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# Accelerating Agricultural Growth—Is Irrigation Institutional Reform Necessary?

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The right to the flow of income from water is vigorously pursued, protected, and fought over in any arid part of the world. Pakistan is of course no exception. Reform of irrigation institutions necessarily changes the rights to water, whether it be those of farmers, government, or government functionaries. Those perceived rights may be explicit and broadly accepted, or simply takings that are not even considered legitimate. Nevertheless they will be fought over.

Pakistan has a long history of proposals for irrigation reform, little or none being implemented, except as isolated pilot projects. Thus, to propose major changes in irrigation institutions must be clearly shown to have major benefits to justify the hard battles that must be fought and the goodwill of those who might win those battles for reform. Proponents of irrigation institution reform have always argued the necessity of the reforms and the large gains to be achieved. Perhaps, however, those arguments have not been convincing.

This paper will briefly outline the failed attempts at irrigation reform to provide an element of reality to the discussion. It will then proceed to make the case of the urgency of reform in a somewhat different manner to the past. Finally, current major reform proposals will be presented.

This paper approaches justification of irrigation reform by focusing on the agricultural growth rate. It does so because that is the critical variable influencing poverty rates and is a significant determinant of over-all economic growth rates. The paper decomposes growth rates and suggests a residual effect of deterioration of the irrigation system that is large and calls for policy and institutional reform. The data are notional, suggesting the usefulness of the approach and paves the way for more detailed empirical analysis and enquiry for the future.

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*Author's Note*: This paper draws upon a report prepared jointly by JMA, Inc. and Asianics International, entitled *Institutional Reforms to Accelerate Irrigated Agriculture*, presented to the Government of Pakistan, 1994, as well as from a sister report, entitled *Agricultural Prices Study*, also presented to the Government of Pakistan in 1994. A particularly important contribution to the irrigation study was made by Asghar Ali Abedi and Leslie Small. The immense knowledge of the irrigation institutions of Pakistan of Mr Abedi and of the range of water charge issues by Leslie Small is gratefully acknowledged.

## FAILED EFFORTS AT IRRIGATION REFORM

In 1967, with World Bank assistance, an "Action Plan" was developed to improve irrigated agriculture. The plan, with its several major components, was soon judged a failure and so the Water and Power Development Authority (WAPDA), this time with financial assistance from the United Nations Development Programme (UNDP) and technical assistance again from the World Bank prepared a Revised Action Plan (RAP) for irrigated agriculture.

The RAP plan was approved in 1979. That plan called for major investments in physical infrastructure, much of which was made. It also laid special emphasis on improving the institutional framework so as to increase the efficiency of irrigated agriculture. A centre piece of the institutional change was better coordination between numerous agencies concerned with irrigated agriculture and improved research and extension.

The institutional reforms called for by RAP were generally judged to have failed to be instituted or failed in their impact, or both. After many years of discussion of this situation a comprehensive study was undertaken and completed in 1991. As before it was organised by WAPDA, financed by UNDP and technical assistance was provided by the World Bank. The resultant Water Sector Investment Planning Study (WISP)(1991) concluded that institutional aspects of operation and maintenance of the irrigation system and efficient management of irrigated agriculture remained the major problems and that they required concentrated attention. Not much happened on the institutional front.

The study undertaken jointly by Asianics International and John Mellor Associates and completed in (1994), was carried out with far smaller resources than the earlier studies, but benefited from the massive data sets and analysis in those studies. It again drew the conclusion that major institutional reform was needed. It added detail to the kinds of reform needed and dealt with some issues not previously raised. But, it follows well in the footsteps of its predecessors; it too has not been implemented.

In view of all this money spent on studies, of broad agreement among the studies as to the needs, and lack of action on meeting those needs for institutional reform, one must ask why does the institutional reform called for not occur? Is it because the studies have failed to recognise that major costs are entailed in making institutional reform and that the benefits are indeed not up to the costs? We will argue to the contrary, but show that the urgency of institutional reform has been well masked by counter forces. We further argue that those counter forces have now weakened considerably and the underlying problem is in the process of being unmasked. Perhaps this is the time to get some action, and, perhaps by pointing out the masking, that action can come before the full damage to agriculture and the economy has occurred. That is the purpose of this paper.

## THE HIDDEN NEED FOR REFORM

The basic argument we present is that for the past few decades, and perhaps considerably longer, the irrigation system has been deteriorating with a substantial depressing effect on the growth rate of agricultural production. However, that depressing effect on the growth rate has been masked by 3 major counter forces: (1) a continuous addition to the volume of water available for irrigation; (2) major improvements in crop varietal yield potentials through agricultural research and extension; and (3) growth in fertiliser use. Further, the adequate growth rate of Pakistan agriculture has been concentrated primarily in one crop, cotton. The record in other crops has been at best modest. The growth rate for cotton can be high, but the extraordinary level of the recent past is not sustainable. In that context, fresh water aquifers have fallen rapidly and saline water aquifers have risen.

### The Overall Agricultural Growth Rate

Pakistan has maintained a growth rate in agricultural GDP of over 4 percent for the past 2 decades (Table 1). That places Pakistan among the fast agricultural growth countries [Mellor (1995)]. Even adjusting for Pakistan's high population growth rate, that still provides a growth rate per capita of 1 percent per annum. That still ranks Pakistan among the success stories of agricultural growth, but not among the best. That would provide, with normal multipliers a 1.5 percent rate of growth of the non-agricultural sector derived from the agricultural growth. Thus, agriculture has been able to play a significant stimulative role in over-all economic growth in Pakistan.

Given the recent, stunning World Bank evidence on the relation between sectoral growth and decline in poverty, Pakistan would be expected to experience a substantial decline in overall poverty directly attributable to an excellent agricultural growth record [Ravallion and Datt (1996)]. That indeed has been the case (Table 2). This is not a record that calls for radical, and politically risky and costly institutional reform of the irrigation institutions.

The case for radical institutional reform in irrigation must be made at least on the grounds that the growth rate could have been a great deal higher if institutional reform had been made in irrigation institutions; or more compellingly that the past growth rate is not only unsustainable but will decline sharply with major deleterious effects on the over-all growth rate and in poverty levels, without major institutional change in the irrigation system.

We approach this issue by discussing 4 key elements in past agricultural growth that we summarise in terms of their effect on the overall agricultural growth rate and from that approximate a net depressing effect of deterioration in the irrigation system that may require rectification through irrigation institutions reform. We start with the assumption that a high agricultural growth rate is essential to the objectives of rapidly

Table 1

*Growth Rate of Agriculture Sector, Pakistan, 1975–1991*

| Year | Growth Rate |
|---|---|
| 1975–1991 | 4.09 |
| 1975–1983 | 4.10 |
| 1984–1991 | 4.09 |

*Source:* World Bank (1992); Government of Pakistan (1992).

Table 2

*Decline in Poverty, 1963-64 to 1984-85*

| | | Trends in Poverty (Percent of Households) | | | |
|---|---|---|---|---|---|
| Study | Poverty Line (in Constant 1984-85 Rs) | 1963-64 | 1969-70 | 1978-79 | 1984-85 |
| Rural | Rs 159 | 36.79 | 44.24 | 29.23 | 24.10 |
| | Rs 172 | 42.69 | 50.76 | 35.19 | 29.21 |
| Urban | Rs 185 | 40.88 | 34.09 | 23.64 | 19.40 |
| | Rs 207 | 48.89 | 42.55 | 30.95 | 25.61 |

*Source:* Malik (1991).

rising per capita incomes, broad participation in that growth, and rapid decline in poverty. With that approach, the relevant question about irrigation reform is not the rate of return on the investment, itself largely intangible, but the effect on the growth rate. Of course, the substantial impact on the agricultural growth rate we will suggest would imply a very high rate of return on even very large investments in institutional reforms.

**Increased Volume of Water Used**

Over a 10 year period in the 1980s, the deliveries of surface irrigation increased by 23 percent due to Tarbela dam and rapid ground water development. About 60 percent of the increment has gone to increase the cropped area under irrigation. The importance of these major additions to water supply should not be understated. In the 10 year period, given that 95 percent of the area is irrigated, and if the response to more

water is linear (a reasonable assumption given that the bulk of the water went to expand the irrigated area) then water alone should have given a 2.2 percent growth rate, or over 50 percent of the actual growth rate.

Of course, the increase in water supply probably gave very little increase in agricultural output. Inefficiencies in delivery, misallocation of the water substantially to a privileged few, and so on, all decreased that return. But, that is the point. An objective of maintaining the marginal product of water as the supply expands, in consort with other inputs, including research on more efficient use, and improving institutions is a reasonable objective. If it is not achieved, the nature of the associated institutional structures requires study and ameliorative action.

**Improved Crop Varieties**

Pakistan has a good agricultural research system and the results of that research have in general moved fairly quickly into use [Byerlee (1990); Azam, Evenson and Bloom (1991)]. It is difficult to estimate what the impact of that flow of research results would be on the rate of agricultural production growth. In the United States, which has a mature agriculture at the forefront of knowledge, yields rise continuously at about 0.5 percent per year. Pakistan should be doing some catching up since its yields are well below those off the mature agricultures of the world. Calculations of potential yield show large existing gaps over average yields (Table 3). Closing a 50 percent yield gap (way below any of the numbers in Table 3) in 10 years would give a 7.2 percent growth rate; 20 years would give a 3.6 percent growth rate.

**Increased Fertiliser Use**

Fertiliser use in Pakistan has been growing at a very modest 6.5 percent rate for the past decade (Table 4). Hence, fertiliser growth has added little to the agricultural growth rate except as a complement to the increased water and research inputs. At most, the fertiliser growth rate may have added another 1 percentage point to the growth rate.

**Conclusions about the Agricultural Growth Rate**

If we view growth attributable to the preceding 3 forces as simply additive, then the growth rate should have been on the order of 6 to 7 percent per year. The actual growth rate was 4 percent, thus, the simple reasoning would go, deterioration of the irrigation system accounts for more than 2 percentage points per year of lost growth. Alternatively one can say that deterioration of the system roughly balances the additions to the water supply from the immense additions to irrigated area.

These estimates are of course very rough and ready estimates. The attribution of the residual to water deterioration includes all the error factors in that residual. Thus, we

Table 3

*Yield Gap of Food Crops in Pakistan, 1990-91*

| Crop | Potential* (kg/ha) | Average** (kg/ha) | Yield Gap (Percent) | Commodity Group Yield Gap (Percent Average) |
|---|---|---|---|---|
| Wheat | 6,415 | 1,773 | 72 | *Cereal* |
| Rice (Paddy) | 9,849 | 1,600 | 83 | 82 |
| Maize | 6,944 | 840 | 88 | |
| Sorghum | 3,500 | 600 | 83 | |
| Sugarcane | 18,300 | 40,700 | 78 | *Sugarcane* |
| | | | | 78 |
| Chickpea | 3,000 | 440 | 85 | *Pulses* |
| Mung | 2,000 | 460 | 77 | 78 |
| Mash | 2,500 | 440 | 82 | |
| Lentil | 2,000 | | 69 | |
| Rapeseed and Mustard | 2,775 | 760 | 73 | *Oilseeds* |
| Groundnut | 5,000 | 1,020 | 80 | 68 |
| Soybean | 4,100 | 1,500 | 63 | |
| Sunflower | 2,500 | 950 | 32 | |
| Safflower | 1,800 | 500 | 72 | |
| Cotton | 1,400 | 544 | 61 | *Cotton* |
| | | | | 61 |
| Potato | 3,128 | 1,040 | 67 | *Vegetables* |
| Chilies | 4,500 | 1,750 | 61 | 67 |
| Onion | 2,200 | 1,220 | 45 | |
| Tomato | 21,000 | 1,024 | 95 | |
| Citrus | 30,000 | 9,220 | 69 | *Fruits* |
| Mango | 25,000 | 9,260 | 63 | 61 |
| Apple | 32,000 | 10,380 | 68 | |
| Guava | 26,000 | 13,260 | 49 | |
| Date-palm | 15,000 | 6,500 | 55 | |
| Banana | 25,000 | 8,930 | 64 | |

*Source:* Government of Pakistan (1992).

* Potential yield under experimental conditions.

** National average yield.

Table 4

*Consumption of Fertiliser, 1983–1991 (000 tons Nitrogen)*

| Year | Nitrogenous | % Change | Phosphate | % Change | Potash | % Change | Total NPK | % Change Over Previous Year |
|---|---|---|---|---|---|---|---|---|
| 1982-83 | 944 | 15.3 | 248 | 7.4 | 26 | 30.0 | 1217 | 13.7 |
| 1983-84 | 940 | –0.4 | 267 | 7.7 | 27 | 3.8 | 1232 | 1.2 |
| 1984-85 | 945 | 0.5 | 296 | 10.9 | 24 | –11.1 | 1265 | 2.7 |
| 1985-86 | 1106 | 17.0 | 346 | 16.9 | 32 | 33.3 | 1484 | 17.3 |
| 1986-87 | 1268 | 14.6 | 372 | 7.5 | 39 | 21.9 | 1679 | 13.1 |
| 1987-88 | 1264 | –0.3 | 409 | 9.9 | 46 | 17.9 | 1719 | 2.4 |
| 1988-89 | 1318 | 4.3 | 376 | –8.1 | 27 | –41.3 | 1721 | 0.1 |
| 1989-90 | 1396 | 5.9 | 395 | 5.1 | 43 | 59.3 | 1834 | 6.6 |
| 1990-91 | 1453 | 4.1 | 385 | –2.5 | 27 | –37.2 | 1865 | 1.7 |

*Source:* Government of Pakistan (1992).

N= Nitrogen, P= Phosphorous, K= Potassium.

need to raise some questions about the logic. How is deterioration of the water system subtracting on a compounded basis from the agricultural growth rate. It does so through: (1) increasing soil salinity from improper irrigation, (2) increasing uncertainty about water supply at the tail end; (3) shifting to high water using crops, such as sugarcane, near the headwork with a lower over-all productivity in use of water.

On both numerical and logical grounds, attributing a loss of 2 percentage points of annual growth to irrigation deterioration rectifiable by institutional reform seems quite reasonable. It would be well for careful analysis of sources of growth to come up with a more carefully determined and precise number. But, for the moment it does justify attention to the issue.

### Unsustainable Success of Cotton

Further light can be shed on the question of the loss in growth rate due to deterioration in the irrigation system. For the period 1983–1991, while agricultural production over-all was growing at slightly over 4 percent per year, or 1 percent per capita, every major crop except cotton and horticulture, was growing at between –1 and +3 percent (wheat +3, sugarcane +2, coarse rice –1, basmati rice +3, oilseeds 0. Horticulture was growing at 6 percent per year, and cotton at 14 percent (Table 5).

The extraordinary growth rate for cotton was largely due to a 12 percent yield growth rate. That in turn was due to a major break through in cotton variety and in pest control. A 6 percent growth rate may be sustainable for cotton with continued major efforts in varietal improvement and pest control, but certainly not 14 percent. Thus, with a more normal growth rate for cotton of say 6 percent, comprised of 2 percent on area (as in the past) and 4 percent on yields the overall growth rate would be less than 3 percent, or no growth per capita. That eliminates the agricultural stimulus to over-all agricultural growth and to poverty reduction.

These numbers are consistent with attribution of a 3.6 percent growth rate to technology in the preceding analysis. That further suggests that deterioration of the irrigation system could easily account for the full 2.2 percent provided by past investment in increasing the volume of water. Even surface plausibility of an argument that the vast irrigation investment was simultaneously being nullified by inappropriate institutional structures is a powerful argument for reform.

## ENVIRONMENTAL DETERIORATION

The root of environmental deterioration in irrigated agriculture of Pakistan lies in depletion of fresh water aquifers and the rise of saline aquifers. Table 6 shows the immediacy of this problem clearly.

Table 5

*Area, Yield, and Production Growth Rates, Major Commodities, 1975–1991*

| Period | Area | Yield | Prod. | Area | Yield | Prod. | Area | Yield | Prod. |
|---|---|---|---|---|---|---|---|---|---|
| | Cotton | | | Wheat | | | Sugarcane | | |
| 1975–1991 | 2 | 8 | 10 | 2 | 2 | 4 | 2 | 2 | 4.0 |
| 1975–1983 | 2 | 4 | 6 | 3 | 3 | 6 | 4 | 2 | 6.0 |
| 1983–1991 | 2 | 12 | 14 | 1 | 2 | 3 | 0 | 2 | 2.0 |
| | Rice (IRRI) | | | Rice (Basm.) | | | Oilseeds | | |
| 1975–1991 | 2 | 2 | 4 | 5 | 0 | 5 | –2 | 2 | 0.0 |
| 1975–1983 | 2 | 3 | 9 | 7 | 1 | 8 | –2 | 2 | 0.5 |
| 1983–1991 | –1 | 0 | –1 | 4 | –1 | 3 | –2 | 2 | 0.0 |
| | Horticulture | | | Milk | | | | | |
| 1975–1991 | 6 | 3 | 7 | n.a. | n.a. | 4 | | | |
| 1975–1983 | 7 | 4 | 9 | n.a. | n.a. | 2 | | | |
| 1983–1991 | 5 | 2 | 6 | n.a. | n.a. | 6 | | | |

*Source:* Government of Pakistan (1992).

*Note:* Horticulture includes vegetable and fruits. The yield figures are for production divided by area, and this also reflects change in composition within the subsectors.

Table 6

*Water Balance in the Indus Plain, 1992*

| Item | Fresh Areas | | Saline Areas | |
|---|---|---|---|---|
| | Punjab | Sindh | Punjab | Sindh |
| Gross Command Area (GCA) (Million Acres) | 18.88 | 4.33 | 5.01 | 10.79 |
| | Annual Flows (Million Acre Feet) | | | |
| Canal Diversions | 41.60 | 11.98 | 12.32 | 33.26 |
| Rainfall | 15.84 | 1.42 | 3.90 | 4.54 |
| Seepage to Groundwater | | | | |
| Rainfall | 1.52 | 0.17 | 0.39 | 0.54 |
| Tubewell Water | 9.69 | 1.12 | – | – |
| Canal Water (incl. field) | 20.68 | 5.41 | 6.26 | 14.24 |
| River Losses (–)/gains (+) | –1.26 | 0.47 | –0.18 | 0.72 |
| Groundwater Pumpage | | | | |
| Private Tubewells | 31.64 | 3.52 | – | – |
| Government Tubewells | 6.76 | 0.37 | – | – |
| Evaporation Due Capillary Rise | 1.99 | 2.92 | 2.40 | 11.33 |
| Net Groundwater Recharge | –9.75 | +0.36 | +3.82 | +3.93 |
| Net Recharge Per Acre | –0.52 | +0.08 | +0.76 | +0.36 |

*Source:* Masood and Kutcher (1992).

## FAILURES OF THE EXISTING CANAL SYSTEM

The existing irrigation system has 3 major sources of failure: (1) unsatisfactory maintenance; (2) failure to follow the operational rules essential to efficient water use given the design of the system; (3) improper modification of the canal distribution system. The first of these failures is due to inadequate provision for raising resources from the users and failure to use those resources efficiently. The 2nd and 3rd arise from the scarcity value of water and failure to insulate the irrigation institutions from inequitable distribution of the power to influence water allocation decisions. Thus, when reform is discussed it must treat the two quite different issues of raising resources and equity.

In addition to the direct effects, each of these problems bias allocation of water towards the head reaches of the system. This results, not so much in less water per crop acre at the tail ends, as excessive drawing of ground water, or reduced percentage of the area irrigated at the tail ends.

**Maintenance**

It is generally agreed that maintenance of the irrigation system is completely inadequate, with consequent shrinking of the canal capacity and consequently increasingly scarce and unreliable water. This creates a vicious circle of higher risk and hence lower returns, consequent diminished capacity and willingness to pay for water, lower collections of water charges, and on to poorer maintenance and even lower returns to water. It is also agreed that there is a dual problem of inadequate level of funding and inefficient utilisation of the funds that are made available.

It is estimated [Agricultural Consulting Engineers (1990)] that there is a 30 percent gap between maintenance needs and actual maintenance collections in the Punjab. The gap in the Sindh is 51 percent. In those 2 provinces alone the gap amounts to nearly half a billion Rs or about $13 million. That is not large compared to total budgets in Pakistan, but is nevertheless a significant addition to public sector deficits. It makes the search for means of users paying for maintenance worth while. In any case, whether the sum is large or small it is not forthcoming under present public expenditure realities. Thus adequate maintenance will require increased user charges. That in turn requires the reforms that will increase the equity and the certainty of water distribution, with consequent higher real returns to the water that is paid for.

One barrier to higher user charges is the inefficiency with which maintenance is now performed. It is difficult to argue that farmers should pay more when it is self evident that existing funds are poorly utilised. That argues for farmer control of maintenance.

The major maintenance problem is failure to desilt the channels adequately. This not only reduces flow, but increases head, due to the higher level of the canal bottom, into the discharges, increasing the proportion of the flow that is used in the upper reaches of the canal.

Within the context of the maintenance resources, personnel costs per employee have been increasing much faster than the inflation rate. In addition, work by contractors for desilting seem to be frequently non cost effective. [Vander Velde (1990); van Waijjen and Bandaragoda (1992)]. Similarly desilting is not targeted to where it would do the most good [Vander Velde (1990)]. The upshot is that while maintenance funds are inadequate they are also used ineffectively.

**Failure to Follow Operating Rules**

The irrigation canals have been designed on the assumption of specified levels of flows. In practice, in some canals at some times, the flows are far less than specified, adding to maintenance costs through increased silting. In other canals and at other times, the flows are far greater than design capacity, particularly as a result

of the larger water availability from Mangla and Tarbella, with consequent increased breaching and erosion of canals. Both too much and too little water have the effect of increased maintenance costs, and that to in a context of inadequate maintenance funds.

One of the key operational rules under which the system was designed is that when water flow cannot be maintained at the design level, say 70 percent of capacity, then it should be shut off completely. That rule is generally not followed. A major reason for that is the gradual shift away from the *warabundi* system, with its set rotations, to a more power based system that responds to political power [Kuper and Strosser (1992); Kijne and Levine (1991)]. Thus, changes in the rotation and changes in the time various channels are kept open not only brings inequity, but also contributes to increasing over-all maintenance costs in a context in which maintenance is already inadequate. Of course, the vested interests in this breaching of the rules are by definition powerful and hence not easily coopted into the reform system recommended steadily over the past 2 decades.

### Improper Modification of the System

It is important to recognise that the initial system design was intended to impose water scarcity on users, so that the water could be spread over a larger number of users. It is water scarcity that brings conflicts that have the unintended effect of bringing inefficiency to operation of the system. Scarcity systems require a high degree of cooperation amongst all users and administrators of the system. A situation of highly unequal power relationships makes such cooperation exceedingly difficult and builds powerful vested interests in the very factors that cause deterioration of the system.

The system was designed to minimise the extent to which distribution could be changed in response to powerful interests. In that context, it was natural that the system would be modified to allow full sway to the vested influences.

The simplest modifications are of course illegal tampering with the *moghas* or outlets. New outlets may be placed, either illegally, or by using power to get a legal addition of an outlet. This increases flows in the upper reaches of the canal system. When steps are taken to increase the flow, farmers with influence in the middles reaches start taking illegally large amounts, so that once again flow does not reach the tail ends, with consequent environmental and productivity impairment.

## ELEMENTS OF REFORM

Irrigation institution reform in Pakistan must strike at the heart of the basic problems. It must: (1) provide funds, technical input, and oversight for efficient maintenance; (2) ensure that operational rules essential to efficiency are followed;

and, (3) prevent improper modification of the system. Conceptually these are simple straight foreword requirements, but they are requirements that the present system does not meet.

At a more operational level, the foregoing elements translate into a longer set: (1) giving responsibility for the downstream activities, those close to the farmer/ users, to user groups that are democratically organised and run; (2) establishing a judicial system that would ensure democratically run user groups by not only providing an appeal body for undemocratic behaviour, but would look for anti-democratic behaviour, seek it out and rectify it; (3) provide an overview authority for upstream activities that place system operation, new projects, and water related research and extension, that is effectively servicing the user groups with scale economy related upstream activities; and (4) provide flexibility in financial and administrative controls and hence release technical personnel to effectively service downstream users.

These elements, simple on the surface require radical change in the irrigation institutions.

## SPECIFICS OF REFORM

The reform specifics have 3 major elements: (1) establishment of irrigation authorities with authority to manage personnel and finances in a manner most suitable to efficient irrigation; (2) establishment of democratic farmer/user groups; (3) establishment of a system of water charges that would fully cover operation and maintenance costs.

We provide just enough detail on the specifics to relate to the preceding arguments for radical institutional reform. The operational details are contained in the numerous studies by the World Bank and WAPDA, and by JMA/Asianics leading to the recommendations for such institutions.

### Irrigation Authorities

Irrigation authorities would operate the primary portions of one or more canal systems including ensuring maintenance and generating revenues to cover costs. It would include management, technical personnel for operating the system, and a cadre of technical personnel to render assistance to the user groups.

The critical element is to remove irrigation management and finances from the current situation of intrusive political interference with operation of the system. One reason the present system survives is that it offers a lot to administrative staff, powerful political interests, and to powerful farmers. Unfortunately, not only is equity lost, but efficient operation, and the potential for high agricultural growth rates are also lost.

The purpose of an irrigation authority is to establish accountability for the operation, maintenance, and most important, high rates of return to the irrigation system. To achieve that end requires a clear set of objectives and operating rules, making public those objectives and rules, and annual reports on the adherence to them and to the results.

Highest priority is to have clear rules for relating to the user groups with respect to irrigation charges and services to be rendered. Given the exigencies of modern agriculture, the system must establish certainty with respect to the time and quantity of water delivered to the user groups. That must in turn establish reliability with individual farmers. Establishing budgets, raising resources, and deploying them effectively would be a requisite of the authorities.

An important purpose of establishing the authorities is to attract high quality personnel. The stature and political independence of those operating the authorities must be established and then the professionalism of the staff. An independent authority would be able to set salary scales and working conditions that attracted the best and left them in a position to make the fullest use of their talents. Individual irrigation authorities would compete against each other against tangible measures of productivity and thereby establish pride and motivation on the part of the staff.

**User Groups**

There is now ample experience throughout Asia that farmers' organisations are providing far more responsible management of irrigation systems than any bureaucracy. It is most important that Pakistan move speedily in that direction. Pakistan's experience with user groups has been more limited, and less successful than that of other countries of the region. User groups formed to develop improved irrigation systems have generally dissolved when the system was finished and hence have not served the critical function of effectively managing the systems.

The lack of success of user groups in Pakistan may trace from the highly unequal distribution of land, economic, and political power in rural areas. Supporting this view is the substantial success of farmers organisations, including the management of water in the Agha Khan Support Foundations work in the more egalitarian societies of Gilgit and adjacent areas. Thus, one argument against irrigation reform is that in Pakistan it will not work. The response is that ways must be found for irrigation reform to work, and there seem not to be models that succeed without democratic user groups.

If inegalitarian rural social structures stand in the way, then if the problem is as urgent as we have made out, a way around this must be found. That is probably a judicial system that seeks out inequity and rectifies it. Simply serving as an appeal

body is not sufficient in the face of major differences in power. Probably a data collection and analytic content is necessary for such a body to work. And, of course, it must have access to a relatively free press to bring attention to its findings and its actions.

Once the hurdle of forming democratic user organisations is solved, the rest becomes straight forward. They need an administrative structure and a decision-making structure. They must budget for expenditures and management of those expenditures. Of particular, importance is the maintenance expenditure at the tertiary level.

**Water Charges**

At present water charges are nominal in level, and act simply as a tax to provide general revenues to the provincial governments [Agricultural Consulting Engineers (1990); Chaudhry (1987); Pakistan/USAID (1985); Government of Pakistan (1990)]. That needs to be replaced by a system of charges for the specific purpose of operating and maintaining the irrigation system at all levels. It needs to be set by the user groups in accordance with those groups' budgets.

If water charges were raised sufficiently to cover all the projected costs of canal operation and maintenance plus the SCARP tubewells, that have an important conservation function, the water charges would have to increase about 5 times from the current level of roughly Rs 1 per acre inch. That would be about 1/6th the price typically paid for tubewell water [Meinzen-Dick and Sullins (1993)]. Thus, even if one discounts the returns to canal water by half (which is an overstatement for a farmer managed system) then the water charges would be less than 1/3rd the price for purchased water. In addition, the maintenance and operating costs are probably overstated given that an authority would increase the efficiency of those operations.

A wide range of approaches have provided estimates of the marginal returns to water. Depending on location and the modeling approach, those studies estimate the marginal productivity of water from as low as Rs 20 to as high as Rs 107. Even the lowest figure is far higher than the requisite water charge. In any case current water charges are not consequential at less than 1 percent of the gross value of output per acre. Even doubling or tripling that leaves a barely consequential figure.

Thus, it would seem that the resistance to water charges is less that the level is onerous and more cynicism over whether or not efficiency ever can or will be increased with higher water charges. Thus, a prime function of the user groups is to provide evidence, on the basis of actual performance, that water charges are actually related to the availability and productivity of water.

A very important conclusion follows from the foregoing. Namely, it is unreasonable to think in terms of increased water charges without major institutional

changes that will increase the marginal returns to water from canals to the levels derived from small tubewells. The technical feasibility of this is well proven. The feasibility of effecting the requisite institutional changes is not.

A further point follows: improvement of the irrigation systems requires more expenditure on maintenance and more cost effective maintenance; but the funds cannot be raised from general revenues nor from farmers until efficiency is increased and that requires major institutional reform to increase the productivity of the system. Thus, one continually comes back to institutional reform. The partial answers have not worked for good reason and hence will not work.

## HOW TO PROCEED

There is no set pattern for process to bring about major institutional change. Each approach must be examined for its feasibility under today's circumstances in Pakistan.

Some would argue an all at once approach—all irrigation segments in all provinces proceed simultaneously. That admits to the urgency of the situation and that the knowledge base for what needs to be done is well established. And, that the risk for some takers is reduced by all proceeding together.

Some would argue for a few pilot efforts, say one or two irrigation segments in one province, for example Punjab. That approach may admit to the urgency and to the technical needs, but also argues that there remains some uncertainty about the optimal institutional approach. And, certainly there is uncertainty as to how well the changes will in fact succeed.

Finally, it is argued that with a pilot or two, the full power of the various expert bodies and the political system can ensure success before proceeding to more diffused change. In this context, it must be remembered that the most trenchant criticism of the radical institutional change is: yes that is a desirable change, but the results will be no different, because the same people will be there with the same power. Perhaps it is the difficulty of changing the people and their behaviour that calls for a pilot effort with deep commitment to that approach.

But, even before a pilot effort, consensus must be developed that: (1) the problem is truly acute (that consensus does not exist at present, particularly amongst a substantial set of highly placed, highly experienced and knowledgeable persons); (2) the precise form is known that reform must take to meet the critical problem as perceived by the key policy-makers; (3) politically powerful groups can be dealt with; and (4) whether it is best to proceed with a pilot effort or to move all at once. Consensus has yet to be developed on any of these 4 points.

## OTHER CONSIDERATIONS

Radical institutional change for irrigation cannot succeed without other changes in Pakistan's agriculture.

Most pressing is solution of the fertiliser supply problem, followed by tackling the increasingly inefficient use of fertiliser at the farm level. Under the fertiliser regime of the recent past, the productivity of better water use will be greatly reduced by the inability to proceed with the appropriate degree of intensification of agriculture, due to lack of fertiliser.

Not as pressing as fertiliser supply and demand policy, but nevertheless important, is the need for further improvements in the agricultural research extension system, particularly including the greatly under researched issues of irrigation agriculture and associated irrigation efficient.

Finally, price policy must be made more rational so as to allow the most efficiency use of water. That rationality will undoubtedly result in increased cotton, horticulture, and livestock feed production and reduced sugarcane production.

## CONCLUSION

The irrigation crisis in Pakistan's agriculture is masked by the superb conditions for growth that have allowed a highly respectable growth rate in Pakistan's agriculture despite a major negative effect from a deteriorating irrigation system. In the past agricultural growth could probably have been 2 percentage points better, that is a 6 percent growth rate. That would in turn have allowed a superlative overall growth rate and extraordinarily rapid decline in poverty.

A 6 percent agricultural growth rate would place Pakistan amongst the worlds very best agricultural performers. To do so, recognises that Pakistan has a superb irrigation resource, waiting to be reformed, is now at a level of productivity that would allow a long period of "catch-up growth", providing 2 percentage points faster growth than could be sustained over the long term, has a strong demand situation from rising domestic incomes and consequent effective demand for horticulture and livestock, and a strong potential market for high value irrigated agriculture output, particularly in the Middle East.

Looking ahead, the choices now appear to be not between a good growth record and a superlative one; but rather between a good record and a poor one. The contribution to growth, perhaps 2 percentage points worth, from increased physical supply of water seems to have run its course. That factor alone requires improvement in management of existing supplies of water. In addition much of future growth will have to come from livestock, with its requirements for high quality fodder and consequent heavy demand for water, and from horticulture, that also requires well controlled and reliable water.

The critical need is an irrigation institution that will: (1) facilitate a level of water charges that will cover maintenance that will assure high quality delivery; (2) provide local oversight of maintenance to assure its adequacy and cost effectiveness;

(3) assure equity in supply of water, another way of saying that the technical rules of operation will be followed. The present system breaks down on all three of these counts and so it is improperly used and inadequately maintained.

The foregoing conditions can be met by irrigation units controlled in a democratic manner by the users. Democratic control removes the current inequities. To succeed in the face of existing unequal political power requires strong rules and an oversight body that ensures democratic operation. User control means user incentives to ensure good maintenance and operating procedures that lead to willingness to pay for maintenance and to ensure that it is efficiently provided.

Democratic control does not meet the need for a high level of technical competence. That must be assured by providing technical oversight of the irrigation units and access to technical knowledge. That system must initiate from the Government and reach down to all levels of the irrigation system.

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