Irrigation Management in Sudan

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Irrigation Water Charges in Sudan

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Contents

Preface

Issues Raised at Rahad and Gezira Seminars

AT THE OUTSET of each of the two seminars preceding the Wad Medani Workshop on Irrigation Water Charges, participants were asked to identify important issues relating to irrigation cost recovery. Meetings were attended by staffs of the agricultural corporation (or SGB) and the irrigation department who were assigned to the respective system. The Rahad meeting was also attended by three representatives of the Sudan Tenants' Union. The issues raised in the two sessions were remarkably similar and have been grouped by category and combined into a single list below.[1] A spokesperson for the Tenants' Union also raised several useful issues and these are included in the list, set off in **bold** type. Explanatory comments are shown in *italic* type.

Setting Fees

1. Inflation seriously erodes the value of the funds recovered from tenants between the time the level of charges is set and the receipt of funds.

2. Measuring the true cost of supplying irrigation service is difficult. *Some felt the cost was higher than it should be.*

3. Determining the proper allocation of costs among different crops is problematic.

4. Can farmers truly afford to pay the costs they are being assessed?

5. Farmers are currently being subsidized (*it was asserted*). Is this appropriate?

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[1] In most cases, I tried to capture each issue as it was raised by noting a short phrase and then reading it back to the contributor for confirmation. I hope, therefore, that issues listed represent the meanings intended by the speakers, though there is always some risk of inadvertent bias on the part of the reporter.

Fee Collection

1. Collection of charges for crops sold in commercial markets is difficult.

2. Is it appropriate to use cotton as a "captive crop" to recover land and water charges involuntarily from tenants for non-cotton crops?

It was pointed out that both the above issues gain added significance as policy shifts to emphasize production of food crops.

3. The incentive effects of the individual account system relative to the joint account system employed previously should be reexamined.

Fee Levels and Revenue Flows

1. The amount raised by water charges is adequate/inadequate. *There were differences of opinion on this point.*

2. Every year rates increase. Why is this?

3. Water charges are not earmarked for system operation and maintenance and are not passed on to the Irrigation Department.

4. Separating the various components making up the combined land and water charge is problematic.

System Performance

1. Water charge rates are unrelated to water consumption.

2. The current charging system does not encourage irrigation efficiency.

3. When a tenant's yields are reduced by inadequate irrigation deliveries, who should bear the financial consequences?

4. There is no clear line of responsibility for irrigation deliveries. When problems occur, the agriculturalists blame the Irrigation Department and the engineers blame the Agricultural Corporation.

5. The irrigation service providers (the Agricultural Corporation and/or the Irrigation Department) are not accountable to farmers for the reliability of their irrigation deliveries.

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Khartoum
May 28, 1991

Introduction[2]

IRRIGATION COST RECOVERY is a topic which enjoys intense interest at the moment and which presents us with a distinct and perplexing paradox. On the one hand, cost recovery (and loan repayment, where foreign borrowing is involved) is a well-established principle of public finance, and public investments typically lie behind all but the smallest irrigation systems.[3] At the same time, however, cost recovery in the irrigation sector usually falls far short of the expectations and targets of planners and international bankers. This is not a new phenomenon, and it has been the case for decades in most countries. Why then has this issue now come to the fore?

There are several reasons. First, national debt burdens are becoming oppressive for a number of developing (and for some developed) countries, and governments are looking for ways to contain indebtedness and to repay loans. Second, recurrent-cost financing burdens of many developing countries engaged in a massive buildup of irrigation capacity following World War II mounted along with the expanding hectarage. Since 1979, along with international funding for irrigation development, the pace of that buildup has slackened drastically.[4] However, the recurrent cost burden of the buildup remains. Third, there is a perception that the poor operational performance displayed by many public schemes is connected with inadequate recurrent cost financing. Fourth, because of the large subsidies and economic rents involved in irrigation development, there is the perception that investment decisions have been seriously distorted by private and political incentives. All of these factors lead to increased attention to and emphasis on the recovery of the costs involved in irrigation development and management from the beneficiaries.

In this paper, I will attempt to present some general principles and concepts useful for examining irrigation cost recovery issues and provide examples which illustrate the Asian experience with cost recovery. The paper begins by defining cost recovery and presenting a typology of cost-recovery modes. The basic purposes of cost recovery are next described, along with the types of costs which can be targets for cost recovery. Restrictions are introduced on the types of costs which are legitimate targets for

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[2]While this paper is a slightly revised version of the original presented to the subject workshop, its author, Mark Svendsen, has a joint appointment at the International Food Policy Research Institute. (IFPRI)

[3]Privately or communally developed systems are often (though not always) small in size but may account for significant portions of national irrigation capacity. In the Philippines, for example such systems make up about 60 percent of the irrigation sector and in Nepal they comprise about three-quarters of it. In Bangladesh, private pump schemes may make up four-fifths of the sector.

[4]For Asia, international lending for irrigation development is about half the level prevailing ten years ago, in real terms.

recovery. Next, the critical importance of financial autonomy for any effective system of cost recovery is highlighted and options for fee bases and recovery mechanisms are reviewed. Finally, experiences with cost recovery in Bangladesh and China are highlighted and a more detailed discussion of the experience in the Philippines is presented.

Basic Issues in Cost Recovery

Cost recovery defined. Irrigation cost recovery can be defined as the process of directly or indirectly capturing and directing to public agencies some portion of revenue resulting from government actions to provide irrigation services, regardless of whether or not these funds are used to pay for any construction or operation and maintenance costs.[5] The extent of the recovery is usually referenced to the costs incurred, with both the amount recovered and the costs expressed in present value terms. Recovery need not be complete to be effective. The objectives being pursued and their relative weights will determine appropriate target levels and modes of recovery. In practice, criteria for successful recovery can vary from some small fraction of O&M costs only, to more than 100 percent of the total costs of construction and O&M.

Types of cost recovery.[6] Recovery may be direct or indirect. Direct cost recovery refers to collections from irrigation fees, betterment levies, the incremental portion of land taxes attributable to irrigation investments, increased crop delivery quotas at controlled prices, or other instruments that increase taxes paid by farmer beneficiaries in the irrigation command area. *Indirect cost recovery* refers to increases in government revenue attributable to the irrigation project, whose incidence is not borne by farmers in the command area. Some policies, such as an export tax on a cash crop like rice or cotton may contribute both to direct and indirect cost recovery, affecting both producers and processors of the product. Cost-recovery instruments may also be classified as *automatic*, to the extent that a project may increase government revenue via existing tax instruments, or *discretionary,* when it pertains to instruments that are explicitly instituted to increase cost recovery.

The cost-recovery problem is illustrated by Roumasset (1987) as in the matrix shown in Figure 1. The example illustrates 100 percent total cost recovery, i.e., the sum of the four cells in the figure is 100 percent. Actual targets, and those recommended by analysts, often differ from this. A common recommendation is that direct discretionary cost recovery should cover 100 percent of O&M costs

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[5]Adapted from ADB, 1986.

[6]The following discussion of direct and indirect costs is taken from Roumasset, 1987.

(ADB/IIMI 1987), which would usually result in less than 100 percent total recovery unless automatic and indirect measures captured the entire present value of construction costs. Some analysts argue that, to forestall rent-seeking behavior, direct cost recovery (from the farmer beneficiaries) alone should equal 100 percent of the total costs (Wicksell 1950; Repetto 1986). In the presence of additional indirect cost-recovery mechanisms, the total cost recovery may then exceed 100 percent.

In the example illustrated in Figure 1, increased production and land values induced by the irrigation project increase tax revenue by 40 percent of project costs simply from general taxes and land taxes already in place on direct and indirect beneficiaries. This leaves 60 percent to be raised by increasing tax rates or by imposing new tax instruments. In the example, irrigation charges, betterment levies and other increased taxes earmarked for irrigation result in a 50 percent recovery from direct beneficiaries and an additional 10 percent from others.

Figure 1. A hypothetical taxonomy of cost recovery incidence (in %).

Class	Direct	Indirect
Automatic	20	20
Discretionary	50	10

A noteworthy special case of discretionary recovery is that of secondary income. Some irrigation agencies undertake to earn income by marketing products other than irrigation service to farmers. To the extent that additional revenues exceed the increased variable costs, this can help offset unrecovered costs of providing irrigation services. Examples are interest on agency deposits, commercial fish rearing in irrigation reservoirs, sale of silt excavated from canals, hydropower generation and sale, and rental of surplus heavy equipment. These are common practices in China, the Philippines, and Korea. Recovery here can be considered either direct or indirect, depending on the clientele for the services.

Land taxes are of special interest in the context of irrigation cost recovery. Ideal systems of land taxation include a provision for betterment levies on publicly provided improvements such as irrigation. This feature limits discrimination against private investments that would occur if publicly subsidized and privately financed land improvements were taxed equally (Roumasset 1987).

The remainder of this paper will focus principally on charges levied specifically on the direct beneficiaries of public irrigation investments, since charges of this nature can be targeted most precisely and have the greatest potential in achieving economic efficiency objectives. It must be kept clearly in mind, however, that discretionary irrigation charges are not the only source of cost-recovery revenue flowing to the government from farmer beneficiaries and are not, therefore, the only financial obligations relative to irrigation service that farmers are required to bear. "Automatic" revenue, the magnitude of which is tied in some fashion to irrigation, is another important form of cost recovery which often substantially exceeds discretionary charges in importance, as in Thailand and the Indian State of Bihar (ADB 1986; Bhatia 1990). Likewise, farmers within the irrigation system are not the only beneficiaries of the irrigation investment and it is not unreasonable to expect these indirect beneficiaries to contribute to cost recovery as well. Thus, before making drastic reallocations of the cost burden on different sectors of the economy and among different groups of beneficiaries, it is critical to understand the magnitudes of all the components making up the cost-recovery revenue stream.

Purposes of Cost Recovery

As outlined by Carruthers and Clark (1981) in a standard text on the economics of irrigation, a charging system for irrigation water has three functions -- *economic, financial*, and *social*. The *economic* function is "to ensure that resources are efficiently used" by charging beneficiaries a price equivalent to the value that society places on the resource employed. Because of the lumpiness of public irrigation systems, this function can be subdivided into two separate sets of effects. One is the effect that water rates have on the construction of future projects. With respect to direct irrigation charges, this effect presumably works through the political process, wherein potential water users, with foreknowledge of the rates to be charged, lobby the government for the construction of additional irrigation capacity to serve them.[7] The government, for its part, must examine anticipated revenue flows to itself as a result of the project and evaluate its capacity to repay indebtedness incurred.

The other economic effect of a water charging system, in theory, acts on resource use within and among existing commands sharing a water source. Here, when charges are set in accordance with well-established principles of marginal cost pricing, water is presumed to flow to locations (and seasons) where marginal returns per unit water are the highest.

The *financial* function of a charging system is to cover the costs of the service provided, i.e., the delivery of irrigation water. Costs involved include capital, O&M, and additional associated costs. A large variety of mechanisms will serve this end, though many may have unintended or undesired side effects. For example, benefit capture by artificially restraining output prices below market levels and employing

[7]Presumably farmers also base private investment decisions on such foreknowledge of costs, and commonly do so in the case of small tube wells. In addition, a user group may invest in small communal schemes independently after examining projected costs and benefits. Most commonly, however, new irrigation capacity is created as a result of public investment decisions made by the government and, thus, the political process comes into play.

forced procurement may reduce output levels significantly by causing farmers to shift to other crops or reduce input levels, or to abandon unprofitable tenancies.

The third function, the *social* one, is "a mixed bag of policies and actions...used to promote income redistribution, (and) economic stability, or to develop backward areas and encourage investment by beneficiaries" (Carruthers and Clark 1981). This third function mitigates, to a major extent, the strict application of "economic principles" in the first two cases above. It was, for example, precisely this set of concerns which led to the use of federally subsidized irrigation development as a mechanism for the settlement of the American West during the first half of the twentieth century. With the West settled, these policies are now shifting to place increased emphasis on economic and financial objectives. As a practical matter, a distinction is often made between the two major categories of capital and recurrent costs.[8]

While it may be true that there is no fundamental justification for this separation (Roumasset 1987), there are practical reasons for it -- including the fact that foreign and multilateral lenders will readily finance the former but seldom the latter. As a practical matter, recurrent cost recovery is often of far greater interest to developing country irrigation system managers, if not to their lenders, than is the recovery of capital costs.

It should be clear from this brief description of the purposes of irrigation charging systems that cost recovery through any of the means outlined above is not an end in itself but a way of achieving specific efficiency and equity ends within the national economy. Small and co-authors (ADB 1986) summarize these ends in the following criteria for usefulness of a charging system. They assert that a charging system has appropriate impacts if

i. it results in improved irrigation performance through,
   a. more efficient operation and maintenance of irrigation facilities, and
   b. more efficient use of water by farmers, and

ii. it promotes other objectives of the government by
   a. leading to better irrigation investment decisions,
   b. easing the government's financial burden, and
   c. resulting in a more equitable distribution of income.

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[8]Two other categories of costs, those connected with revenue collection and with negative externalities are, in practice, usually ignored, though there is slight but growing recognition of the significance of the costs of revenue generation in the cost-recovery process (Bhatia 1988).

Costs to Consider

The total costs associated with irrigation form an upper ceiling on the amount for which recovery is sought, since "recovery" beyond this amount is more properly considered as general revenue. Total cost comprises expenditures in a number of categories -- design and construction, operation and maintenance, the costs of revenue collection, and theoretically at least, the costs of external diseconomies resulting from the service (Carruthers and Clark 1981).

In addition to expenditures by the government, beneficiaries also incur costs in both construction and O&M, especially in smaller systems. In some countries, such as the Philippines and China, there is explicit provision for such direct beneficiary cost sharing at the time of construction. In the Philippines, farmers are required to pledge 10 percent of the cost of construction of small communal systems in cash, kind, and labor contributions before construction can begin. In China, elaborate systems are employed to mobilize local labor for the construction and repair of both large and small irrigation facilities. This labor is either donated or paid for at below-market rates. Direct contributions of farmer labor to operate and maintain irrigation systems are widespread in many countries. Farmer labor is often directed at cleaning canals, providing information on water requirements, deliveries, and operational problems to system managers, and providing operational control at both tertiary and higher levels of the system. Such contributions must be acknowledged and accounted for when analyzing cost- recovery patterns.

A second important implication of farmers' willingness to contribute directly to the construction and management of irrigation systems under certain circumstances is the opportunity it suggests for an alternative approach to the cost-recovery problem. This alternative approach involves farmer participation, from the earliest stages, in new construction, and the devolution of certain O&M and irrigation fee collection responsibilities to the farmers (Coward and Uphoff 1985). Devolution of duties to beneficiaries is an approach that is a part of the government irrigation policy in a number of Asian countries, including China, Sri Lanka, Indonesia, and the Philippines, and it is usually understood as a component of a comprehensive cost-recovery strategy which aims at reducing costs of construction and O&M, as well as enhancing revenue collection.

Returning to the issue of total irrigation costs, Rao (1984) has provided a very important qualification for assessing the legitimacy of costs to be included in the total. He points out that current design and construction processes result in many irrigation facilities that are "unproductive, irrelevant, and extravagant." In India, it is estimated that actual irrigation development costs are typically greater than those estimated at appraisal by a factor of two (Daines), and that a significant portion of these overruns is attributable to private financial "leakages." In this case, it is unreasonable to include the total costs of system construction in the amount to be recovered from beneficiaries, and some discounting is required. To the extent that the government is unwilling or unable to prevent such leakages, the resultant incremental costs should be borne by the general revenue base and not by the cultivators of the scheme. Likewise, to the extent that system O&M is inefficient, there is justification for limiting farmers' liability for these costs. Reducing the costs of providing irrigation service is an important and underutilized approach to cost recovery (Sagardoy 1986).

Irrigation Service Fees and Cost Recovery

Having looked at the different ways in which public money expended for irrigation can be recovered, we focus on the topic of the most immediate interest -- the role of discretionary water charges in recovering costs. We look first at the types of fees that are often levied, the types of collection mechanisms available, and the modes of collection. Finally, we turn to a common misconception relating to the connection between irrigation fees and irrigation performance -- that marginal cost pricing results in efficient allocation of a scarce water resource.

Types of Irrigation Fees

Irrigation fee charging systems can rest on a number of bases. *Volume-based fees* are those in which charges depend on the measured volume of water delivered to a particular agricultural unit. This unit can be an individual farmer or a group of farmers sharing a common set of delivery channels. It is also possible for a separate agency to act as a middle man in the water delivery process, receiving (purchasing) water from the upstream agency and providing (selling) it to individual users or to user groups. These mechanisms can be very effective ways of creating efficient patterns of water use, but are likely to work effectively only under a condition of financial autonomy as discussed later.

A volumetric charging system is the only true example of *water pricing*, as it is the only one which provides a financial restraint on water use by the users. Where measurement capability is not available at the point of delivery to each agricultural unit, the number of deliveries can serve as a proxy for volumetric measurement. This proxy approach assumes that the flow volume of each delivery is constant across deliveries and across farms for a given crop and that the duration of each delivery is either constant or measured. This method also has the potential to induce the water users to apply water economically. Moreover, it makes an important contribution to fairness, and legitimacy in the eyes of the water users, by linking water charge payments to a measure of *irrigations actually provided,* rather than to an intended delivery schedule.

Where water has a high value, surface drainage outflows may be monitored as well, and a surcharge imposed on the user unit based on the amount of these outflows. This provides an additional financial incentive to regulate irrigation inflows.

Irrigation fees are most commonly based on the *area* irrigated. This basis has the great advantage of ease of administration, since only three things need to be known -- the area of the farm irrigated (which generally does not change from year to year), whether or not the farm received irrigation service during a given season, and the identity of the cultivator responsible for the fee. Common variations on this basic theme are differential charges based on the crop grown and the season. These refinements add to the information requirement of administration, but require monitoring only once a season.

Fees can also be assessed on a *per capita* or per family basis. This mode is simpler still, but has the significant disadvantage of favoring larger cultivators. Where farm sizes or tenancies are equally sized, this system is identical to an area-based approach. This charging mode is often employed in farmer-managed irrigation systems (FMIS) where fees are paid in labor, in part, for system maintenance. Each family might thus have the obligation of contributing a fixed number of days of labor per season.

A fourth mode of levying fees is on the basis of *benefits* received. This approach is attractive from an equity point of view where it is desired to reduce income disparities, but its information requirements are large, measurement difficult, and the level of other input use, such as own labor and managerial skill, may unfairly bias a yield-based assessment and reduce production incentives.

Types of Collection Mechanisms

Irrigation fees can be collected either through a general purpose government revenue collection establishment, or by a special unit affiliated with the irrigation service provider. Both approaches are common. A third outside body may also be contracted to make collections. Irrigators' Associations serve this purpose in the Philippines and local Village Government Units in Indonesia and China. In the United States, Irrigation Ditch Companies or Districts, which are essentially cooperatives of farmer irrigators, make collections from their members.

Modes of Collection

A variety of modes of collection also exists. In different systems and countries, payments can be made in *cash* or in *kind*. Where collection is in kind, a premium may be charged to cover handling costs or to adjust for quality of output received. Charges can be deducted from input credits obtained through formal lending sources, or from the proceeds of output sales. The latter mechanism is effective only where markets are state-controlled or where procurement is forced. Where procurement prices are administered, irrigation fees may be submerged in a general implicit tax on output.

Fees and Efficiency

Central to the idea of economically efficient use of inputs is the notion that a producer will use a purchased input until it costs more than it earns for him and then buy and use no more. All depends on a rational decision maker choosing to buy and apply more or less of an item (input) based on its cost and his return. If the price paid is divorced from decisions about how much to buy, then price cannot perform this rational, allocative function. In fact, the effect tends to be exactly the opposite of that intended. Higher charges result in higher use.

The question we must ask then, if we expect pricing mechanisms to promote efficient allocation of irrigation water, is "to what extent is irrigation water actually delivered and paid for on a per unit basis?" To begin with, we observe that cases of true volumetric delivery of irrigation water by public agencies in the developing world are extremely rare. On the other hand, it is also uncommon to find water delivered by publicly managed systems for a flat fee that is constant for all the users.

In practice, pricing mechanisms fall between these endpoints on a continuum that ranges between metered and flat-rate services. The first elaboration of a nominal flat-rate schedule is usually an adjustment for the area irrigated. Subsequently, crop type, season, and source of water (e.g., pumped or gravity) may be taken into account.[9] There may also be special discounts or exemptions granted for crop failure or typhoon damage, or occasionally for such steps as the creation of a water user organization.

All of these adjustments attempt to distribute the charges levied more equitably among the users and to encourage actions deemed desirable by the authority levying the charge, such as irrigator group formation or choice of less water-intensive crops. But as far as rational water resource allocation among farmers is concerned, they *assume restraint rather than providing it.* There is nothing in any of these pricing contingencies which deters an individual farmer, acting rationally in his own self-interest, from taking as much water as he chooses, regardless of his need or that of neighboring farmers. On the contrary, having "contracted" to pay for water for 10 acres of wheat during the dry season, it is perfectly rational for the farmer to attempt to obtain as much water as he can (without causing waterlogging damage) for that crop.

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[9]ESCAP, 1981 reveals several other bases for assessing water-related fees, none of which contradict the argument being presented here.

In fact, almost all common charging mechanisms except volumetric ones implicitly assume that the *irrigation bureaucracy* will administratively allocate water to the cultivators in accordance with the contingencies determining the fee. With the possible exception of the a *warabandi* (rotational) system of northwestern India, however, irrigation agencies in developing countries seldom have the ability to control water to a degree even approaching the one hypothesized here. The most common circumstance is for effective irrigation agency control to cease at some point well above the individual farm turnout. Within the community of the users formed by this de facto transfer of control, water allocation patterns are generally governed far more by social relationships than by economic ones. Thus, neither hypothetical economic incentives, nor administrative controls are effective at the tertiary level where water allocation among individual farmers takes place.

The upshot of all of this is that it is virtually impossible to construct a plausible scenario wherein the price set for irrigation water has some incentive effect on water use decisions at the tertiary or "on-farm" level *without* postulating significant changes in the way water is generally measured and delivered or in the way farmers and the irrigation agency are organized and interact with each other.[10]

Fees and Financial Autonomy

A necessary condition for functionally linking the collection of irrigation service fees and effective irrigation performance under these circumstances is that the agency involved in providing the service is financially autonomous. Financial autonomy is defined as a condition where (a) the irrigation agency must rely on user charges for a significant portion of the resources used for O&M, and (b) the agency has expenditure control over the use of the funds generated from these charges (Small 1990).

When financial autonomy is present, several incentive forces come into play which are otherwise absent. First, there is incentive to increase agency income. Increased income implies maintenance of jobs, higher salaries, incentive payments and bonuses, greater staff mobility, new vehicles, quarters and facilities, and the like. If fees are levied on an area basis, this means that the irrigation agency has an a strong vested interest in expanding the area receiving adequate irrigation service, increasing fee collection rates, increasing value of agricultural output per unit of water (e.g., avoiding system failures during the irrigation season, and minimizing missed irrigations), and increasing farm incomes (to increase ability to pay).

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[10]This, of course, assumes that farmers do feel some obligation to pay whatever fees are levied, which may be the case but is often not. If this obligation is not compelling, the entire discussion is moot.

Second, there is incentive to reduce costs. In many ways, this motive runs counter to the one mentioned above, and it is the dynamic tension between these two that creates an efficient and responsive service provider.

Working together, these two motives generate a demand for better agency relations with cultivators, greater accuracy in information collection and record keeping, new technology to manage information more effectively, better water control, and greater farmer involvement in system maintenance and fee collection. Thus, the incentive for greater efficiency in resource use made possible in a context of financial autonomy affects the *providers* of irrigation service at least as powerfully as the *consumers* of those services. Overall, a relationship of mutual dependency is established between the two, where the agency provides an essential service to the farmers who, in turn, provide to the agency the financial resources it needs to operate. This relationship of mutual dependence and accountability is at the heart of an effectively managed irrigation system.

Examples from Asia

This section of the paper contains examples of innovative cost-recovery policies and practices drawn from three Asian countries. The Bangladesh example is of interest, in part, because it is a relatively small effort, embedded in an administrative culture with long-established and elaborately structured routines and centralized decision making. Implementation of the innovative project described here was possible only because the managers of the effort were able to secure exceptions to standing government rules and practices. It suggests the importance of pilot efforts in which established policies and rules can be modified or suspended while innovations are developed and tested. The China example is a brief synopsis of a number of innovative practices being employed in which financial autonomy, separate agencies for water supply and water delivery, intensive farmer and local government involvement and special financial incentives within the government agencies are some features. It is a significant case because China has proceeded further down this financial reform pathway than most other developing countries in Asia. The Philippine case is treated more extensively as it is the most richly documented and contains almost all of the elements identified as being associated with cost-recovery reform in one setting or another.

Bangladesh

Bangladesh, is one of the poorest and most densely populated nations in the world and depends on pumping from wells and surface sources for almost all of its irrigation water supply. Because most water used must be lifted, operating costs comprise a major component of total irrigation costs and, in public schemes, they are borne principally by the government. Administrative and irrigation policy frameworks are similar to those of other countries which share the British colonial legacy.

It may, therefore, be somewhat surprising to find a most instructive example of cost-recovery reform springing from this context. M. Asaduzzaman (1990) reports the experience of the Barind Integrated Area Development Project in northwestern Bangladesh which is based on a set of 3,000 deep tube wells and a number of low-lift surface pumps. Although the technology employed is similar to that found in many other installations in Bangladesh, the administrative arrangements, particularly those having to do with financing, represent a distinct departure from the norm. Key features are the following:

i. The project undertakes to formally guarantee irrigation service to participating farmers.
ii. The project requires fee payment in advance of each season.
iii. The project itself collects irrigation fees rather than working through the regular government revenue establishment.
iv. The project retains fees collected by it and uses the money to pay salaries and other operating expenses, investing any surplus to generate additional income.
v. The project provides incentives to farmers for prompt payment of fees and imposes penalties for delayed payment. It has also proposed a set of sliding incentives for fee collection personnel to reward effective collection efforts.

At the outset, the project established for itself the goal of full recovery of operating expenses and capital costs. In computing per acre fee assessments, it divided costs by acres of assumed <u>potential</u> command and not by the command actually served, thus putting the burden of distributing water effectively and economically upon itself. If it failed to reach the planned area targets, then the project administration would bear the impact of the revenue gap, rather than turning to the farmers who did receive irrigation service to make up the deficit through higher tariffs.

What has been the effect of these changes? In 1989, the project was recovering one-third of its target in terms of combined capital and O&M cost recovery. This shortfall was due to the fact that irrigated area per tube well remains considerably below the assumed potential. Of the area actually served and billed, the project collected more than 90 percent of the amount due for each of the three years reported (1986-1988). This cost-recovery performance is compared with that of the three projects operated under traditional rules and organizational arrangements. Collection percentages reported for those schemes are in the range of 2 to 3 percent. Moreover, in Barind, the area served per unit of installed capacity showed a steady increase across the three years, increasing between 1986 and 1988 from 20 acres per cusec to 31 acres per cusec. This suggests that positive incentives on both sides of the water management equation are working and is in clear contrast to the pattern in many Asian systems of steady decline in performance commencing with system commissioning.

On the other hand, in spite of a fee structure designed to encourage cultivation of non-water-intensive crops, rice cultivation increased over the period from 88 percent of the total cropped area to 96 percent of the total cropped area. This suggests that crop-based fee differentials must be large and the total assessment must constitute a significant share of the total production expenses before fee structure has a functional impact on the choice of crop.

China

China has one of the largest irrigation sectors in the world and covers an extremely wide range of environmental conditions, from the arid steppes of the north to the lowland tropics of the south and the mountains of the west. It also spans a wide range of organizational and financing arrangements. One region visited in 1988 provides a sampling of this range of institutional arrangements. A common feature, however, is an emphasis on financial viability.

Irrigation in the Wulin Mountains of Hunan Province is extensively developed and effective financial management in irrigation schemes is a high priority. System managers have considerable autonomy and are experimenting with a variety of organizational and financial structures and rules to achieve the goal of operational self-reliance. Many of these practices are those which had been advocated repeatedly elsewhere but infrequently applied. These include the volumetric wholesaling of water to distribution organizations, farmer water charges with both fixed and volumetric components, financially autonomous irrigation management agencies, and delegation of water distribution and fee-collection responsibility to village-based organizations. Heavy emphasis currently rests on financial self-reliance of schemes as denoted by the slogan, "let water support water." This has led to a proliferation of secondary income-generating enterprises associated with irrigation system management such as fish culture, watershed forestry, and hydropower sales. Often the secondary enterprises generate a larger share of the total income than does the irrigation service itself. Strenuous efforts to collect irrigation fees are also mounted, and there is a system of financial incentives rewarding successful collectors.

Fee levels for rice generally fall into the $12 to $20 per hectare per year range, intermediate to those prevailing in Pakistan at $8.50/hectare for two crops of rice and the Philippines at $45/hectare for double cropped rice. Collection of fees is typically handled by the village. Charges are usually levied on an area basis but one large system employed a more complicated system which had both fixed and variable components. Water allocation at lower system levels is also delegated to the village in many cases, with the state serving as a wholesale provider of water. In the case of one large system, a separate government department acts as a middle-man, between the village and the Water Conservancy Bureau (the state irrigation agency) in delivering water and collecting charges.

The experience that is accumulating with these innovations could provide very useful empirical guidance to other nations which are also moving out of a construction/growth phase and becoming increasingly concerned with system management tools and techniques and with financial self-reliance.

Philippines

In a major departure from regional norms, the Philippine Irrigation Department was abolished in 1964 and a public corporation created in its stead. During the first decade of its existence, however, the National Irrigation Administration (NIA) operated in a way that differed little from regular government departments. A major overhaul of its charter in 1974, however, led to far-reaching changes in NIA's organizational values, structure, and operations. At the core of these values was the presumption that, to be successful, NIA must be financially viable, taking in more income than it spent. By 1979, it had achieved the goal of overall financial viability, and in 1981, the last operating subsidy paid out from the national treasury was received.[11]

To understand how these changes came about, and the impact that they had, both on NIA itself and on the performance of the irrigation systems that it operates, a study based on the model shown in Figure 2 was undertaken, drawing on data and documents contained in the NIA central office files and on interviews with past and present NIA Heads and other senior NIA officials. Policy documents and directives were analyzed to generate both an explicit set of statements defining and shaping the new financing policy and NIA's responses to those policy changes.

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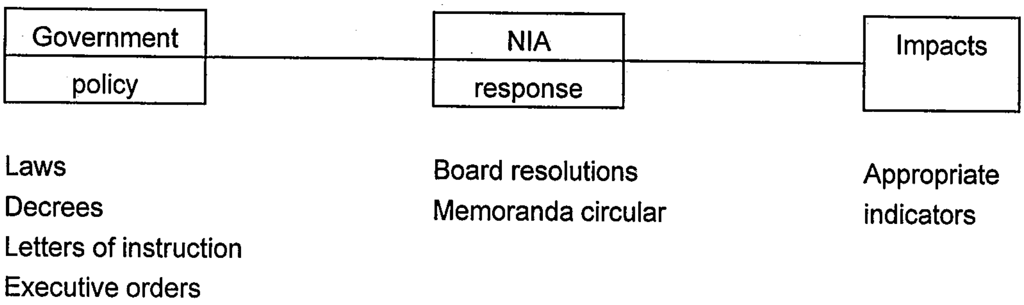
[11]It is noted that the costs discussed here are recurrent costs only. The level of total costs attributable to irrigation typically exceeds the incremental net farm income due to irrigation but total recovery from direct beneficiaries is not attempted. The types of incentive principles discussed here are not significantly affected by the recovery target set to include only O&M costs.

Figure 2. Conceptual model for the Philippine study.



Source: Svendsen, M., M. Adriano, and E. Martin. 1990. Financing irrigation services: a Philippine case study of policy and response. IFPRI, Washington, DC. Draft mimeo.

Policy Shift

The major thrust of the 1974 Charter Amendment was to allow NIA to retain all revenues generated by it, including irrigation fee collections, which heretofore had been turned over to the treasury in exchange for an annual appropriation for operating expenses unrelated to NIA's self-generated revenues. The annual appropriation that NIA received has always exceeded the collections that it turned over to the treasury by a significant margin. Accompanying this shift, however, was an agreement that all government operating subsidies to NIA were to be phased out over the ensuing five-year period. At the end of that period, NIA's operating budget would be completely self-financed.

Beginning around 1979, as a result of the severe downturn in the Philippine economy, the government began implementing a series of increasingly stringent economy measures, many of which applied to NIA. These measures included restrictions on travel, building construction and modernization, and purchase of vehicles, furniture and equipment. This policy mandating administrative economies reinforced the cost-control pressures put on NIA by the subsidy reductions.

NIA Responses

NIA management responded to these charter changes with a fourfold strategy aimed at bringing its costs and revenues into balance. The strategy comprised actions to:

- Devolve responsibility for certain operational, maintenance, and fee-collection tasks to farmers,
- Increase corporate revenues by raising fees, improving collections, and generating secondary income from ancillary activities,
- Reduce operating costs through a series of minor economies and through major cuts in the personnel budget, and
- Provide financial incentives for superior performance to outstanding field units and to individual personnel in them.

Devolve responsibility. The program to devolve responsibility for certain management functions in government-run (national) systems grew out of similar efforts in farmer-managed (communal) systems which had earlier proved successful and, like the communals effort, employed a cadre of community organizers. NIA's objectives in this were (a) to reduce its O&M costs by turning over to Irrigators' Associations (IA) responsibility for many O&M functions, (b) to improve system O&M due to the increased farmer involvement in these processes, and (c) to achieve higher levels of irrigation service fee payments. The first pilot effort was begun in 1980.

In 1983, the extension of the approach to other systems was accelerated by a reorganization of the NIA accounting system which created separate cost centers for each national system. This change made the status of fee collections and O&M expenditure for each system apparent to both system managers and central office supervisors. It reinforced the perceived need of field managers to build strong farmers' organizations in their systems which could take on a greater proportion of O&M activities and assist in irrigation service fee collection. It also allowed the personnel evaluation procedures for irrigation superintendents to be modified to incorporate objective measures of performance based on fee collection and expense data.

Viability incentive grants. The development of separate cost centers also provided the basis for a program of cash incentive payments to successful systems, provinces, and regions for distribution among NIA staff in these units, which was implemented in 1984. Termed Viability Incentive Grants (VIG), these awards supplemented an earlier program of cash incentive payments to individual fee collectors. Together, these incentive programs lie at the heart of NIA's effort to achieve overall corporate viability.

The concept of the VIG is simple. When a field unit achieves a surplus of revenue over O&M expenses, the unit is awarded 10 percent of the excess for distribution among its staff. In addition to the positive net-income criterion, units receiving VIG payments must also satisfy other tests which differ according to the type of unit involved. These tests include reaching physical construction and rehabilitation targets, actually serving with irrigation water high percentages of areas programmed for irrigation, and success in getting Irrigators' Associations to accept responsibility for operating and maintaining newly built or remodeled communal irrigation systems.

Increase revenues. To increase its revenue flow, the agency undertook several measures which fall into two categories. The first and most important comprises measures to enhance the revenue stream derived from irrigation service fee collection. The second consists of efforts to increase income from supplementary sources. Surprisingly, little bureaucratic energy seems to have gone into lobbying for increased government subsidies.

In 1974, NIA sought and received a fee rate increase from its board. Besides the higher rates, the new fee structure contained two additional features which continue to have very significant impacts on NIA's operation. The first is the denomination of irrigation fees in terms of rough rice, providing an important measure of automatic indexing for fee levels in the face of continuing inflation. The second feature allowed the collection of irrigation fees in kind, permitting NIA to move into farmers' fields and collect fees in rough rice at the time of harvest. This has had a major impact on the organization, involving it increasingly in a whole range of rough rice handling and marketing arrangements, in addition to its regular irrigation construction, operation, and maintenance functions.

When the current set of pressures for financial viability began around 1980, a further rise in irrigation fee rates was not possible, and the only means at NIA's disposal to increase irrigation service fee revenue was to increase the collection percentage of fees already owed to it. One major barrier to doing this was the poor quality of existing parcellary maps of system service areas and of the Irrigation Fee Registers (IFR). A study done by NIA in one system showed that only 61 percent of the lots shown on the IFR were also shown on the parcellary map of the system and that about 30 percent of the reported area irrigated was not billed. To rectify this situation, an extensive program of mapping and updating of fee registers was undertaken in 1979. Efforts were also initiated to establish computerized billing systems in selected systems.

Perhaps the major effort to improve revenue generation through irrigation fee collection came through increasing the number of people involved in collecting irrigation service fees and in developing management mechanisms that evaluate and reward strong collection performance. Key features of this process were (a) the devolution of responsibility and significant autonomy to provincial and regional offices, (b) the creation of effective systems of target-setting and data collection and monitoring, (c) the depulization of an increased number of authorized fee collectors, (d) the involvement of Irrigators' Associations (IAs) in fee collection, and (e) the provision of direct financial incentives to both NIA employees and IAs for meeting collection targets.

In addition, NIA moved to establish or enhance the yield of secondary sources of income. To this end, it continued to encourage the rental of NIA heavy equipment to private contractors, set up a subsidiary consulting corporation drawing on NIA engineering talent, and encouraged provincial offices to establish subsidiary income earning enterprises. NIA also succeeded in convincing the government to share the burden of maintaining the network of canal bank roads that NIA had constructed over the years, which are widely used as public farm-to-market roads.

Control costs. In the period after 1980, NIA also took a number of steps to control costs. These included administrative orders aimed at curbing vehicle use and other energy consumption, staff travel, seminars, new building construction, and furniture and equipment purchases. Non-viable pump schemes were closed down or turned over to farmer groups to manage. Other assets were sold, including two helicopters, a radio station, and two unused training centers.

In addition to these short-run economy measures, three more-sweeping changes were made with significant longer-term impacts. All three were aimed at reducing staff levels, which are responsible for about three-quarters of NIA's operating budget. The first of these was to expand the area covered by NIA-employed water masters in National Irrigation Systems (NIS) from 500 hectares to 750 hectares each. Commensurate increases were made in the responsibilities of ditch-tenders and gatekeepers, effectively reducing the need for NIA field staff on existing national systems by one-third. The second move was to take advantage of the staff redundancy achieved in this way by offering an attractive early retirement program to staff which included one month's salary for each year of service and a lump-sum payment for accumulated leave time. Involuntary layoffs were avoided. The third measure was to accelerate the turnover of responsibility for national systems, or portions of them, to organized groups of farmers, thereby reducing the NIA staff requirements.

Impacts of Measures Taken

Staffing levels. Because salaries make up roughly three-quarters of the NIA operating budget, any program designed to reduce costs had to deal with this line item. Between 1976 and 1986, staff levels fell 63 percent on a per hectare basis; however, it is difficult to attribute this decline to particular programs or actions on the basis of the aggregate data analyzed. Staff retrenchment programs did undoubtedly exert downward pressure on staff levels and so contributed to the decline, though other forces may also have been at work. Data from the 5 systems in which varying degrees of farmer control had been introduced showed definite reductions in NIA staff levels in these systems, demonstrating clearly the impact of devolution on staff levels.

Viability incentive grants. The Viability Incentive Grant program is a clear success when evaluated on the basis of growth in the number of operating units qualifying for payments. In 1986, 5 of 11 regions were viable, along with 44 percent and 66 percent of the national systems and provincial irrigation offices, respectively. Since viable status indicates success in generating a positive cash flow, along with the accomplishment of other system tasks, these figures also serve to represent successful achievement of the larger goals of the organization. One cost of the viability program was the tripling of real service fee collection costs between 1983 and 1986, though, at around 10 percent of total collections, these costs are still low by regional standards.

Diversified cropping. In 1983, a new policy emphasis on the production of non-rice crops appeared in government planning documents. Since the existing NIA irrigation fee structure made no distinction between rice and other short-season irrigated crops, NIA responded, in 1984, by dropping fees for short-season non-rice crops to 60 percent of those prevailing for rice in a particular irrigation system. There was no obvious response to this change in terms of area planted in these crops, probably because the amount of the reduction was small relative to other economic factors influencing the crop choice decision.

Costs. Average real NIA operating expenses during the period 1982 to 1986, on a per hectare basis, were 29.1 percent lower than they were during the 1976 to 1981 period which preceded emphasis on financial viability. Roughly four-fifths of this drop is attributable to reductions in salary expenditures. The portion of the operating budget devoted to field operations of NIA's national systems fell by only 15.5 percent across these same two periods, indicating the high priority given to field operations and the delivery of irrigation services during this period of cost cutting. At the same time, the share of salaries in the total field operations budget was reduced from about 90 percent in 1979 to around 80 percent in 1986. At least some of the resultant savings were used to fund maintenance contracts with Irrigators' Associations.

Taking a somewhat longer view, it can be seen that per hectare O&M expenditures in the "post-viability phase" (1982-1986) were still about 42 percent above the level prevailing during NIA's earlier years (1964-1981), in real terms. In absolute terms, O&M expenditure in 1986 of₱ 323/hectare (US$15) was within the US$10 to 35 range typical of Asian countries during the early eighties.

Revenues. Between 1976 and 1986, NIA's real income tripled. Over this same period, irrigation service fees gradually replaced government subsidies as the revenue mainstay. During the early eighties, interest income and management fees on construction monies were also significant, but have since declined in importance due to falling interest rates, declining levels of new construction, and a shrinking corporate fund.

The task of increasing irrigation service fee (ISF) revenues has been a major emphasis of NIA in recent years. Increases in ISF rates in 1968 and 1974 were impressive in nominal terms, but their real impact was quickly eroded by inflation. In real terms, ISF rates were lower in 1986 than they were in 1938. Indexing of fees in measures of rough rice, introduced in 1974, helped to offset this deterioration in real value, but because rice prices have risen less rapidly than more general measures of inflation, real value of ISF rates has declined nonetheless.

ISF revenues actually taken in, when converted back to kilograms of rice per benefited hectare to eliminate the effects of inflation, are seen to be an almost constant 60 kg/ha since the last ISF rate increase in 1974. This would suggest virtually no improvement in NIA's ability to collect irrigation fees owed to it. However, because the general economic position of rice farmers declined over this period, enhanced collection efforts may have been necessary simply to maintain past collection levels. In this case, it is difficult to judge the effectiveness of enhanced fee collection efforts other than to say that, per se, they have not resulted in any dramatic rise in NIA's ISF revenues.

System Performance

Regardless of the impacts of post-1981 policy changes, and their responses on NIA's internal processes, the most important impacts are those which affect the physical performance of the irrigation systems for which NIA is responsible. Any cost savings in system operations are likely to be small compared to the costs to farmers of foregone production if system performance deteriorates significantly in the bargain. Assessing the impact of the new policies on physical system performance, thus, becomes a paramount consideration in evaluating the entire process.

Accordingly, four measures of physical performance for five sample national irrigation systems were examined. With respect to the first indicator, the level of average system water adequacy, it was seen that, after adjusting for differing amounts of rainfall during the two periods, overall per hectare system irrigation water adequacy declined significantly after the implementation of the 1981 changes. However, this parameter is only partially under the control of the system managers, reflecting, principally, a decline in available water supplies to the schemes and not increased wastage of water within the command area.

Yields are another indicator of quality of irrigation service. However, yield is also a function of other factors and inputs besides irrigation water supply. Moreover, because it reflects the agricultural utility of water, yield also responds to the timeliness of water deliveries and the distribution of the total quantity across the command. After accounting for differences in fertilizer application and rainfall received, analysis showed that in both seasons, yields were statistically no different before and after the changes. This means that even though system-wide per hectare water deliveries were reduced, in this case by about 13 percent in each season, yields did not change significantly. This is significant, for it suggests that either the timeliness or equity of water delivery improved, or losses within the system were reduced. Since systems were not subject to physical rehabilitation during the period of the analysis, the most likely cause of this is a change in the equity of water distribution across the command.

To examine this possibility, the ratio of benefited area to service area was compared for the two periods. In this case, this ratio is treated as an "equity ratio" because it is assumed that the higher the ratio, the more evenly a given supply of water is spread over the service area. To make water supply conditions for the two periods equivalent, results were adjusted for the quantities of irrigation water and rainfall received. For the wet season, the equity ratio was found to be largely independent of both rainfall and irrigation water supply and showed no significant difference between the two periods. During the dry season, however, the ratio was strongly related to the supply of irrigation water received and, in addition, was significantly higher during the post-1981 period after accounting for this water supply difference, with the magnitude of the difference being about 7 percentage points.

This is an important finding for it shows that equity of dry-season water distribution improved significantly in the aftermath of the 1981 policy changes. It was possible with system management, which consists of NIA, farmers' associations, and individual farmers, to spread a given amount of water more widely and evenly in the period after 1981 than before. Moreover, this was done in a way that did not reduce average system yields. Additional area irrigated during the dry season, as a result of improved equity, increased the overall dry-season rice output from the five sample systems by 10.5 percent. For the wet season, the sign of the regression coefficient for the period, the variable was negative, implying that equity had been reduced, although the change was not statistically significant. Nevertheless, if this wet-season effect is included along with the positive dry-season effect, there still remains a 2.7 percent increase in rice output for the year as a result of the expanded area irrigated due to increased equity of distribution.

This type of response is exactly what would be expected in the wake of an emphasis on increased farmer satisfaction and cooperation and increased fee revenues. Because the fee schedule is tied to benefited area, the only way in which NIA can increase its revenue from that source is to expand benefited area and to increase collection efficiencies. The former depends on spreading a fixed supply of water more evenly across the command, while the latter requires that (a) farmers be satisfied with the irrigation service they are receiving and (b) the local Irrigators' Association is committed to assist in the task of collecting the amounts due. The evidence, while not conclusive, is highly suggestive that this is what happened.

Concluding Remarks

Some points are highlighted here to suggest issues for consideration in the light of Sudan's unique circumstances:

1) Farmers often have financial obligations with respect to irrigation service in addition to explicit irrigation service fees. These need to be taken into account. Other sectors of society benefit from the provision of irrigation services and perhaps should also bear some of the financial burden.

2) Costs recovery systems have a variety of purposes, and different modes and levels of recovery will affect these different purposes differently.

3) In the absence of volumetric water pricing, higher prices for water have little or no direct effect on water resource use efficiency.

4) For financially viable irrigation, reducing irrigation costs is as important as enhancing revenue. Involving farmers and devolving certain responsibilities to them is an approach that is showing promise in many Asian locations.

5) Financial autonomy in irrigation service providers is a necessary condition for many of the potential benefits of irrigation charging systems to be realized.

6) Accountability between farmers and irrigation service providers is a powerful tool for building self-regulating, financially viable systems.

Source: Roumasset, Jim. 1987. The public economics of irrigation management and cost recovery. Agriculture and Rural Development Department, World Bank, Washington, DC. mimeo.

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Budgeting for Irrigation Services Cost
and
Its Relation with the Cost Recovery Mechanisms in Different Irrigation Schemes

by

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INTRODUCTION

THE IRRIGATION SYSTEMS in Sudan are designed to irrigate a Number (90 F) every fortnight. The FOP gates are opened to discharge 5,000 m^3 every 12 hours. In a 2-course rotation project (like Rahad) one of every two FOP gates is open to irrigate a Number in one week. In a 3-course rotation project (like Managil) one of every three gates is open at one time and in a 4-course rotation project (like Gezira) one of every four is open at one time.

The main canal of a 2-course rotation project is designed at a 28 factor x gross area and the minor canal at a 30 factor x gross area. Provision is made for losses in the minor canal (331/2 as in Rahad). In the 4-course rotation project the minors should be designed at factor 15, but, for providing for these losses, the canals are designed at factor 17.

In the Sugar Schemes the main canal is designed at a 42 factor while the minor canals are designed with a factor of 45 (i.e., 15-cm water depth as factor 30 satisfies 10-cm depth).

In 1980, when the cost-recovery committee first started its work, the land and water charges were distributed amongst the different crops according to the number of irrigations of each in a season (taken from notes to the new personnel of SGB) as follows:

ELS cotton	=	16 irrigations
MS cotton	=	12 irrigations
Dura	=	4 irrigations
Groundnuts	=	8 irrigations
Wheat	=	10 irrigations
Vegetables	=	14 irrigations
Forests	=	14 irrigations

The Ministry of Irrigation is working in close contact with ARC and the dams are emptied according to their recommendations of crop water requirements to be delivered to every crop, every 10-day period, with provision of transmission losses to the field.

A ministerial committee for extension in this field had already started its work in the Gezira and it is hoped that the ARC recommendations will be applied in the 1991/1992 season. The Ministry of Irrigation has already changed from the old system of number of irrigations and is distributing the irrigation cost amongst the different crops according to ARC crop water requirements during the whole lifetime of each crop, i.e.,

ELS cotton	=	4,887 m^3/Feddan
MS cotton	=	4,100 "
Dura	=	3,067 "
Groundnuts	=	4,103 "
Wheat	=	2,473 "
Vegetables	=	9,661 "
Forests	=	9,661 "

The cost recovery includes the following:

1 - Capital Cost
2 - Chapter I Budget (salaries and allowances)
3 - Chapter II Budget
4 - Chapter III Budget

Capital Cost

The capital cost is recovered using the "Straight line method with the minimum attractive rate of return on first cost with salvage value = 0"

$$CR = \frac{P}{n} + \frac{Pi}{2}\frac{(n+1)}{n}$$

where

CR = Recovery cost
p = Capital cost
n = Life of asset
I = Rate of interest

The lifetime of the mechanical and electrical equipment is taken as 25 years.
The lifetime of the civil works is taken as 50 years.
For example, Sennar Dam and Gezira canalization cost is not charged but the Managil cost is charged.

The rate of interest was 8 percent and in the early eighties the U.S. of the Ministry of Finance directed that a 6 percent rate be applied.

The most recent calculations of cost recovery of Guneid New Electric Pumps were calculated at a 16 percent rate of interest but this rate is not approved to be applied as yet.

Chapter I Budget (Salaries and Allowances)

The salaries and allowances for the field staff are totally charged but the salaries of staff of the related departments at headquarters are distributed amongst the different schemes according to area and this is multiplied by the fraction

$$\frac{\text{cropped area}}{\text{rotational area}}$$

Chapter II Budget

The three Irrigation Services Directorates prepare their annual Chapter II Budget to meet the following:

a - silt removal from main canals, branch canals, major canals, minor canals and drains.
b - maintenance of structures in canals and drains.
c - maintenance of steel works.
d - supply of FOP pipes and gates.
e - weed control by manual mechanical, and chemical means.
f - minor items such as health services, electricity, office expenditure, supply of tools, furniture maintenance, looking after garden, etc.

The Mechanical and Electrical Engineering Directorate prepares its Chapter II Budget to meet the following, for all its diesel and electric pumping stations:

a - gasoline or electricity cost
b - engine oil
c - gear box oil

d - grease

e - spare parts

f - pump house maintenance

g - casual labor wages

h - health services

I - miscellaneous

j - main workshop budget

k - mechanical transport budget including maintenance of vehicles and their fuel.

The Dams Directorate prepares its Chapter II Budget for dam maintenance and special equipment.

The dams budget is distributed between the different schemes according to (their water withdrawn (e.g., the Gezira Scheme uses 38 percent of the Roseires Dam storage. Similarly, the Nile Waters Directorate and the HRS Budgets are distributed in the same ratios).

Chapter III Budget

Chapter III Budget includes maintenance of buildings, provision of office equipment, etc., and is distributed according to the CWR.

Certain decisions are sometimes made, e.g., the Gezira Scheme was suffering from a backlog of silt. The cubes of silt excavated in 1990/91 were excessive and were excavated at a very high cost as earthmoving equipment was availed of.

The cotton cost committee was advised to charge only 70 percent of the earthmoving cost, the ration being a reasonable measure of the normal annual silt build-up figure.

The cost-recovery mechanism was found very satisfactory by the cost-recovery committee and the same procedure has been applied to the land rates since 1980.

The purpose of cost recovery is to subsidize the tenant in the Land and Water Charges and to reduce this subsidy gradually until rehabilitation is complete and the tenant is expected to pay the actual cost.

Efficiency of Water Delivery Systems and Its Linkage with Land and Water Charges

Workshop on Irrigation Water Charges
held at Wad Medani on 29 May 1991

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

Disadvantages

i. Charges are related to landholding only. They are unrelated to farm income, cropping intensity or water use.
ii. Head, middle and tail-end problems remain unsolved.

Flat-crop-charge. The flat-crop charge is based on cropped area in which no distinction is made among crops. It is related to cropping intensity and would be best implemented in irrigation schemes where access to water is not uniform. The flat-crop charge is the easiest one to administer.

Advantages

i. The charging structure is easy to implement and administer.
ii. It is relatively cost-effective when compared with the one based on crop water requirements.

Disadvantages

i. This does not consider the amount of water required by a crop.
ii. It is unfair if farmers grow different crops.

Water-based crop charge. In contrast, the water-based crop charges are based on cropped area, which vary with the crop depending on its estimated water use. Since actual water use is not being measured, this is, in fact, an indirect water tax. This type of tax is often used as an expensive proxy for volumetric pricing and other area-based charges (United Nations, I970, p.5: World Bank, I976 p.5). This method is now being used by the Ministry of Irrigation for charging the farmers in many irrigated schemes.

Advantages

i. Easy to administer and is acceptable to all parties.
ii. Indirectly related to water use but actual water use is not measured.
iii. Good instrument for collection of revenues to maintain and operate the delivery system.
iv. Since it is used as a proxy for volumetric water pricing, it can be used to improve technical and economic efficiency at the farm level.

Disadvantages

Does not meet the equity concern.

Gross or net revenue-based crop charge. "Gross revenue-based crop tax" differentiates crop charges according to the gross revenue generated by each crop. Similarly, the "net revenue-based crop taxes" are based on net revenue. It should be noted that when dealing with the net revenue system, labor costs are deducted from the gross revenue as part of the cost of production. Both these charging mechanisms are more closely related to a measure of farm income, i.e., the ability-to-pay, rather than cost recovery. Net revenue is perceived to be a better estimate of farmers' ability-to-pay since it subtracts farm expenses which vary considerably among crops.

Gross revenue is favored over net revenue as it is easier to measure. Theoretically, this system is very attractive because the farmer pays for his actual irrigation water use. This system meets all the objectives of efficiency, cost recovery and equity but its implementation is impractical in developing countries. Although this form of water charging has rarely been used in developing countries, it has been tried out in India on the sugarcane plantations.

Volumetric water charges. Variations of the volumetric approach include a flat tariff, increasing block rates, and decreasing block rates. Studies indicate that in places where time-based variations are known, as in Sudan, seasonal presentation of rates can be adjusted to a low tariff in the low- value (in terms of water) season and relatively high tariff in the high-value season. Some of the possible approaches in establishing these charges and their underlying objectives are discussed below.

Annual volumetric water charges. Annual charge implies a flat single fee throughout the year.

Seasonal volumetric water charge. Seasonal charges refer to different water charges during different seasons. When the marginal value of water is high in one season, then the tax levied will be high and vice versa.

Monthly volumetric water charges. Monthly charges imply different water rates for each month depending on the crop water requirement for that month.

Advantages

Theoretically they are perfect to measure the actual water consumption and are relatively fair by the farmers.

Disadvantages

Involves capital cost to buy equipment. Not practical as there are a large number of farmers.

CONCLUSIONS

In the last two decades Sudan has witnessed cycles of drought. Avoidance of risk and instability in farming is largely insured through irrigation. This irrigated subsector has paved the way for alleviating rural poverty, hunger and malnutrition. During the same period, the Ministry of Irrigation has been facing difficulties because of lack of foreign and local funds for maintenance and operation of the existing large irrigated schemes. At present, these schemes are operating below their designed capacity. The delayed maintenance is reflected in an inefficiency of irrigation water delivery systems. This has affected the technical and economic efficiency at the farm level.

Currently, the major form of agricultural taxation in Sudan is a commodity tax levied on major crops. The revenue of these taxes flows into the government's general coffers, from which the Ministry of Irrigation must obtain its share. Inability to obtain the designed level of funding through the competitive annual budget process has prompted the Ministry of Irrigation to consider the direct methods of land and water charges for recovering the cost from farmers. When irrigation water is considered a vital resource in the production process, then the regular operation and maintenance of the delivery system becomes the major concern of a community. Levying of appropriate water charging instruments on all the beneficiaries in the command area will lead to enough funds to run and maintain the system. In addition, this instrument might lead to welcome changes in production efficiency.

Accordingly, two broad types of water charging schemes, namely, area-based water charges and a volumetric charge were evaluated. Five area-based water rates instruments were evaluated within the context of the above mentioned development objectives. The area-based water charging instruments are: i) flat-land charge; ii) flat-crop charge; iii) water requirement-based crop charge; iv) gross revenue-based charge; and v) net revenue-based crop charge.

Volumetric water charging schemes require control structures, measurement devices and policing. These make its implementation costly and impractical in developing countries. The evaluation of water charge instruments has proven the area-based crop tax to be the best. Among the area-based charges, the water requirement-based charge seems to suit the institutional setup of various irrigation schemes in Sudan. The crop water requirement-based mechanism is similar to volumetric water charge but the latter is related to the actual water use whereas the former depends on the water consumed. The water requirement-based rate is more cost-effective than the volumetric charging system. It is easy to administer and is acceptable to all parties concerned. It is designed to generate enough revenues to maintain and operate the water delivery systems. This, in turn, leads to the improvement of the technical and economic efficiency at the farm level.

It could be a very effective instrument if it is adopted in a differential manner with respect to farm location along the watercourses.

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Valuation of Irrigation Water for Different Crops In the Gezira Scheme

Proceedings of a Workshop on Irrigation Water Charges
held at Wad Medani, 29 May 1991

by

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INTRODUCTION

COSTS OF OPERATION, maintenance and development of large irrigation schemes are steadily increasing. This puts pressures on governments and aid donors to find ways and means to charge the beneficiaries with a substantial share of the costs of the services they enjoy.

The purpose of this paper is to review some general economic concepts regarding the valuation of irrigation water. Some water pricing considerations are discussed. The method of water charging used in the Gezira is then described and finally, a program aiming at the improvement of the existing water charges is proposed.

Economic Concepts and Allocative Pricing and Valuation of Irrigation Water

Efficiency objectives. The neoclassical economists have argued that the market system, under certain conditions, can efficiently allocate resources. According to the postulates of the market system, prices should be used to allocate water to its highest valued uses (where value corresponds to the Smithian value in exchange). This implies that the value (price or cost) of the last unit is the same in all uses to achieve economic efficiency. However, in real world situations the prerequisites of the market system are frequently violated -- economies of scale, decreasing average costs, mobility, solvent properties, sequential use, social values, etc. (Young and Haveman 1985: 469-71). The market failure leads to the need for collective action, in the form of public intervention. The Pareto-optimal pricing policy would use marginal cost (MC) as the price schedule (Figure 1):

$$P = MC$$

The optimal quantity to supply and consume is at q*, where marginal cost equals marginal benefit (or marginal value):

$$MC = MB$$ (Young 1986: 155-60])

Equity objectives. From a pricing perspective there are two approaches to equity:

The Benefit Approach, which considers that it is fair that the beneficiary should pay all the cost of a service, and the Ability-to-Pay Approach which on the other hand, addresses in general terms, the income distribution but violates the efficiency assumptions.

Administrative objectives. To achieve allocative efficiency and equity, through the implementation and maintenance of a pricing system, some administrative costs are incurred. Hence, care should be taken to ensure that the benefits introduced by a pricing system exceed its costs.

Slippage (corruption and administrative in efficiency) is the second concern of administrative objectives, while administrative complexity is the third one.

Achievement of multi-objectives. Conflict between objectives in water resources management confronts those involved in irrigation development with some difficulties. Nevertheless, the problem of multi-objectives can be solved by the use of multiple policy instruments where there are at least as many instruments as objectives (Bowen and Young 1983:5). Policy instruments are prices (including alternative rate structures), quotas, permits and transferability in water rights. In an interdisciplinary approach other institutional and structural instruments can also be used.

A unified approach is usually suggested to draw the framework for valuation of irrigation water. If the curve MB in Figure 1 represents the marginal benefit or demand for water reflecting marginal willingness to pay (with shadow prices as points along it) and the curve MC represents the opportunity cost of the incremental water supply (willingness to pay for foregone opportunities), Pareto-optimality will be achieved at point q, where, P = MB = MC. The rate setting (P^1) is left to the political decision maker on condition that it shall not exceed the maximum willingness to pay. Allocative efficiency losses are incurred to the degree that p^1 differs from MC (Young 1986:156-62). Non-price retiming (i.e., quotas) will be needed to distribute the limited water supply in the months with the highest water values.

Other Water Pricing Considerations

There are other considerations which affect the water pricing system.

Estimation of shadow prices. The classical method is the use of production functions in which irrigation water is the explanatory variable. The value marginal product of water (the derived demand function) represents the shadow price of water.

Residual Imputation - the essence of the method is to allocate the total value product (TVP) among all resources used in production. If all inputs but one can be assigned their appropriate prices, the remainder of the TVP is imputed to the residual resource.

Linear Programming Procedures - are mathematical approximations of the residual imputation, where the value of water is derived as a benefit function using parametric variation of the water supply.

Rate setting. Different rate-setting principles are used or proposed to satisfy one of the major objectives.

Marginal Cost Pricing Principle - is applied where allocative efficiency is the primary concern.

Ability-to-Pay Principle - emphasizes the equity objective. Only operating costs plus a small fraction of the initial investment are usually recovered.

Net Benefit Principle is a rent aiming at capturing all or part of the incremental benefits of irrigation.

Average Cost Principle is used when cost recovery is the main objective. It charges each unit received according to an average cost.

Charging Vehicles and Structures

As stated earlier, no one instrument can achieve multi-objectives simultaneously. Nevertheless, the use of alternative rate structures helps to realize as much of the objectives as anticipated. The more common charging vehicles are given below.

Volumetric charges. Though rarely adopted in developing countries the vehicle of volumetric charges "has been used extensively and successfully in the USA and Australia" (Carruthers and Clark 1981: 191). Water is also volumetrically delivered and charged to cooperatives in Israel and Taiwan which, in turn, allocate it to small holdings. Beside being the most precise method of assessing the units consumed, the volumetric charges have the further advantage of providing inducement to the cultivator to economize upon the use of water (Ansari 1968:107). Empirical evidence to this effect was presented as a case study on irrigation in Mexico by Schramm and Gonzales (1976).

Flat charges. The vehicle of flat charges is the more common charging structure due to its high administrative efficiency but, unless it is used with volumetric charges, it rarely achieves the equity objective. To promote allocative efficiency multi-part charges are used, in which one tariff is made to cover the indivisible costs, while another is charged to reimburse variable costs.

Area-based charges. Area-based charges are either based on the gross cultivated area or cropped area. This method is favored in developing countries due to its simplicity and consequently the use of this method enables to achieve the administrative objective.

Flat-land and flat-crop charges. Flat-land and flat-crop charges are the more common methods used for cost-recovery purposes. In schemes, like the Gezira, where the cropping pattern is dictated by the state, such charges are liable to distort the profitability of the different crops and accordingly the allocative efficiency of the water resource. To combat this difficulty, the flat-crop taxes are weighted by its water requirements. It is thought that neither equity nor efficiency can be guaranteed when this method is used, since farmers with better access to water deprive the tail-enders of their water allotments. The Indian Irrigation Commission (1972:430) recommended the association of crop charges with gross or net revenue.

Time-shares charges. Time-shares charges are mostly used in non-storage irrigation systems, where flow is neither stable nor certain. When the time- shares vehicle is based on the size of holding (as in the *warabandi* system in India and Pakistan, where the cultivator pays for an amount of water allowed to pass through a sluice at prescribed intervals of time) neither efficiency nor equity is guaranteed (Malhotra 1982:59). However, where water transfers are permitted, allocative efficiency may be realized.

Water Charges and Delivery Systems

Another important issue is the impact of the water delivery system on deciding which charging vehicle to use. Delivery systems are classified in different ways by different writers. The FAO Paper No. 40 [1982:65-8] uses the following nomenclature

i. *The on-demand system.* When the on-demand system is used water is supplied to the user at the demanded time and quantity. Israel and parts of USA use the on-demand system. In extensive gravity irrigated schemes with a large number of small holdings, the system is impractical and uneconomical, especially when the water value is not high enough to sustain the high costs involved. Volumetric charging is the more suitable form in the on-demand delivery systems.

ii. *The semi-demand system.* The semi-demand system is sometimes called the on-request system where the user's demand is fulfilled within a few days. The Gezira Scheme was originally designed to this system up to minor canal head level (taking the water indents as an estimate for the users' demand). In the presence of fairly accurate measuring structures, volumetric charging can be used.

iii. *The canal-rotation and free-demand system.* The canal-rotation and free-demand system is where the secondary canals receive water in turns. Farmers can take as much water at the time they wish. Flat land-based taxes are usually levied.

iv. *The rotational system.* The rotational system is where all the primary and secondary canals receive water by turn, while farmers at the tertiary canal level receive their water shares according to a preset schedule, proportional to their landholdings. The time-shares vehicle is widely associated with this system.

v. *The continuous flow system.* The continuous-flow system as the name implies gives the farmer a continuous flow to balance the water lost through daily evapotranspiration. It is practiced in rice fields in South East Asia, where excess water is drained from one field to another. It is depicted as the least efficient system, although it has the advantage of saving in labor and capital. Flat-land charges are the more customary levies here.

Water Charges in the Gezira Scheme

General. Water charges were established in the early days of the Tayiba Experimental Station (1911) at the rate of L.S. $2^{1/2}$ per *feddan* (1 feddan = 1.038 acres) (Gaitskell 1959: 69-72). A few years later it was changed to a partnership arrangement to the dissatisfaction of the tenants.

In 1981, the Joint Collective Account System (JCAS) was abolished and was replaced by an Individual Account System (IAS) incorporating a Land, Administration and Water Charge (LWC).

The Components of the LWC to Recover Water Charges

i. Capital costs of the irrigation system comprising depreciation, replacement cost reserve and interest on long-term loans.
ii. Operation costs which are the expenses of O & M.
iii. Overhead costs other than capital costs which include a proportion of the Ministry of Irrigation headquarters costs (Cost Recovery Committee 1980).

Administration Charges. Administrative charges consist of the same types of expenses as the water charges.

Land Charges. On the assumption that the government either owns the land or administers it for the general good, it is entitled to an income as a landlord which is obtained by enforcing land charges.

The main objective of the new LWC was cost recovery; however, some concessions were made to the tenants' trade unions. Moreover, when implemented, the LWC never incorporated a land charge (before 1990/91), nor were the proceeds of the water charges transferred to the Ministry of Irrigation or the Ministry of Finance.

CALCULATION OF WATER CHARGES

Costs

Capital cost.

i. Depreciation - To calculate depreciation "a straight line plus average interest on first cost with salvage value equal to zero" method is used; i.e.,

$$CR = \frac{P}{n} + \frac{Pi}{2}(n+1)$$

where n = life of asset
I = minimum attractive rate of return (6 to 8%)
P = initial cost
n is usually estimated as follows:

Capital works, buildings and consulting fees	50 years
Major items of mechanical equipment and plant	25 years
Roads	20 years
Vehicles and minor plant	10 years

Most of the fixed assets of the Gezira mains are considered sunk. The contribution of the Roseires Dam is estimated to equal 35 percent. The fixed capital assets of the Managil extension and the received gates of Sennar Dam are also depreciated.

ii. Replacement Cost Reserve -- The Replacement Cost Reserve should be credited with the difference between the cost of replacing a capital item at the end of one accounting year, and what it would have cost at the end of the previous year. However, this item was never included in the calculation.

Operating costs. Operating costs are all costs needed to operate and maintain the irrigation system in the scheme. Chief among these items of expenses are:

Salaries and payroll expenses
Silt clearance
Weed clearance
Maintenance and operation of civil works
Maintenance and operation of mechanical works
Minor renewals
Vehicles and plants

Overhead costs (other than capital costs). Overhead costs other than capital costs include a proportion of the Ministry of Irrigation headquarters, dams and hydraulic research costs.

Areas. The details of the areas under each crop are supplied by the Agricultural Managements.

Crop water requirement (CWR). The CWR is fixed according to the recommendations of the research workers of ARC. Until 1989/90, a predetermined number of irrigations for each crop were used.

Cost allocative. As the Roseires and Sennar dams are multipurpose ones, costs are assigned to irrigation and hydropower according to the "Separable Costs - Remaining Benefit" (SCRB) method.

Estimation of water charges. Each crop area is multiplied by its CWR to give its water consumption. These products are aggregated to give the total water consumption. Then total annualized costs (net of costs allocated to hydro- power) are multiplied by the ratio of total crop water consumption to the aggregate water consumption to give the cost recovered from each crop. The annual cost recovery of each crop divided by its area gives the water charge per feddan.

From the foregoing description it is clear that the vehicle used is an area-based charge weighted by CWRs, and that the rate setting is made according to a combination of average cost and ability-to-pay principles, because the farm-gate prices of cotton and wheat are determined according to a cost-plus criterion including LWC costs. Certain deductions are allowed to compensate for the inefficiencies of the irrigation system.

Improvement of the Existing Water Charging System

Many people dismiss volumetric pricing on the assumption that water measurement is either expensive or inaccurate. However, the Gezira Scheme is readily adaptable to volumetric charges with little additional costs. Such a move toward volumetric charging was looked forward to enhance economic efficiency, engineering efficiency, equity and cost recovery. The following alternative management procedures are suggested to be implemented one after another, every two or three years, giving enough time for monitoring, evaluation and amendment:

1. The existing head regulators of minors have to be calibrated, the side angles to be marked to show the gate-opening and the downstream water gauges renovated. This will enable reasonably accurate volumetric measurement at the head of the minor level. Simple meteorological screens can be erected at Ministry of Irrigation subdivisional headquarters to estimate CWRs. The BI should be enabled to verify the quantities of water supplies passed to him. Similarly, the Assistant Divisional Engineer (ADE) should be enabled to examine the progress of the agricultural operations schedule, in order to develop mutual accountability. Multidisciplinary teams should conduct experiments of crop-water production functions. These functions have to show the impact of the availability and timeliness of the different inputs and agronomic practices.

2. The flat annual volumetric system can be extended to the AXX level. The FOPs should be calibrated at this stage.

3. The volumetric pricing can be extended to the AVI level. The discharge through an individual AVI can be measured using V-notches. The estimation of E^0 will remain as before, but the crop factors can be amended to suit the actual crop stands after consultation with BIs. Automatic level gauge recorders at minor canal heads can be erected at this stage.

To enhance equity and obviate social and political pressures exerted by strong groups for unnecessary maintenance of the stretches of the irrigation system serving them, the cost recovery can be based on the actual O & M for each individual major canal. Later, the accounting unit can be reduced to the minor canal level.

To ascertain the success of the above procedures, similar efforts should be made at the Block Offices to comply with the agreed agricultural operations.

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