FINANCING IRRIGATION: A LITERATURE REVIEW

IRRIGATION FINANCING AND THE OBJECTIVES OF IRRIGATION DEVELOPMENT

The approaches to irrigation financing need to be understood in relation to the objectives of a nation's irrigation development program. At least four general categories of objectives can be identified: increased national food production (including stabilization of production and "self-sufficiency"), increased production by subsistence farmers (including famine protection), general national or regional development (including land settlement), and generation of increased government revenues.

Increased national food production is an objective underlying irrigation development in many nations. In Bangladesh, a very rapid increase in irrigation was seen as a key element in meeting the primary objective of the medium-term food production plan, namely, "to ensure food security to the nation by achieving food grain self-sufficiency" (Huq 1980:168). Self- sufficiency in rice has also been an important element underlying the irrigation development plans of the Philippines and Indonesia. In Malaysia, the government has used irrigation as a means of increasing the proportion of domestic production in the country's rice consumption. Just as irrigation development is seen as an important component of the strategy for achieving the self-sufficiency objectives of these nations, the irrigation financing mechanisms must also be seen as consistent with these objectives. Any financial mechanism which would limit the planned rate of development and use of irrigation would be deemed unacceptable.

Increasing the income and production of subsistence farmers was one objective underlying the development of irrigation in India and Pakistan during the late 19th and early 20th centuries. Projects which, when judged by a financial productivity criterion, were deemed to be "unproductive" had an important place in the irrigation development program if they would benefit the nation by reducing famine. Such projects might also have some fiscal advantages to the government in the form of reduced expenditures on famine relief (National Council of Applied Economic Research 1959:65). The explicit income distribution objective associated with this policy has clear implications for financing mechanisms. In particular, it would be inconsistent to use a mechanism requiring the water users to pay for the full cost of the development and operation of the irrigation system.

Regional development, often including land settlement, has been an important objective of irrigation in many countries. Much of Sri Lanka's irrigation development has been in the context of land settlement in the dry zone of that nation. The country's largest irrigation scheme, the Mahaweli Project, might best be described as an irrigation-based regional development and land settlement scheme.

In the USA, land settlement and regional development were major objectives underlying the construction of irrigation facilities in the western part of the nation (US National Water Commission 1973:257, US Water Resources Policy Commission 1950:76). Pressure to undertake such projects generally did not stem from farmers or potential settlers; rather, it came from "local chambers of commerce and similar organizations" of businessmen who expected to gain from the indirect benefits of irrigation associated with the development of communities based on agriculture (Teele 1926:439; US Water Resources Policy Commission 1950:172). Thus, for example in 1899, ... "[T]he National Irrigation Association was organized by railroad officials, manufacturers, businessmen, and others interested in the development of irrigation" (US Water Resources Policy Commission 1950:151). As a result of these objectives, it has been argued that it is inappropriate for the entire financial burden of irrigation to be borne solely by the farmers . ... "[T]he argument for all public participation in reclamation [i.e., irrigation] is the claim that a great public benefit arises from the reclamation of arid lands. If such is the case, the question arises whether the water users should be expected to repay the whole cost" (Teele 1926:439).

Increasing government revenues was one of the two major objectives of irrigation development in India and Pakistan during the late 19th and early 20th centuries. In selecting irrigation projects to achieve this objective, a productivity criterion was used. The criterion required that a "productive" irrigation project show, by the tenth year, a certain percentage expected return (in terms of net government revenues from irrigation fees) on the initial capital cost, including interest (National Council of Applied Economic Research 1959:65, Prasad and Rao 1985). Investment in "productive" irrigation works thus had an objective similar to that which governs investment in a profit-motivated private sector. This has obvious implications for the types of financing mechanisms that would be appropriate.

INSTITUTIONAL ARRANGEMENTS

The effects of financing policies depend on the organization of responsibilities for the four processes of 1) allocating resources to irrigation, 2) using these resources to implement irrigation services, 3) obtaining resources from irrigation beneficiaries, and 4) controlling the resources obtained from the beneficiaries. The key distinction is between situations of full or partial *financial autonomy* and those of *financial dependence*. With financial autonomy, an irrigation agency has at least partial responsibility for all four processes. In particular, it has control over the resources which it obtains from the water users, and thereby over the allocation of all or a major portion of the resources devoted to irrigation operation and maintenance (O&M). Financial autonomy may involve either decentralized implementing agencies or a centralized irrigation agency. With financial dependence, an irrigation agency has no control over any funds collected from the water users, and is thus dependent on resources allocated to it through the general government budgetary process.

Decentralized financial autonomy can be found in a number of countries where control of irrigation operations is vested in local irrigation districts (USA, Mexico, China), companies (France), land improvement districts (Japan), farmland improvement associations (Korea), irrigation associations (Taiwan), or irrigation cooperatives (Greece). In China, for example, irrigation districts are, in

principle, supposed to be able to sustain irrigation operations without reliance on external subsidies (Nickum 1982:iii). In practice, however, many subsidies are provided by the government, even for normal O&M activities (Nickum 1982:4,35). In Mexico and the USA, localized irrigation districts are financially autonomous within the structure of government rules and regulations that provide for subsidies for initial construction (Adams 1952; US Congress, Office of Technology Assessment 1983; Olaiza-Perez 1986). A similar situation exists for irrigation companies in France (Bergmann 1984, Pelissier 1968) and for irrigation cooperatives in Greece (Bergmann 1984). Essentially the same can be said for the land improvement districts in Japan (Okamoto et al. 1985, Kimura 1977, Kelly 1982). Irrigation Associations in Taiwan follow a similar pattern (Bottrall 1978b, Abel 1976), although there may be more direct government supervision and control of activities than in the cases of the countries mentioned previously. The situation in Korea is similar to that in Taiwan, with financially autonomous Farmland Improvement Associations responsible for operating the irrigation facilities, but under fairly close supervision through the provincial government and through the Ministry of Agriculture and Fisheries.

In almost all countries with decentralized, financially autonomous irrigation institutions, there are substantial subsidies which the irrigation agencies receive from the central government. In some cases the nature of the subsidies is fairly clearly defined, so that within the framework of regulations associated with these subsidies, the individual irrigation agencies show a high degree of financial autonomy. In other cases, however, either the magnitude of the subsidy is so large (covering portions of normal O&M as well as capital costs) or the procedures whereby the subsidies are determined are so politically motivated that the irrigation agencies may have very little financial autonomy. One brief report in the literature suggests that this latter situation may prevail in Italy (Bergmann 1984).

One of the potential advantages of decentralized financial autonomy is that it may create financial accountability linkages between the managers of irrigation projects and the water users. It is reported, for example, that irrigation districts in China, unlike most economic enterprises in the state sector, are not overstaffed. The reason given for this is that the arrangement whereby the revenue of the district comes from the water users provides an incentive to limit the number of personnel (Nickum 1982:22). There is also evidence that water users in China use the threat of nonpayment of water fees as a means of leverage over management (Nickum 1982:38).

On the other hand, cases are reported where decentralized financial autonomy results in a vicious circle of low fee collection, leading to inadequate budget for O&M, leading to poor quality O&M, leading to low ability to pay and to low rates of fee collection. This appears to have been a problem with some of the small pumping projects in China (Nickum 1982:27).

Centralized irrigation agencies may also be financially autonomous, although this appears to be relatively uncommon. The most notable example occurs in the Philippines, where a semigovernmental corporation, the National Irrigation Administration, is responsible for the construction and operation of national irrigation systems throughout the country. Although it has in the past received substantial funding through government subscription of capital, it is increasingly being forced to conduct its operations within the budget constraints of the revenues which it can earn from its corporate activities. It seems quite clear that the increased financial autonomy of the National

Irrigation Administration has been a driving force in modifications of the financial procedures for O&M of irrigation projects in the Philippines. In particular, much more attention is now given to fee collection from water users, and efforts have been undertaken to establish systems of incentives to increase the rates of fee collection.

A common alternative financial arrangement is that of financial dependence, whereby a government line agency responsible for operating irrigation projects depends solely or primarily on government budgetary procedures for its revenues. This approach prevails in a number of countries including Nepal, Thailand, Indonesia, and India (Bottrall 1976, Pawar 1985), Pakistan (Wolf 1985, Bottrall 1978a), Sri Lanka (Silva et al. 1985), and Bangladesh (Khan 1981). One feature of this approach is that the amount of water charges collected from farmers has little or no relationship to the amount of funds which is made available for the O&M of the irrigation systems.

PRINCIPLES FOR ASSESSMENT OF FINANCIAL OBLIGATIONS

Assessment of financial obligations is usually based on either the cost or the benefit principle. Although these approaches are conceptually distinct, financing policies developed in any given country may incorporate a mixture of the two.

When the cost approach is used, it is common for the government to provide subsidies that cover some specified portion of the irrigation costs. Typically, the subsidy involves a portion of the capital costs (either for initial construction or for major upgrading or rehabilitation), but no portion of the O&M costs. In France, for example, it is reported that the range of the explicit subsidies was 20-60 percent of the capital costs. In addition, an implicit subsidy exists in the form of low-interest loans available to the farmers to cover the remaining portion of the capital costs (Pelissier 1968). Japan also follows a cost approach with varying levels of subsidies from the central and prefectural governments (Kimura 1977). Similar arrangements are found in Taiwan (Bottrall 1978b) and Korea. In the USA, irrigators are obligated to repay the full cost of irrigation construction, but only over periods of 40-50 years at no interest (US Water and Power Service 1980). The average effective subsidy resulting from the application of this policy has been calculated to be equivalent to 81 percent of total (both capital and recurrent) costs of irrigation (US Congress, Congressional Budget Office 1983).

The cost principle is sometimes modified to accommodate considerations related to the amount of benefits received. In the USA the cost principle, which was originally specified in the 1902 legislation providing for the federal government to engage in the construction of irrigation projects, was modified in 1939 to incorporate explicit considerations of ability of the irrigators to pay from the benefits derived from irrigation (US Congress, Office of Technology Assessment 1983). The net effect is that the total nominal amount which farmers are required to repay is determined on the basis of cost, but the amount which is actually paid in any given year is determined on the basis of benefits received.

Considerations of ability to pay also appear to have been incorporated into policies on water charges in Taiwan and Korea. In Taiwan, for example, the government has set a maximum amount which

farmers can be charged for water by the irrigation associations. In some cases, if the costs of the irrigation association cannot be met by these maximum charges, special subsidies may be provided by the government (Taichung Irrigation Association 1985). In Korea, ceilings are placed on the maximum amounts which farmers can be charged for the capital cost of new projects and for their O&M.

There are a number of problems with the application of the cost principle. It has been argued, for example, that because of corruption, inefficiency, and other "leakages," officially reported cost figures for irrigation in India may be as much as double the appropriate or "real" level that users should be expected to repay (Prasad and Rao 1985). Furthermore, for a variety of reasons, projects with very high "real" costs may be built, even though farmers would be unable to pay for their full costs. It has been argued, for example, that very few, if any, of the irrigation projects built in the western part of the USA since 1960 can be justified on rigorous economic efficiency grounds (Young 1978).

Basing financial obligations on levels of benefits received is common in many countries. Under the commune system in China, some of the construction work on irrigation projects was financed by direct labor quotas placed on the production teams. It has been reported that the allocation of these labor quotas to production teams was on the basis of expected benefits from the project (Nickum 1979). In Bangladesh, subsequent to 1976, a water charge equal to three percent of incremental gross benefits was supposed to be levied on projects implemented by the Bangladesh Water Development Board (Khan 1981), and in a large number of countries, financial obligations of farmers are directly related to the size of the area being irrigated.

The benefit principle is consistent with financing mechanisms that place some financial obligations on indirect beneficiaries of irrigation. Few examples, however, of such mechanisms are reported in the literature. In the USA, some irrigation development and operation are financed from assessments made against land in irrigation districts. In California, urban land may be included in these districts as long as this land is deemed to have benefited from irrigation (Adams 1952). It has also been argued that in the USA the use of public revenues to pay for part of the cost of irrigation is justified to the extent that public benefits accrue from irrigation (US Water Resources Policy Commission 1950). In India, it is reported that betterment levies have been tried in various states, although without much success (Braibanti and Spengler 1963, Gandhi 1966). The concept is to help finance irrigation by using some of the windfall private benefits which were created at public expense.

TYPES OF FINANCING METHODS

Earmarked charges levied on the water users. Earmarking of funds collected from user charges for O&M occurs in virtually all situations where decentralized financial autonomy prevails. Thus, for example, revenues from water charges in China are handled as earmarked funds, rather than being treated as financial income that could be used on nonwater expenditures (Nickum 1982). Many irrigation districts in the USA rely on direct charges for water to provide the revenues necessary both to operate and maintain the irrigation systems, and to meet any obligations with respect to the provision for a return on the initial investment (Teele 1927b:130-131, Revesz and Marks 1981, Hutchins 1923).

Benefit taxation of direct beneficiaries. Efforts to impose benefit taxes on the direct beneficiaries of irrigation generally involve taxes on irrigated land, including land-betterment levies. The rationale for this type of financing arrangement is that the direct benefits of irrigation are capitalized into land values. Capturing a portion of these increased land values is a possible alternative to the use of irrigation service fees or water prices for obtaining funds from the direct beneficiaries. Some of the irrigation districts in the USA finance part of their irrigation activities in this fashion (Adams 1952, Hutchins 1923).

Sale of water rights. Some irrigation developments have been financed through the sale of perpetual rights for water. In the USA, for example, such sales have been designed to cover the cost of the construction of irrigation facilities (Mead 1903). The allocation and implicit sale of water rights through those who develop a communal irrigation system in Nepal have also been reported (Martin and Yoder 1983).

Indirect methods of financing. In some countries, funds for irrigation services are provided directly from the government budget. The government budgetary process itself can be thought of as a method of irrigation financing. But in addition, it is useful to consider the various indirect ways that a government may obtain revenues related to the benefits created by irrigation. Four common indirect financing methods are secondary income for irrigation agencies, output price and marketing policies, taxes on agricultural inputs, and general taxes.

In some countries, local irrigation agencies have sources of income other than water charges. These sources of *secondary income* may also be used to finance irrigation activities. For example, irrigation districts in China may undertake sideline economic activities which generate income that is then used to finance irrigation services (Nickum 1982:4). Some irrigation associations in Taiwan located in urbanizing areas have found that the conversion of previously irrigated land into nonagricultural uses has made some of the existing irrigation canals unnecessary. These associations have been able to sell the land on which these canals were located, and to use the proceeds to finance the cost of irrigation services (Taichung Irrigation Association 1985). In the Philippines, part of the funds used to finance O&M activities of the National Irrigation Administration has come from income from secondary sources of income including equipment rental, interest on construction funds received but not yet spent, and a management fee which the National Irrigation Administration charges for its management of the construction of new irrigation projects. In Korea, secondary income from interest earnings, sale of water for nonirrigation purposes, and rental of assets provides, on the average, about one-fourth of the total income of the irrigation associations. In the USA, the formation of Water Users' Associations was encouraged by governmental policy that gave these associations the rights to certain types of secondary income, such as revenues from the leasing of project lands used for grazing and farming, and the profits from project hydropower plants (Thompson 1985).

In some situations, attempts have been made to impose *benefit taxes on the indirect beneficiaries* of irrigation. This approach usually also involves taxation of increased land values. In this case, however, the land which is taxed may not be limited to agricultural land, but may include nonagricultural land whose value has been enhanced because of the increased economic activity associated with irrigation development. This has been done in parts of the USA, where irrigation

districts are permitted to incorporate nonagricultural land within the district, and to levy a tax on the land if the land is deemed to have benefited from an irrigation project.

Government revenues may be enhanced by irrigation as a result of combinations of *pricing and procurement policies for the major crops* produced on the irrigated land. For example, for many years there has been controlled marketing of grain crops in China, which has effectively meant that much of the increase in production from irrigation could be channeled into the hands of the government. Prices at which this product had to be sold to the government were set at a low level (Nickum 1982:36). Low output prices have also been used in Mexico. For many years, rice prices in Thailand have been held well below world-market levels through the imposition of taxes on rice exports. To the extent that irrigation has led to increased exports, it has also led to increases in government revenues from these taxes.

In some cases a government may increase its revenues from irrigation through placing *taxes on inputs* which are complementary to irrigation. The most common example of this involves taxes on fertilizer sales.

The government may increase its revenues from irrigation due to the structure of *general taxes* in the economy. For example, a general land tax based on the productivity of the land should result in increased revenues to the government. Taiwan has this type of land tax, with 26 land productivity categories. Similar taxes are also found in Indonesia and Nepal. There may also be other taxes which are affected by irrigation activity. If an income tax exists, collections may be higher due to the development of irrigation. Special taxes on agricultural processing activities, such as rice milling, may also increase with irrigation.

Nonmonetary methods of financing. In some cases, farmers may be mobilized to undertake some of the construction and maintenance activities associated with the provision of irrigation services. To the extent that this type of unpaid labor is used to provide irrigation services, the services are financed by the direct labor contributions rather than through any mechanism involving flows of cash.

In China, O&M activities have sometimes been undertaken by farmers who are compensated on the basis of work points. This effectively means that there is no net additional financial cost to the irrigation district for these activities (Nickum 1982:3). In Japan, farmers' organizations are formed to mobilize farmers to construct the terminal irrigation system, and to operate and maintain these facilities (Kimura 1977). It is notable that the cost of these terminal facilities may be twice that of constructing the primary and secondary structures (Kimura 1977). Farmers and their local organizations are responsible for O&M of all facilities at the tertiary level and below. In many cases, part of these responsibilities are met in the form of direct contributions of labor.

METHODS OF CHARGING FOR WATER

In the previous section, various methods for financing irrigation services were considered, some of which involved direct charges on the users of irrigation water. This section reviews the experience of different nations with the various methods by which such charges may be imposed.

Volumetric water prices. It appears that there are relatively few places where volumetric water prices are applied. China has reportedly experimented with some volumetric water charges, but the approach has not been widely used (Nickum 1982:40-42). Some systems in France include a volumetric charge as part of a two-part tariff structure (Pelissier 1968). Volumetric pricing can also be found in some systems in Morocco.

In evaluating approaches that charge for water on a volumetric basis, a distinction needs to be made between situations where the basis for the calculation of the water charge is volumetric but the farmer has little or no control over the volume of water received (as is the case of some projects in Morocco), and those situations where individual farmers make decisions on the volume of water to receive (as is true in other projects in Morocco and apparently in France). The latter cases represent situations of true water pricing, comparable to the pricing of other farm inputs, such as fertilizer. The former situation amounts to a special form of an irrigation service fee similar to a flat charge for water per unit of land area.

Time-based water prices. In some cases a price for water is based on the length of time that a person receives water. This method, which appears to be most common with pump projects, is found in some projects in Mexico.

Area-based water charges. Perhaps the most common type of water charge is an irrigation service fee based on the area served by the irrigation system. The simplest form of this type of charge is a uniform fee per unit area of land commanded by the irrigation system. This system is being introduced in Sri Lanka (Silva et al. 1985). A common modification of this simple approach is to adjust the charge to take into account the cropping intensity of the land. Thus there may be a flat fee per unit area for the wet season, and a separate fee for a dry-season crop. This is the typical approach used in the Philippines. Another modification is to adjust the fee to reflect the type of crop grown. This is done with some systems in France (Pelissier 1968), in parts of India (Pawar 1985, Asopa 1977) and Pakistan (Wolf 1985), and the Philippines.

Another adjustment is to modify the charge according to the number of times which the farmer receives irrigation water. This method may be feasible in situations where there are distinct irrigation deliveries, as opposed to more or less continuous delivery of irrigation water. Such a method has been used in some irrigation projects in Mexico.

Other adjustments are also possible. For example, areas served by pump projects in Pakistan are sometimes charged at a higher rate than areas served by gravity systems (Wolf 1985). In Korea, land is generally categorized on the basis of the benefits derived from the construction of the irrigation facilities. Charges are differentiated accordingly. Distinctions are also made on the basis of the costs of the particular irrigation facilities serving different areas.

Two-part charges. In some countries, the charge for water is based on a two-part tariff, comprising a fixed charge and a variable charge. The fixed charge may be in the form of a capacity charge, as in France, where each irrigator may contract for a certain maximum rate of flow (Pelissier 1968). In this case, the variable charge is for the amount of water actually consumed, measured on a

volumetric basis. Alternatively, the fixed charge could make the irrigator eligible for some "normal" or basic supply of water, with the variable charge imposed on amounts of water taken in addition to this basic amount. For example, it has been suggested that in India a fixed charge could be levied for the "normal" number of irrigations, with an additional variable charge for each irrigation in excess of the "normal" number (National Council of Applied Economic Research 1959:85).

In the USA, two-part charges are frequently used. The fixed component is generally an *ad valorem* assessment on the land, which is a benefit tax on property. This fixed charge may be supplemented with a charge for the actual use of water (Adams 1952). In some cases, the fixed charge may entitle the landowner to some fixed quantity of water, which is generally less than what the farmer wishes to use. A variable charge is then applied to additional quantities of water which the farmer decides to purchase (Teele 1927b:19, 130-131).

Water wholesaling. It has sometimes been suggested that volumetric pricing of water, which is difficult to achieve at the individual-farm level in situations where farm sizes are very small, could be achieved if the irrigation agency were to sell water in bulk at some level in the system where the volume of water could be measured and the individual farmers served by the unit to which the bulk delivery was made could be given the responsibility for distribution of the water within the unit. Such a system has been proposed for Mexico, and apparently introduced in one irrigation district with some success. A similar arrangement is also used in some systems in Morocco, although the farmers served by the unit to which the water is delivered may have little control over the volume of water received.

ENFORCEMENT

Enforcement of the rules for water allocation and for payment of charges and taxes is critical to the long-run sustainability of the financing system. Several types of enforcement mechanisms are reported in the literature.

Termination of irrigation services. In some cases, the agency operating the irrigation system will not deliver water to water users who have not paid their obligations. In Mexico it is reported that in some systems, water will not be delivered without a receipt showing that prior payment has been made. In China, violations of water allocation rules may be punished by the cessation of water deliveries to the offending unit, although the extent of such enforcement is not clear (Nickum 1982:5).

A slightly modified form of this penalty has been suggested for the Sardar Sarovar Project in Gujarat, India. Under the proposal, water deliveries would be organized and monitored, not to individual farmers, but to units comprising groups of farmers served by a defined service area. Delivery of the full water allotment to the service area would occur only if the total water bill for the area is fully paid. If payment is not made in full, water deliveries would be reduced in proportion to the percentage of the total unpaid bill (Frederiksen 1985).

Financial penalties imposed by the irrigation agency. In a number of countries, regulations provide for the imposition of fines for improper water use and for failure to make prompt payment of the

financial obligations associated with irrigation. Fines are levied in Mexico for illegal use of water, but are of questionable effectiveness, as they are reportedly less than the value of the water taken. Fines are sometimes imposed in China (Nickum 1982:5). Fines for late payment of water charges in Korea may be imposed, up to a maximum of 15 percent of the amount due.

Legal sanctions. In several countries, legal sanctions for failure to fulfill financial obligations are imposed. In the USA, failure to meet the financial obligations which are levied for irrigation services may lead to foreclosure and sale of the land of the delinquent water user. This is possible where irrigation districts are in existence and water charges are assessments against the value of the land. Failure to pay thus results in a lien on the land (Teele 1926). The United States Federal Government has further required that irrigation districts impose joint liability for the repayment of the construction costs to the federal government. This means that if the district does not fully pay the costs, no landowner within the district can obtain a clear title to his land (Huffman 1953:86). Some irrigation districts in the USA have the power both to require the installation of water meters, and to read them (Revesz and Marks 1981). Incorporated mutual irrigation companies in the USA have the legal ability to enforce payment of obligations by the shareholders, although unlike irrigation districts, they do not have the ability to levy assessments against the land (Revesz and Marks 1981).

Legal sanctions are not always effective. In Sri Lanka, failure to pay the water charges is punishable through legal means, but the difficulties associated with taking court action against numerous small farmers make this sanction of little practical importance. Similar situations prevail in a number of other countries.

Social sanctions. In some countries social sanctions may be an important method of encouraging water users both to obey water allocation rules and to meet their financial obligations. It is reported that despite the existence of fines for illegal water use in Mexico, social sanctions are the key deterrent to illegal water use. Social sanctions against nonpayment of water charges in Korea are reported to be very high (Wade 1982).

CONTROLS ON EXPENDITURES

Generation of revenues is only one aspect of the problem of financing irrigation services. Another equally important aspect is that of controlling expenditures, to make certain that these expenditures are reasonable and desirable within the context of the benefits that they create for the users of the irrigation services.

Information on this aspect of financing irrigation services is relatively sparse. In some cases, evidence of problems created by the lack of controls is reported in the literature. For purposes of exposition, it is convenient to consider controls on O&M expenditures separately from controls on capital costs.

Controls on Expenditures for O&M

In situations of decentralized financial autonomy, there may be local pressures to scrutinize expenditures more carefully than would otherwise be the case. It has already been noted that in

China, the financial autonomy of irrigation districts seems to result in less overstaffing of the professional management agency than is typical for government agencies in China (Nickum 1982:22). It is reported that in Japan, the alignments of terminal-level field ditches have sometimes been modified to reduce O&M expenditures (Kelly 1982:45). It should be noted, however, that this may be partly a response to the availability of government subsidies for new construction and major repairs, and the absence of such subsidies for normal O&M (Kelly 1982:41). It is also reported that local politicians may resist expensive projects designed to modernize terminal facilities because of the unpopularity of the associated requirement of raising water charges (Kelly 1982:47).

In Mexico, where irrigation is also organized on the basis of decentralized financial autonomy, the financial linkage between user charges and funds for O&M appears to exert some degree of control over expenditure. Mexican farmers have reportedly stated that failure to operate the irrigation system in a cost-effective manner makes them unwilling to pay higher irrigation charges. It has also been noted in Mexico that in communally operated irrigation projects (i.e., irrigation units), where the water users are directly responsible for the conduct and financing of O&M, the maintenance is better than in government-run irrigation projects (i.e., irrigation districts), where farmers have little involvement in expenditure control, other than the payment of water fees. This example is of particular interest, because it runs counter to the argument which is sometimes made that if farmers are responsible for determining (and paying for) O&M expenditures, they will fail to maintain the irrigation facilities at a satisfactory level of performance due to short-sighted desires to reduce costs.

Under systems of financial dependence, the control of O&M expenditures is likely to come through some form of assessment of the "requirements" for operating and maintaining various physical structures present in the system. Thus, for example, in Pakistan, the funds allocated by the provincial finance departments for O&M are based on rigid formulae regarding the physical characteristics of the irrigation system (Wolf 1985).

Controls on Capital Expenditures

Controls over capital expenditures appear to be a particularly difficult problem. Institutional linkages between those making capital expenditure decisions and those who will pay for the resulting facilities are typically weak. In the USA, it has been noted that the increasingly costly projects for irrigated land reclamation are beyond the repayment abilities of the water users. This raises the question "as to whether there is any reasonable limit to the extent of Federal investment" (US Water Resources Policy Commission 1950:172). More recently, it has been argued that most of the irrigation projects that have been built in the western part of the USA since 1960 have been uneconomic from a strict economic-efficiency framework (Young 1978). The implication is that either the control over capital expenditure decisions has been inadequate, or the economic-efficiency framework for project evaluation is inadequate.

A contrasting example comes from recent experience with communal projects in the Philippines. In this case, the government made the water users responsible for the repayment of the capital costs of these projects. A contractual arrangement between the association of water users and the National

Irrigation Administration (which provided assistance for the construction of these projects) meant that farmers had to agree in writing to repay the costs which the National Irrigation Administration would incur on their behalf. It soon became apparent that farmers would not sign such agreements without some authority to control costs. It seems clear that in this case, a serious commitment by the users to repay a portion of the capital costs led to a much more careful control over the capital expenditures.

A similar example comes from another small, communally based pump irrigation project in the Philippines. In this case, the farmers were able to reduce the overall expenditures considerably, in part by removing certain structures from the design that were deemed unnecessary. They were also able to reduce the effective costs by substituting locally available materials and labor for more expensive purchased items. As a result, it was found that the loan which the farmers had to take from the government for the construction of this project was only about 58 percent of the amount originally estimated (Svendsen and Lopez 1980:16).

EVALUATION OF EXPERIENCES WITH IRRIGATION FINANCING

Collection Costs

Any method of financing irrigation which involves collection of funds from a large number of individuals will require the expenditure of resources to administer and implement the collection process. In evaluating the overall effectiveness of different financing methods, these costs of collection must be considered. Unfortunately, it is often difficult to determine their magnitude, and one finds relatively little information on them in the literature on irrigation financing.

Data on the costs of collecting water charges in the State of Bihar, India, for the years 1977/1978 through 1981/1982 are presented in a recent paper, along with data on the total amounts collected. In 4 of the 5 years, the costs of collection ranged from 46-84 percent of the total amount collected. In the fifth year, when collections lagged, the cost of collection was 117 percent of the amount collected (Prasad and Rao 1985). Part of the reason for this poor performance is that the total collections ranged from only 11-28 percent of the amounts due. It is obvious that in such a situation, collection of water charges will contribute little to the net resources available to the government.

In the Punjab Irrigation Department of Pakistan, about 15 percent of the work force is assigned as a special revenue group to assess water charges. For 1983/1984, the budget for the expenditures of this group amounted to 6 percent of the total budget of the Irrigation Department, and was equivalent to about 10 percent of the total amount collected from water charges for that year (Wolf 1985, McAnlis et al. 1984). Since the actual collection of water charges (as opposed to their assessment) is undertaken by the Revenue Department, the total cost associated with the collection of water charges is considerably greater than the cost represented by the above figure.

Collection Efficiencies

The amount of funds collected relative to the amounts which are due varies considerably among nations. As noted above, between 1977/1978 and 1981/1982 in Bihar State, India, collections were only 11-28 percent of the amounts due (Prasad and Rao 1985). In one case study done in Pakistan, the rates of collection of water charges ranged between 70 and 86 percent of current assessments. When the amount of assessments in arrears is included in the calculation, the collections amounted to 55-70 percent of the assessments (Bottrall 1978a:49). By contrast, a case study of the Yun Lin Irrigation Association in Taiwan found collections to be about 98 percent of the assessments. It was noted, however, that in the early 1970s collection rates had fallen to about 28 percent, in part due to the inability of farmers to pay the charges, and in part because of farmers' unwillingness to pay owing to unreliable water supplies and poor service (Bottrall 1978b:65).

Quality of Management Performance

There is little concrete evidence in the literature on the relationship between financing methods and management performance. It has been noted that in Pakistan, the nature of the financing mechanisms for irrigation results in the provincial irrigation departments being accountable upward to the provincial governors, rather than downward to the farmers. The result is a situation where the irrigation departments "can be fiscally accountable and fully responsible for their work, and yet have minimal interaction with farmers, who often feel that the irrigation service they receive is not satisfactory" (Wolf 1985:15).

In Taiwan, it appears that the method of financing is such that the managers of the irrigation associations face an incentive structure, which encourages them to manage the system efficiently. This is partly due to the financial autonomy of the irrigation associations, and the resulting importance of high rates of fee collection to preserve the jobs of the staff of the irrigation associations (Abel 1976). As noted above, farmers in one irrigation association who felt they were not receiving good service responded by withholding payments. The fact that such an action was taken, and that it apparently led to subsequent actions to improve service, resulting in very high levels of payments a few years later, suggests that the financial accountability associated with the financing mechanism used in Taiwan has a positive effect on the efficiency of management performance.

In Mexico, government subsidies are available for rehabilitation and deferred maintenance, but not for normal maintenance. This provides an incentive to neglect normal maintenance, in order to put more of the cost burden of providing irrigation services on the central government. This probably results in reduced project performance.

In an evaluation of a large number of irrigation projects, a World Bank study has noted that in general, the best irrigation performance was achieved in projects where 1) the irrigation agencies themselves were responsible for the collection of the financial charges and 2) the funds collected by the irrigation agencies remained with them for use in operating and maintaining the irrigation projects (Duane 1986). These are the key elements of financial autonomy.

Efficiency of Water Use

There is very little precise information in the literature on the relationships between irrigation financing methods and efficiency of water use. Abel (1976) suggests that the incentive structures for both managers and users of water appear compatible with efficient use of water within irrigation systems in Taiwan, but no data on efficiency of water use are presented. For India, it has been noted that in many projects where water allocation procedures result in deliveries to farmers which are substantially less than they need to irrigate their entire holdings, the opportunity cost of water to the farmer is higher than the water rates charged by the government (Prasad and Rao 1985). The presumption is that the incentive for farmers to be efficient in the use of water is provided by the water allocation mechanism, independently of the method of financing irrigation services.

In 1981, the Operations Evaluation Department of the World Bank undertook an evaluation of water management in 26 projects which had been supported by the World Bank. The report concludes that the information available on the relationship between water charges and water use efficiency at the field level is too limited to draw any conclusions on causality. But it concludes that there were factors that were always considerably more important in explaining farmer behavior than the amount of water charges or whether or not water charges were imposed (World Bank 1981:4). In some cases with low or nonexistent charges, other factors caused farmers to fail to adopt irrigated agriculture. This was reported in the case of five lift irrigation projects in Sri Lanka, where farmers paid nothing for the O&M costs. But in a sixth project in Sri Lanka, farmers paid US$50 per hectare (ha) per season, and immediately used the irrigation water and continued to use it at a high rate (World Bank 1981:40). For a project in Iran, it was concluded that due to the irrigation agency's tight control over the farmers, the subsidization of water did not result in any serious misuse of water by the farmers (World Bank 1981:40).

A report of the US National Water Commission (1973) noted a study conducted in the State of California which examined the price responsiveness of demand for irrigation water. The study estimated that a 10 percent increase in the price of water might result in a 6-7 percent decrease in the use of water. The report concluded that "demand for irrigation water is responsive to changes in price and that greater efficiency could be attained in irrigation water use by adoption of a pricing system" (US National Water Commission 1973:256-257). The report goes on to note, however, that many irrigation districts in the USA do not even measure the amount of water delivered to the users, hindering the implementation of such a pricing system.

Efficiency of Investment Decisions

The review of literature suggests little effective use of irrigation water charges as a means of ensuring efficient investment decisions. The generally low level of capital cost recovery in irrigation projects financed by the World Bank has had no apparent dampening effect on the levels of investment in new irrigation. It appears that in many countries, factors other than the levels of cost recovery dominate the investment decisions.

Financing policies related to capital costs of irrigation development frequently appear to be designed in ways that are likely to encourage *inefficient* investment decisions. A common approach is for a subsidy on the capital cost of irrigation, but not on ordinary O&M. It has been noted that in the USA, the existence of such a subsidy may lead irrigators to select an irrigation method which involves a relatively high capital cost but lower O&M costs, even though such a system may be economically inefficient (US National Water Commission 1973:490).

Specialized social and economic objectives such as regional development or enhanced food self-sufficiency may lead to a further severing of any linkage between cost recovery and investment decisions. In the development of irrigation in the western part of the USA, the government initially encouraged private financing (Teele 1927a). But private financing was plagued with problems that led to many bankruptcies, so that many farmers ultimately acquired irrigation facilities at much below their original cost (Huffman 1953:72-73, Teele 1926). Because of these problems, it eventually became almost impossible to obtain funds for irrigation development (Teele 1927b:70).

This situation led to the passage in 1902 of the Reclamation Act which provided for a revolving fund for financing new projects, and a subsidy in the form of long-term interest-free loans for repayment of the capital cost. But this revolving fund quickly "failed to revolve" leading eventually to direct Congressional appropriation of funds for each project (Huffman 1953:83, Thompson 1985).

Over time, the difficulties in meeting repayment schedules under the 1902 Act became increasingly apparent. Meanwhile, the costs of new irrigation projects continued to rise. One observer suggested the need for "the Bureau of Reclamation to appraise adequately and conservatively the benefits from irrigation and to recommend to Congress only those projects for which reasonable repayment plans can be presented" (Joss 1945:167).

The alternative was to accept the idea that irrigation projects would require continuing government subsidies (Huffman 1953:88). Acceptance of this idea was facilitated by arguments on the importance of irrigation as a means to general regional development. "Yet the argument for all public participation in reclamation [irrigation] is the claim that a great public benefit arises from the reclamation of arid lands. If such is the case, the question arises whether the water users should be expected to repay the whole cost" (Teele 1926:439). In a similar vein a quarter of a century later, the US President's Water Resources Policy Commission argued that it would be improper to sell water to farmers at full cost. "But irrigation development in this country has followed a quite different course [than selling water on a commercial basis]. We have been concerned with developing the arid and semiarid West, with increasing agricultural production, with establishing independent, family-sized farms, with creating opportunities, with broadening the scope of individual property ownership" (US Water Resources Policy Commission 1950:76).

As a result of these types of arguments, irrigation projects which clearly could not be paid for by the water users were built. A number of observers have criticized such policies, arguing that the subsidy has benefited a relatively few individuals (Teele 1927a, LeVeen and Goldman 1978, Seckler and Young 1978). Furthermore, an *ex-post* examination of investments has led to the judgement that most of the projects constructed since 1960 could not be justified in economic terms (Young 1978,

Beale 1978). The general regional development arguments for irrigation projects provided a means for justifying "uneconomic" projects which probably would not have been constructed if the users had been required to pay the full costs.

Income Distribution Objectives

The literature on experience with irrigation financing provides little evidence that irrigation investments contribute to public savings. Financing methods may reduce the outflow of public funds associated with the provision of irrigation services, but it is hard to find examples of a net inflow. The effective rates of subsidy from the central government may be much greater than the nominal rates. For example, in the USA, the nominal subsidy on irrigation projects is zero, with full construction costs to be repaid by the water users, at no interest, plus all O&M costs. But the effective subsidy has been calculated to average 81 percent of the present value of the total costs of irrigation (including both construction and O&M costs) (US Congress, Congressional Budget Office 1983:chapter 2). A recent study on the Central Valley Project in California estimated the effective subsidy in that project to be 91 percent of its total cost (LeVeen and King 1985:table 9). Similar calculations for other countries are not available, but it is clear that low-interest, long-term loans for substantial portions of the capital costs of irrigation lead to very large effective subsidies.

The effect which financing policies have on income distribution among groups within the private sector has received some attention in the literature. Over the years, the income distribution consequences of the federal government subsidy to irrigation in the USA has been criticized (LeVeen and Goldman 1978, Seckler and Young 1978, Teele 1927a). "The public has spent over US$1 billion to create, at most, 300-350 farms. Not only have the windfall benefits accrued to a very few individuals, but also the subsidy will have been used to create economic opportunities for a very few new farmers. . . . In conclusion, the linking of water resource development with rural development has not led to a wide distribution of project benefits to new farmers" (LeVeen and Goldman 1978:932-933).

Because the anticipated benefits of irrigation may be capitalized into land values even prior to the completion of irrigation facilities, the distribution of benefits of irrigation within the private sector may be affected by patterns of land speculation. It has been argued that in the development of the western part of the USA, land speculators sold land to farmers at prices which reflected not only the value that would be added by the irrigation works to be constructed by the government, but also the value of the expected development work on the farm itself. The farmer who purchased land at such prices soon found himself in an impossible financial position (Huffman 1953:chapter 5). Under these conditions, it was the land speculator who was able to capture much of the subsidy provided by the federal government.

More recent studies have also shown that the effect of the government subsidy in the USA is reflected in land prices. Using data from California, and the estimates of the Department of the Interior on the amount of the subsidy associated with irrigation water, Seckler and Young (1978) conclude that the subsidy accounts for almost all of the gross annual revenue of the landowners. Thus, if the owners

were to be charged for water at full cost, nearly all of the rental value of the land would be required to make this payment. Such a situation implies that those who owned the land at the time that its value rose due to the government investment benefited from the subsidy. People who purchased land subsequent to the rise in price did not receive any significant subsidy. Furthermore, to introduce a charge now for the full cost of water would create a severe financial hardship on such people, as it would effectively require them to pay twice for the value of the irrigation water.

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