivery point. Total deliveries will consist of water rights and purchases from public utility or other farmer organisations. In non-farmer organisation areas the public utility will revise the *warabandi* if a dispute arises. Technical wing of public utility provides assistance in installation of control structures and measuring devices within its area.	Farmer organisation is responsible for O&M of the system below the delivery point, public utility above. In non-farmer organisation areas farmers are responsible for O&M below *mogha* and public utility above *mogha.*	O&M cost estimated on volumetric basis for the water delivered as water rights and incremental water is delivered at the negotiated price. For water trade among farmer organisations the public utility will charge a delivery fee. In non-farmer organisation areas, water charges are crop based.	Public utility collects charges from farmer organisations where they are formed and from farmers in non-farmer organisation areas.
Phase III Development and Expansion. Period 3-4 Years	Public utility improves delivery efficiency and expands the water supply. Drainage needs are assessed and drainage network developed if farmer organisations agree.	Same as above	Same as above	Same as above
Phase IV Final Phase Period. About 10 Years	Rest of the canal commands are converted to public utilities and PWAs are formed.	Same as above	Same as above	Same as above

Phase I: Formation of Institutions

The first step is to develop legislation and issue administrative orders and notifications allowing formation of public utilities, farmer organisations, water property rights, and water markets. The next step is to define the structure of a public utility and the provincial regulation commission. Because the new institutional structure may be readily introduced through a series of development projects it is very important to establish a link between it and the Annual Development Programme. The transition will start by selecting one of forty-three canal commands of IBIS as a pilot project under the annual development programme. Proposed allocations in the Eighth Five-Year Plan for the Irrigation System Rehabilitation Programme, On-farm Water Management Programme, and drainage can be used to establish the new institutional structure in the selected area.

After the public utility is established control of irrigation and drainage in the project area would be transferred to the public utility. During transition the old and new systems would run in parallel, with built-in incentives to move toward the new system. Selection of the project and formation of the public utility would be announced to the farmers, who would be encouraged to form farmer organisations. In the beginning considerable assistance would be required to help farmers form farmer organisations and to prepare them for taking over responsibilities. These services could be provided through consulting firms or NGOs; the technical assistance wing of the public utility could assist in arranging such services. In areas in which the farmer organisations are ready for handling bulk water deliveries from the public utility on a volumetric basis, deliveries would be switched over the new system. In the rest of the area the current system would continue with revised crop-based charges to recover full O&M costs.

The public utility would prepare a water budget and distribution schedule for the command. It would define new rules of *warabandi*, which would include watercourse losses in determining time allocation for each farmer. Farmers on a water course could continue with the *kacha warabandi* (mutually agreed rotational schedule for irrigation deliveries on a watercourse). However, if a dispute arose the public utility would intervene in that watercourse command and fix new *pakka warabandi* (a fixed rotational schedule of irrigation deliveries), which would account for losses in the watercourses. The public utility would not be responsible for enforcing the *warabandi*. If a dispute arose the arbitration wing of the provincial regulation commission would adjudicate and its decision would be final. Users who did not pay water charges would be excluded from the *warabandi*; if nonpayment continued outlets would be closed.

The public utility would estimate O&M costs and establish water charges using the current system (by crop) and these charges would be approved by the regulatory commission. If the government wished to phase increases in the public utility's water charges the difference would have to be met by the government. To recover O&M cost

from a farmer organisation area the public utility would determine the O&M cost of delivering water at different points in the system and develop a volume-based rate structure, which would be approved by the provincial regulatory commission.

After a farmer organisation is formed the public utility would work with it to determine an appropriate delivery point. This point should have a control structure for regulating and measuring flows. If such a structure does not exist the public utility would provide it. Based on the approved guidelines by the provincial regulatory commission, the public utility and farmer organisation would estimate basic water rights at the delivery point. The volume, timing, and O&M cost of delivering these basic water rights would then be approved by the provincial regulatory commission.

Phase II: Institution Building

As the farmer organisations are formed and the water balance in the command area may changes the public utility would update its water budget. In addition, the public utility would assess water losses in the channels under its control and develop plans to recover those losses. Improvement plans would be examined by the provincial regulatory commission (especially in the FGW areas) to determine the extent of the incremental water. The provincial regulatory commission could use the technical services of agencies such as WAPDA for this purpose. Improvements would also be needed to develop operational flexibility and to provide water accounting necessary for efficient operation of the system. At the pilot stage the public utility would require expert technical assistance to design replicable models. As the system developed, the public utility could sell any excess water to farmer organisations or to other public utilities; to meet the demands of farmer organisations public utilities could purchase water from other public utilities or the provincial water authority (when they are formed at a later stage).

Different development alternatives for the pilot should be evaluated and designed as part of the project preparation and the public utility should be assisted in designing suitable controls to make the system flexible. The complexity of the problem and the importance of arriving at the best solution make development of the pilot critical. A water measuring and accounting system for the project area should also be designed and consultants should assist in preliminary designs for notifying the distributaries and minors that are transferred to farmer organisations. These designs should be finalised and implemented in consultation with the farmer organisations. Drainage needs for the area should also be assessed and an overall plan prepared.

The technical assistance wing of the public utility should be assigned to work with farmers on a distributary/minor to explain the new system and to assist them in forming farmer organisations. Farmers world elect representatives, register the farmer organisation, and establish an office and a bank account. With assistance from public utilities, technical assistance teams, and project consultants the farmer organisation

would assess the suitability of existing structures and identify the structural improvements (such as watercourse improvement, control structures, canal improvement, and measuring devices required to distribute water efficiently. Assisted by consultants, the farmer organisation would prepare plans for the development and financing of these improvements.

In areas without farmer organisations the current system of distribution of water would continue, except in these areas that would receive water from the public utility rather than the PIDs. Water rates would be revised to recover total O&M costs. In the event of a water distribution conflict a revised *warabandi* (that would include delivery losses) would be implemented.

During transition incentive packages would be offered to encourage farmer participation and speed the development of the public utility. Costs of such assistance would be fully recovered after a grace period. For the public utility technical assistance would be needed in the form of consulting services, establishment of offices, and improving structures. For farmer organisations the incentive package may consist of technical assistance and office establishment to be provided from the development budget. On-farm improvements (such as lining the watercourses, providing flow control and measuring devices, and improving on-farm drainage) could also be financed from the development budget. These would, however, be fully recovered in the form of cash advances, labour contribution, water charges, and /or revenue installments. The farmer organisations would also contribute toward improvements above the *mogha*. The recovery level from farmer organisations would be determined on the basis of types of improvements provided, reduction in the O&M cost of the public utility as a result of transfer of these facilities, and the paying capacity of the farmer organisations.

Phase III: Development and Expansion

Development and expansion (Phase III) would proceed simultaneously with Phase II. The public utility would improve delivery efficiency and expand the water supply by reducing excessive losses, remodelling the delivery system, and developing storage and groundwater. If most of the farmer organisations agreed, the public utility would plan and develop the drainage system and arrange for the disposal of drainage effluent.

Phase IV: Expansion of the Pilot Project

The final phase of the restructuring would involve development of public utilities in the remainder of the canal commands. Lessons learned from the pilot project would be incorporated during the transition of the rest of the area to the new structure. The provincial water authority would be formed after several public utilities began functioning.

Bottom-up Versus Top-down Approach to Restructuring

The current institutions could be transformed into the proposed structure in two ways. A bottom-up approach would establish a series of pilots projects (at the canal command level) in which public utilities and farmer organisations would take over O&M functions of the irrigation and drainage system. Changes at the provincial level would be made after the new institutional structure began functioning satisfactorily in a few canal commands.

A top-down approach would establish the provincial institutions (the provincial water authority and the provincial regulatory commission) first and only then set up the public utilities and farmer organisations at the canal command level. This approach might bring some efficiency at the top and could speed up transition. The first option is superior, however, because it minimises overall disruption by limiting its scope to pilot areas, leaving the rest of the system to function as it currently does; allows the system turnover methodology to be improved upon as the transition proceeds (this experience will also be useful in designing the top-level institutions); and allows the time required to reorient and train institutions do not become bloated replicas of the old ones.

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