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ECONOMIC FAILURE PLAGUES DEVELOPING COUNTRIES' IRRIGATION: AN ASSURANCE PROBLEM

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As is well documented in the literature, many developing countries have neglected the operation and maintenance (O&M) of their irrigation projects, which has resulted in a rapid depreciation of past irrigation investments (Carruthers, 1981; Easter, 1987).[1] Irrigation projects fail to irrigate their planned or projected command areas and after a few years, parts of the systems no longer function (Wade, 1975). There are too few farmer or government agency incentives which foster investment of capital and human resources in O&M because of the weak linkage between those providing O&M and those benefitting from O&M.

> "Concern with O&M is not a new issue, and indeed, there are precedents in provision of resources to sustain O&M. The new dimension is the apparent scale of the problem and the likely trend. Unease with the scale of deficit operating performance of irrigation schemes stems from a variety of sources ..... Tangible evidence of general need comes from the increasing number of rehabilitation projects being implemented in countries as diverse as Mexico, Nepal, and Indonesia," (Carruthers, 1981, p. 53).

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[1]Operation and maintenance includes the management of water supplies and the upkeep of system facilities from the water source to the farmers' fields. Operation means the allocation and delivery of water supplies, including the management of any storage facilities, and handling of drainage runoff. Maintenance is the upkeep of irrigation and drainage structures, embankments, dams, outlets, and channels and the removal of silt and vegetation from canals and storage facilities.

In contrast to this bleak picture, there are a number of irrigation systems in which O&M has been quite adequately performed. This is particularly true in a number of communal systems. Bali Indonesia provides one of the best examples of well operated communal or traditional irrigation systems in Asia (Coward, 1986). Here a community builds, owns, operates and maintains a very complex irrigation system. The community of water users has complete responsibility for O&M, which continues to be conducted in a very effective manner.

Why Poor Irrigation Performance?

There is no one reason for these differences in performance across systems and countries. In some cases, the low relative economic value of water does not warrant investments in institutional change,[2] capital investments or administrative efforts to improve water delivery and/or reduce water losses (Young, 1985, and Young and Haveman, 1985). The low value of water compared to the high cost of improving water transportation and control, along with the high transaction costs[3] of increasing farmer

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[2]Institutional change may be necessary to reduce uncertainty. "An economic system operates with the aid of indispensable rules and conventions which are collectively referred to as institutions. An essential element in the creative activities of entrepreneurs is some degree of predictability over these institutional arrangements--property rights are the essence of predictability in these rules and conventions. When such rules are only selectively followed--or are changed in an arbitrary manner--the best plans of entrepreneurs are confounded. Irrigation systems are characterized by institutional uncertainty in that the rules and conventions for water allocation are more often than not ignored by some of the irrigators," (Bromley, 1982, p. 3). In other cases, institutional arrangements do not even exist for water allocation.

[3]Transaction costs include costs of obtaining information such as the water requirements of farmers and their production levels, contracting costs required to conclude agreements with farmers and the cost of policing and enforcing rules and agreements.

participation in O&M, leads to declining system performance. In other cases, the public or collective good character of water makes it very difficult to organize to provide water at the time and in the quantities demanded by farmers. Finally, there is the classic case of government failure due either to rent seeking behavior or poor public management (Krueger, 1974).

Collective goods aspects

There are the basic problems associated with jointness in supplying[4] irrigation water and the difficulty of excluding farmers located along irrigation canals or over ground water aquifers. A farmer's contribution to O&M typically confers benefits on the group of farmers served by the same canal or outlet, thus creating a technological externality.[5] In addition, those at the head-reaches of a canal will gain few of the benefits, while those in the tail-reaches receive the most benefits from

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[4]Jointness in supply when providing irrigation water has, at least, three aspects. First, the reservoir used to store irrigation water is likely to be used to provide other goods and services such as flood control and domestic water supplies. Second, the water itself may provide other goods and services such as hydropower, recreation and commercial fishing before it is used for irrigation. Finally, there are the interdependence problems that are created when farmers are jointly supplied from the same pump, river diversion or canal outlet.

[5]Technological externalities are present whenever an irrigator's production or utility function includes real (non-monetary) variables which are selected or influenced by other irrigations (Bromley, 1982, p. 3). These externalities cause both inefficiency and inequity in irrigation system. Farmers pumping from the same aquifer may reduce the ground water level and increase the cost of pumping for each other. Externalities also arise when one farmer's diversion and use of water from a river or canal reduces the amount or quality of water available for farmers downstream. In addition, the externality can occur just from a delay in the timing or a reduction in the reliability of water delivered downstream.

improved O&M. The uneven distribution of benefits clearly influences farmer incentives to contribute to O&M. In analyzing these problems, should the emphasis be on: (1) the "free rider" or egoistic motivations of farmers or, alternatively, upon (2) other incentives, such as farmer concerns for fairness and the need to provide assurance regarding the actions of others?

As pointed out above, we observe cases where farmers do not contribute to O&M ("free rider") as well as cases where they do. Thus, the "free rider" model does not provide a complete answer to the question concerning the range of irrigation performance in providing O&M. In contrast, work done by Runge, 1984, and Sugden, 1984, suggest that a more complete framework is provided by the principles of assurance and reciprocity in conjunction with the idea of fairness. "The reciprocity principle says, with certain qualification, that if everyone else contributes a particular level of effort to the production of a public good, you must do the same," (Sugden, 1984, p.776). This contribution can be in terms of labor, absolute money amounts, relative money amounts, commodities and equipment services, or some combination of them.

The idea of reciprocity can be included in the more general concept of assurance. If assurance is provided that members of a group will contribute to the collective good, it can significantly influence the willingness to contribute of other group members.

> "In the AP (assurance problem), the particular outcome depends crucially both on prior expectations and on a preference for coordinating one's own actions with the actions of others. These expectations are formed by institutions that facilitate the coordination of behavior by providing prior information. If public goods problems are perceived by many people as AP's, this has implications for the structure of incentives likely to yield voluntary contributions. Where people are motivated to

> contribute and if this behavior is also expected of others, institutions which convince them that these expectations are justified can promote voluntary provision of public goods. This does not imply that voluntary contributions can supply all necessary public goods. However, that significant incentives exist, internal to any group, to contribute voluntarily, implies that public goods can, in some cases, be provided without coercion or selective side-payments from outside the group," (Runge, 1984, p.158).
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> "The AP acknowledges that incentives exist to free ride if this behavior is expected of others, but implies that the assurance that others will contribute their fair share increases the likelihood that one will contribute too. The problem is: how can one predict the actions of others with assurance?
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> "Assurance is a matter of degree. The ability to predict the behavior of others is subject to varying limits of confidence ... Political and economic institutions can increase this mutual predictability, reducing uncertainty and stabilizing expectations by coordinating individual choice ... Adhering to such institutions can be its own reward, leading to stability over time if others are expected to adhere to them too." (Runge, 1984, p. 162).

Contributions towards a collective or public good will depend on expectations of group members and the potential size of the gain from contributing as compared to non-contributing. The expectations are contingent on individuals' abilities to predict what others will do and are affected by institutions which influence the actions of others. Expectations are also affected over time by the contributing behavior of others and institutions that provide information about likely behaviors over time. Contributions will be small if gains from cooperation are small, predictions of what others will do (assurance) is difficult, or the probability of others contributing is small.

Water users as a group have the option to contribute to the provision of a collective or public good. They benefit from receiving a more assured water supply but, in return, they must contribute resources to O&M of the system. What conditions and institutions appear to raise water

users' assurance and contributions? Abel, 1977, explains how institutions and penalties were used effectively in Taiwan to elicit the desired farmer contributions for O&M.

> "The members of an irrigation association are entitled to irrigation water and other benefits and are required to pay fees and perform duties for the association. Non-compliance of a member with the obligations imposed on him by law and regulation can lead to a suspension of rights to water and other benefits." (page 35).

The laws and regulations make it clear what is expected of association members, while the loss of rights makes it expensive not to perform. These institutions and penalties provide members assurance that other members are not likely to free ride.

Fairness

Another important consideration in O&M is the question of fairness. This, combined with benefits (rates of return) and stability of expectations (provided by assurance), appears to be the major factor guiding farmers' contributions to O&M for irrigation systems. Fairness is based on the idea that a distribution is fair if it involves no envy by any individual of any other individual (Baumol, 1982). In an irrigation system, this would mean that farmers at the end of a canal would not be envious of those at the head of a canal. In other words, they would not have a desire to change places with those at the head of the canal. Fairness is also similar to Rawls' principles of compatible liberty and justice which preclude "an individual or group from enjoying undue influence over water receipts, systems maintenance, or system enforcement," (Bromley, et al., 1980, p. 377).

One good illustration of fairness being introduced into irrigation through the water allocation rules is the case where water is delivered first to those at the end of the canal. Rules for equal distribution of water based on crop water requirements is another example of fairness. In theory, everyone should get enough water to grow the crop or crops they select to plant. However, in most irrigation systems, everyone cannot receive water at the same time. Thus, those in the tail-reaches of the system will have to wait longer for water unless specific allocation rules are adopted that make adjustments for location. Set rotation schedules that change from year to year can be devised so that different locations are given priority. For example, the irrigated area can be divided into three sections designated A, B, and C, with section C being the tail-reaches. In the first year, section C might have priority followed by A and B while in the second year section A would have priority followed by B and C. The third year would find section B with first priority. When more than one crop season is available, priorities could be varied by season. Again, such rotation schedules show a concern for fairness.

Since the distribution of O&M benefits usually depend on the farm's location along the canal (the tail-reaches obtain the most benefits from improved O&M), rules may have to be designed which assign responsibilities and assess contributions for O&M based on locational differences. Traditionally, contributions of labor for O&M have been related to farm size, with the larger farms required to provide more labor. A similar strategy has been used to account for location benefits. Farmers all along a canal are required to help clean and maintain the upper reaches of the canal as well as the reaches near their farms. Those in the tail-

reaches must help maintain the whole canal, while those in the upper-reaches only help maintain the upper canal. A slight variation in this model is when all farmers start cleaning at the head of the canal and continuing cleaning down to the outlet, which irrigates their own field or fields. Assuming the initial distribution of land holdings is agreed upon, then these rules provide a "fair" match between the costs and benefits of canal maintenance.

This arrangement does not completely square with Baumol's fairness criteria, because those in the tail-reaches of the system would rather be in the upper-reaches. Only the rule which allocates water to the tail-reaches first appears to approach Baumol's criteria.

In a number of communal irrigation systems, farmers have land located in different parts of the irrigated area. This helps circumvent the problem of location benefits (advantages). It may also help with problems associated with a limited family labor supply, since farmers can have different cultivation schedules for different plots of land. Planting would start in the head-reaches and moves down the system. Farmers can stagger their planting and harvesting to better suit their labor and water supply availability.

Government failure

Another explanation of the difficulties involved in providing O&M for irrigation has been the idea of government failure and rent seeking. Rent seeking is simply the attempts by potential recipients to capture economic rents created by government investments or restrictions upon economic activity. The competition for these rents can be perfectly legal or

involve such things as bribery and corruption (Krueger, 1974, Repetto, 1986). In the case of irrigation, these economic rents can be substantial, and competition for them can lead to undesirable social behavior.

> "Successful rent-seekers can well afford to spend a portion of their rents to safeguard, defend, and increase them. These defensive expenditures finance organizational efforts, political contributions and lobbying, and activities or investments that strengthen rent-seekers' claims to the resources being allocated. Over time, the mechanisms by which successful rent-seekers obtain their gains become extremely well entranced and defended.
>
> "Those who control the allocation of rents, whether administratively or politically, are in a position of power relative to rent-seekers because they are dispensing rights to resources for which excess demand is chronic. They typically find ways to appropriate a share of those rents for themselves--often through corruption and monetary gain, but also in other forms. Politicians gain votes and contributions, and public agencies gain expanded budgets, staffs, and authority," (Repetto, 1986, p. 14).

In terms of external assurance, government failure is an important cause of inadequate O&M. Because of the lack of incentives and/or resources, the irrigation agency does not provide adequate O&M. This, of course, influences what water users will contribute as they look to the irrigation agency for assurance concerning the delivery of adequate water supplies. Water users usually have limited influence over the performance of irrigation officials unless the officials' salaries and other rewards are determined by water users. In Taiwan, water users did have influence over irrigation management and this provided the needed external assurance and resulted in high irrigation performance.

> "In the case of Taiwan, the rewards to management are determined by the elected representatives of the members of irrigation associations. And there is evidence that irrigation associations do reward good management and do penalize poor management. The reward structure includes financial returns to

> management, promotions, and nonmonetary recognitions such as prizes. In contrast, systems where management is divorced from water users have incentive structures for management which are usually not linked or are linked weakly to the operating efficiency of the irrigation system...
>
> "Another important aspect of the incentive system is the interrelationship between the collection of irrigation fees and financing the operations of an irrigation association. The operating budget of an irrigation association depends directly on the collection of water fees from farmers. In order to preserve their jobs, the technical and administrative staffs of an irrigation association have a strong interest in ensuring the collection of fees. If collections are poor, revenue will not be adequate to cover operating costs and will eventually result in a reduction in the size of the staff of the association.
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> "The willingness of farmers to pay their fees depends heavily on how well the irrigation associations are operated, i.e., the amount and timeliness of water received. The better the system is managed, the more willing the farmers will be to pay their fees. This is also true for voluntary farmer participation in certain operations of the system, such as controlling the release of water into fields, performing maintenance work on the portion of the system located near their farms, etc. Thus, job security and levels of remuneration for management personnel are tied directly to how well a system is managed," (Abel, 1977, p. 41-42)

However, preventing government failure does not provide a complete answer to the O&M problem, since cases can be found where government operated projects work well and where non-government projects have inadequate O&M. The need to provide assurances and incentives within an irrigation organization seems to be a more complete approach. Thus, a model that explicitly considers the need to provide assurances and positive incentives within government and among water users, offers a better framework for understanding the differences in irrigation performance. Add to this the degree to which there exists a commitment to contribute resources for O&M and a sense of fairness derived from the water allocation rules, and the result is a model that can explain performance in providing O&M.

Providing assurance

In the operation and maintenance of irrigation projects, there is both an assurance problem and a question of commitment both for farmers and government officials. First, individuals need to have information and assurance concerning the actions of others. Second, the individuals need to make some level of commitment for the provisions of O&M. The lack of either information and assurance or commitment usually means inadequate O&M.

Thus, one should not be surprised to find the three general characteristics of the assurance problem present in irrigation O&M:

1) the larger the group of farmers involved in the irrigation project, the greater the O&M (assurance) problem;

2) the more heterogenous the group served by an irrigation system, the greater the O&M (assurance) problem, and

3) the larger and more heterogenous the group irrigated, the greater the incentive to redefine the group into small homogeneous groups in which O&M (assurance) is more readily achieved.

Two additional characteristics of O&M are suggested by the assurance problem:

4) the lower the amount of user group participation in system management, the greater the O&M (assurance) problem. This is because participation increases commitment and provides information concerning what others are contributing, and

5) communities can learn over time about the benefits from providing public goods and the costs of not contributing one's share. "It is thus possible to explain the evolution of institutions that provide public goods in terms of prior information and sample information regarding group behavior." (Runge, 1984 p. 170)

Renfro and Sparling, 1986, found that, the more collective projects in a village, the more likely the villagers were to cooperate in

irrigation O&M. Farmers appear to have learned about the costs and benefits from cooperative action as well as how to promote collective action.

Various incentives and institutional arrangements can be used to help provide this assurance. Establishing water rights either in terms of quantity or timing or both, provides information concerning the likely actions of others. Rules concerning the allocation of water among farmers conveys information and assurance. As systems become larger and more impersonal formal penalties must be imposed to obtain the desired behavior. Even police forces may be necessary in some large heterogeneous irrigation systems to assure compliance with rules and to enforce fee collections. The other option is to subdivide large systems and allow more local decision making concerning O&M.

Coward, 1986, suggests an interesting alternative which appears to establish assurances concerning the actions of other water users and commits or obligates farmers to "their" irrigation project. He basically argues that if farmers make a major contribution to the construction of an irrigation project, they will retain a commitment to operate and maintain the project. This is partly because they have established a property right and partly because they have information about the commitment of other users to the project.

When government gives farmers the irrigation service, this appears to relieve the water users of any responsibility for the system. In contrast, when farmers create the system, it is theirs and they are committed to it. There are alternative ways of achieving such a commitment or obligation, but Coward's idea of creating irrigation

property to which farmers are committed is an important concept. One must be careful that government investment does not create negative incentives concerning farmer commitment to an irrigation project. How many times have we heard farmers say this is the government's irrigation project and they should operate and maintain it?

In evaluating a country's O&M, one needs to determine if institutional and organization arrangements provide the necessary assurances to elicit the desired behavior. One characteristic to look for is whether or not there are institutions which encourage or require water users to contribute to O&M. Another important characteristic is the community's commitment to the irrigation project. Finally, do water users feel that others, including the government, are contributing their fair share?

Model for Evaluating Performance

The model for evaluating O&M in irrigation projects includes four components: (1) internal assurances; (2) external assurances; (3) commitment and (4) fairness. The first component is a measure of the degree to which irrigators feel confident that other irrigators will contribute their agreed upon share to O&M. External assurance is concerned with how much confidence irrigators have that government officials and water managers will adequately perform their duties. Will they deliver the water when the farmers need it and will they help with maintenance?

The third component is based on the idea that obligations or

commitments[6] are required to maintain a group which provides collective or public goods (Hechter, 1987). Coward suggests that construction or investing in a project establishes such commitments. Farmer participation in project planning and design also appears to foster commitment. In contrast, government constructed projects that do not involve farmers until it is time to collect water fees will not find farmers committed to the project.

The final component relates to the degree to which irrigators feel that the system is "fairly" operated and maintained. The definition of fairness will likely have to vary somewhat across projects and must include what irrigators feel is fair; not what outside individuals think is fair. For many countries, fairness appears to mean some type of rule concerning uniform water delivery, which is generally not physically possible to implement. Since fairness varies across projects, it was difficult to measure in a macro level study such as this one.

Performance Indicators

For external assurance, there are a number of possible indicators of performance. Those that are used in this study include:

(1) assurance that water fees will be used for O&M on the water users project;

(2) penalties for inadequate water management including maintenance;

(3) good communication and information flow among farmers and irrigation officials;

(4) clear division of responsibility for O&M;

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[6]This could be thought of as developing a collective ethic as compared to pure self interest, although the individual benefits from collective action and loses if no collective action occurs.

(5) dependable water delivery, both in terms of timing and quantity, and

(6) high levels of farmer participation in project management.

The sixth indicator is also a good measure of internal assurance and commitment, since high levels of farmer participation generally mean that farmers are committed to cooperating in the provision of O&M. The first indicator would be a good measure of fairness, since it would provide a closer link between those who receive the benefits and those who pay the costs. Indicators which emphasize the control aspects of internal assurance include:

(1) penalties for non-payment of water fees;

(2) financial incentives for high levels of water fee collections;

(3) high priority given to water fee collection, and

(4) high levels of water fee collections and of farmer contributions to O&M.

Commitment is difficult to measure and overlaps with assurance. Clearly, commitment could be measured by water user participation and the level of fee collections. The three indicators of commitment employed in this study, which are used to measure government rather than farmer commitment, include:

(1) government priority given to efficient water use;

(2) government priority given to project maintenance, and

(3) adequacy of government resources for O&M.

The measures of fairness are not as extensive as those regarding assurance. However, one can get an idea of the country's concern for fairness by considering the rules used for water management. Possible indicators of fairness include:

(1) rules governing the levels of water rates that indicate a strong concern for farmers' capacity to pay,[7] and

(2) rules allowing for non-payment of fees if a natural disaster occurs.

Several other important performance indicators, that are best suited for measuring individual project level performance compared to objectives, were not used in this macro analysis. These include: (1) the community of irrigators past record in providing collective goods; (2) water allocation rules that try to give all irrigators equal opportunity to receive adequate water supplies;[8] (3) adequacy of project design and construction; (4) reliability of water deliveries relative to prior expectations of users; (5) the status of water rights for farmers in the project and (6) project productivity and sustainability in terms of output relative to water availability over time. Output measures should include both crop production and area effectively irrigated over time. Most of these six indicators focus on the problem of providing assurance, both internal and external. The first indicator is somewhat of an exception, in that it would be a good measure of both internal assurance and the commitment that exists in an irrigation community. The second indicator is another exception, since it is a measure of fairness and equal treatment of users. Indicators three and four also have

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[7]This suggests a strong correlation between benefits received and costs paid by individual farmers. It also assumes that project benefits received are directly related to ability to pay.

[8]This measure could be broadened to indicate either fair or unfair rules for allocating water. For example, what biases exist in the water allocation rules, and who do they benefit? An unbiased set of rules would be those that would be selected if one did not know where in the system they would be located, i.e., rules selected under a "veil of ignorance" (Rawles, 1971).

implications for fairness, since they both can help prevent a few well-placed farmers from capturing most of the irrigation benefits.

Finally, a set of indicators could be developed to measure the uncertainty involved in the rules for water allocation. For example, are the rules well established and equitably monitored and enforced? Is there general understanding and agreement amongst users concerning the rules and their implementation? Do the users generally obey the rules?

Country Experience

The countries selected for evaluation presented a wide range of experience. They ranged from Nepal and Sri Lanka, with a rather poor record of O&M, to the Philippines and Maharashtra State in India, which have shown signs of providing improved levels of O&M. In the case of Nepal, the poor performance of government irrigation systems may well go beyond the organizational and institutional questions raised in this model. The basic question in Nepal may be the lack of technical and financial resources. In contrast, farmer developed and managed systems, which provide more than 70 percent of Nepal's irrigated area, appear to have a much better record of performance.

External Assurance

What have the four countries done to resolve any of the external assurance questions? In general of the four countries considered, the government of Nepal showed the least progress towards addressing O&M problems (see table 1). One exception to this was the Irrigation Management Project (IMP) which was initiated in 1985 with the assistance

of USAID (Kadi et al., 1989). The project had three objectives: (1) implement systematic operation and maintenance procedures; (2) facilitate the organization of water user groups and (3), initiate, monitoring, evaluation and feedback procedures (Kadi et al., 1989, p. 5). In the midterm review of the program, the only real accomplishments related to the second objective. Water user groups had been established in two field sites, but little had been achieved concerning systematic O&M or monitoring and evaluation procedures. The Philippines model was used to establish the water user groups and appeared to be as effective as it has been in the Philippines. Sri Lanka also employed the Philippines model in its efforts to increase farmer participation and improve O&M.

Another strategy tried by Sri Lanka was to establish special O&M accounts for each major irrigation project and have the farmers' irrigation fees deposited in "their" project's account. Farmers then were to be represented on the committees which were to decide how these funds would be used. Thus, the more fees contributed, the more funds that would be available for operating and maintaining "their" system. Unfortunately, this policy was not fully implemented and the fees collected ended up in general revenues rather than the special accounts.

The lack of information was a particular problem in both Nepal and Sri Lanka (Shrestha, 1985). Their inadequate information system was a constraint to efforts to provide more resource for O&M. For example, in Sri Lanka, collection of O&M fees was based on a specific register for each irrigation system prepared under the supervision of the Government Agent for the district. The register was supposed to give the name of the legal allottee and tenant cultivators, the extent of their paddy holdings

in the scheme and their location. Yet, the register was out of date and failed to identify accurately those who received water and did not include any land on which illegal irrigation and cropping had occurred (Engineering Consultants, 1985).

The Philippines used a slightly different approach than Sri Lanka to provide a link between fees and funds for O&M. The government decided to turn over more management responsibility and even ownership of irrigation systems to water user organizations (WUO). This, in general, improved irrigation performance of the smaller and more homogenous irrigation projects (De los Reyes and Jopillo, 1986). Where well organized WUO existed, they took control of water deliveries and internalized this important management activity. They removed one element of uncertainty from water allocation, that is, the National Irrigation Agency (NIA). This changed the external assurance problem to an internal one. As part of the agreement, the WUO was required to maintain and operate the system with resources provided by their members. The control over water allocation provided them enough benefits so that they generally agreed to take over systems from NIA and even paid capital costs. In cases where the irrigation systems were in poor condition, irrigators have refused to take control unless the system was first rehabilitated.

Hunt, 1985, points out the importance of farmer water control as an incentive for system O&M. He argues that unless the farmers can derive some benefits from operating the system, they will leave it to government. Control over water allocation can provide such benefits.

The 1976 Philippine water code is a good example of another serious attempt to improve both external and internal assurances concerning water

supplies. But because of already existing water rights and the lack of information, the effectiveness of the law varies widely across irrigation systems. In those systems where the new code was effective, it helped improve operational efficiency by providing greater assurances concerning the actions of others regarding use of water supplies.

The code gave control over water development to the Philippine government. The primary implementation tool was the issuance of water permits. No person, corporation or government agency could appropriate water without a water permit. The permittees were required to pay all fees and charges imposed by the government. They were also obligated to maintain water control and measuring devices, to keep records of water withdrawals and report water use information when requested by the government. Finally, water rights must not prejudice the rights of third parties (Cruz, et.al., 1987, p. 31).

> "The water permit ... provides the wet and dry season discharge rate (in liters per second), total area to be irrigated, location of diversion points along the source, and the approved structures to be installed," (Cruz, et. al., 1987, p. 50).

However, the process of issuing water permits was constrained by information problems. It has been difficult to estimate the water supply available for appropriation, which resulted in the over-appropriation of water and a delay in processing of applications for permits (Cruz, et.al., 1987, p. 74).

Maharashtra has taken a centralized approach to irrigation management. This poses a slightly different type of assurance problem. Here they attempted to use control and stiff penalties to deal with assurance problems. When compared to other Indian irrigation programs, the state has been fairly effective. They have covered 70 - 116 percent

of their O&M costs with fees collected from farmers. The irrigation department has been responsible for collecting water fees which gave them an incentive to provide a reasonably assured water supply. If farmers receive water when they need it, they are more willing to pay their water fees (Abel, 1977). The government also established clear responsibility for maintenance so that the irrigation agency and the farmers knew what they were expected to provide. Finally, both farmers and irrigation officials appeared to give high priority to efficient water allocation because of scarce water supplies.

Internal assurance

The percentage of farmers paying water fees varied widely across projects and among the four countries (table 1). But both the Philippines and Maharashtra had a much better record of farmers paying their water fees than did the other two countries. In Maharashtra, Pawar, 1985, found collection levels of between 58-67 percent of assessments, even with relatively high water fees. They gave a high priority to collecting the fees, which were supposed to cover O&M costs plus provide a 1 percent return to the government for the depreciation costs of irrigation capital.

Water charges in Maharashtra were varied by crop and season. The 1983-84 water fees for surface irrigation ranged from Rs 50 ($3.33) per ha for kharif (wet) season crops to Rs 750 ($50) per ha for sugarcane and plantation crops.[9] Other fees included Rs 75 ($5) per ha for rabi (dry) season crops and Rs 150 ($10) per ha for many hot season crops. For the hot season's cotton and groundnut crops, the fees were Rs 200 and 400

[9]The banknote rate, November 1984, was 15 rupees per U.S. dollar.

($13.33 and $26.67) per ha (Pawar, 1985, p. 18). Thus, charges were varied by crop and season, based mainly upon crop water requirements, the amount of rainfall likely to occur during the season and the average gross crop income.

Although Maharashtra has done better than the other areas studied, it has not yet reached its objective of covering O&M costs plus depreciation. Part of the reason for this shortfall was that the government sets water fees for a 10 year period. The 1983-84 fees were the same as those for 1975-76 for all surface water irrigation systems. With the real value of fees dropping, total collections have not kept up with O&M.

Penalties and sanction have been a regular part of the system of collecting water fees in Maharashtra. If water charges were not paid by the due date, an extra penalty of 10 percent of the amount due was added to the charges. Sanction could also be imposed, such as rejection of a farmer's application for irrigation water. As a final resort, the government could use coercive measures provided for under the Maharashtra Land Revenue Code. The delinquent payments were added to the land tax and collected along with the regular land revenue by revenue authorities (Pawar, 1985).

The Philippines was the only country in the study which used direct positive incentives to obtain payments from a higher percent of farmers. Where water user associations were deputized to collect fees from members, they usually received offers of a graduated bonus for achieving certain collection efficiencies.

> "If collection efficiency (on current account) is 100%, the association is given 5% of the total collected fees; 4% if

> collection efficiency is 90%; 3% if collection efficiency is 80%, and 2% if 70% efficiency. The deputized associations are also given as much as 25% of all back accounts collected," (Cabanilla, 1985, p. 37).

The Philippine Government also imposed penalties for non-payment of water fees, particularly for tubewell irrigation. In fact, the government shut down a number of wells because farmers were unable or unwilling to pay operating costs. In contrast, the cut-off rule or legal sanctions were not enforced in gravity-fed surface systems. Water control was not adequate to allow enforcement of the shut-off rule for a few farmers on a canal. Legal sanctions were also difficult to enforce because many delinquent farmers were economically powerful (Cabanilla, 1985).

The National Irrigation Agency's (NIA) program to improve water fee collections was based on the policy that, "NIA should charge fees that are just sufficient to defray cost of operating and maintaining the systems, plus repaying the construction costs within 50 years without interest. Thus, pump systems which entail higher O&M costs charge higher fees," (Cabanilla, 1985, p. 21 and 24). However, the irrigation fees and equipment rental fees covered only 37 to 53 percent of NIA's budget during 1978-83 (Cabanilla, 1985). In 1983, about 62 percent of the assessed fees were collected, which amounted to 75 percent of NIA's total costs of O&M (Small, et al., 1986, p. ix).

To help increase and stabilize collections over time, NIA tied water fees to a given quantity of rice. Thus, as the support price of rice was increased, water fees were also raised. However, the price of rice did not keep pace with inflation and water fees have declined in real terms since 1976. The real value of irrigation fees for wet season gravity

systems dropped from 120 pesos ($6.15) per ha in 1976, to only 80 pesos ($4.10) per ha in 1984.[10]

Four general water fee levels were used in Philippine government projects providing water for rice irrigation. There were rates for wet and dry season irrigation and for pump and surface (gravity) irrigation. For gravity systems irrigating rice, water fees were 50 percent higher in the dry season than in the wet season. In gravity systems serving other annual crops such as sugar cane and banana, the fees were 60 percent higher than for dry season rice. Almost all payments were made in cash and were collected twice a year, once after each season (Cabanilla, 1985). In communal systems entirely under farmer control, farmer-members could elected to pay their irrigation fees in terms of labor for cleaning canals or in cash.

In general, Cabanilla found that the small and medium-sized irrigation systems had higher collection efficiency than those with service areas of 5,000 ha and above, and new systems or newly rehabilitated system had higher collection efficiency than old unrehabilitated systems. A larger percentage of small-scale farmers and upstream farmers paid their water fees than did large-scale farmers and mid-stream or tail-reach farmers. The collection efficiency for the sample projects ranged from 27 percent in one pump project to 100 percent in a communal gravity flow irrigation system.

In Sri Lanka, the government's policy on water charges changed over time. Before 1970, the water charge was Rs 5 ($.19) per acre in most schemes, but in some schemes the rate was as low as half a rupee.[11] Even

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[10]The banknote rate, November 1984, was 19.5 pesos per U.S. dollar.

[11]The banknote rate, November 1984, was 26.5 rupees per U.S. dollar.

with these low rates, collections were less than 2 percent. From 1970 to 1977, water fee collections of any form were virtually abandoned. During the early 1980s, new fees of Rs 30 ($1.13) per acre for cropping intensity over 150 percent and Rs 20 ($.75) per acre for intensity less than 150 percent were introduced for irrigated rice land. Again, collections were insignificant.

According to the new 1984 water policy, farmers in all major Sri Lankan irrigation systems were to pay the O&M costs of irrigation. In 1984, the first year of implementation, farmers were required to pay only 50 percent or Rs 100 ($3.77) of the estimated O&M cost, while the government was to match the farmers' contribution. The contribution by farmers for O&M was supposed to be progressively increased by 20 percent each year so that, at the end of the fifth year, the entire sum of Rs 200 ($7.55) per acre was to be paid by farmers.

Penalties for non-payment of water charges were also introduced in Sri Lanka's new program to increase water fee collections. The law was amended to allow action to be taken against non-paying farmers. If farmers did not pay, they could be prosecuted and fined. Prior to 1984, no penalties or sanctions were imposed on defaulting farmers. In addition, there were many farmers who used irrigation water illegally and were not subject to water charges or penalties. This, of course, added to the internal assurance problem.

The amount of assessments collected up to October 1984 were only above 2 percent in seven of the seventeen districts. Only two districts, with 22 percent and 53 percent respectively, had collection rates over 15 percent, while the average for all the districts was only 8 percent.

Although these collections were higher than the less than 2 percent level found before 1984, this is not enough of a change to suggest a significant improvement in program effectiveness.

In Nepal, there were generally no criteria for setting the level of water charges. They were usually fixed on a flat per acre basis by individual project boards or the Department of Irrigation, Hydrology and Meteorology, with approval by the Ministry of Finance. Thus, the water charge for the Narayani, Kankai and Morang-Sunsari projects was Rs 100 ($5.56) per ha per crop, while it was Rs 60 ($3.33) in the Jhanj, Manusmara, Chitwan and Patharaiya projects.[12] Pump irrigation projects tended to have charges based on hours and cost of pumping. In the Farm Irrigation and Water Utilization Division (FIWUD) managed ground water irrigation projects, the charge was Rs 16 ($.89) per hour (Shrestha, et al., 1985).

The percent of O&M costs covered by water fees collected in the sample projects ranged from less than 1 percent in the Kankai and Manusmara projects to almost 19 percent in the Jhanjh project. Among these projects, the medium-sized projects covered a higher proportion of O&M costs than did the large projects (Shrestha, et al., 1985). Small, et al., 1986, found average collections of about 20 percent, which were only about 10 percent of O&M costs. In contrast, they found annual farmer contributions to some farmer owned systems to be as high as Rs 750 ($41.67) to Rs 1000 ($55.56) per ha.

Government collections of established fees were particularly low during the wet season. Many farmers seemed willing to pay for dry season

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[12]The banknote rate, November 1984, was 18 rupees per U.S. dollar.

irrigation but not for wet season irrigation. They argued that, in the wet season, they had traditionally (before government irrigation) grown a rice crop without any problems. Nevertheless, many farmers in Nepal provided free labor to repair and maintain "their" irrigation systems when they had tertiary canals. Where tertiary canals existed, farmers had usually built them and they were willing to maintain them. In a sample of three large projects, 42% to 95% of the farmers reported their willingness to provide free labor for small repair works, provided that the irrigation project assured timely supplies of water (Shrestha, et. al., 1985, p. 46).

In Nepal, their cut-off rule for gravity-fed surface irrigation also could not be enforced, while for tubewell irrigation, enforcement was not clear. According to Shrestha, et al., (1985), "In tubewell irrigation...the supply can be stopped for non-payment cases" (p. 29). However, in the farmer survey none of the farmers reported any penalty for non-payment of water charges or having ever been approached by project officials to help in project repair or maintenance (Shrestha, et al., 1985).

Commitment

As Abel, 1977, pointed out, commitment by governments to the idea that water is a scarce factor of production which must be used efficiently is essential for effective water management. In three of the four case studies, commitment at the government level was improving as Sri Lanka, the Philippines and Maharashtra all recognized water as a scarce resource and gave efficient water use a high priority (see table 2). They also appeared to be moving towards giving maintenance a high priority, although

the commitment is less certain for Sri Lanka. The current record in this regard needs to be checked against actual performance. Only Maharasthra was close to providing enough resources for O&M.

In Maharashtra, due to the relative scarcity of water, irrigation development has had a high priority since independence. Even improved water use was given high priority during the 1970s. This does not mean that operations and maintenance expenditures have matched requirements. Still, expenditures for O&M in a sample of major and medium irrigation systems were Rs 261 ($17.40) and 210 ($14) per ha, respectively (Pawar, 1985).

In Sri Lanka, the government gave irrigation and water use efficiency high priority and recognized some of the organizational problems (Engineering Consultants, 1985). The important question is whether or not the new policy thrust will ever be fully implemented and the organization problems resolved, given the current political problems that plague the country.

Nepal did not give efficient water use or O&M a high priority. New projects have strained the country's ability to operate and maintain existing projects. The best staff go to new projects while inadequate and poorly trained staff perform O&M on existing projects. "The targets for irrigation development have increased over the years, resulting in a steady decrease in the budgetary allocation for regular and recurrent expenditures" (Shrestha, et. al., 1985, p. 38). This acts as a serious constraint on efforts to improve implementation of irrigation projects and perpetuates a vicious circle. Irrigation services remain poor, resources

for O&M are limited and farmers do not pay water fees (Easter and Welsch, 1986).

In contrast, the National Irrigation Administration (NIA) in the Philippines shifted its program emphasis to O&M away from new construction. It made progress by focusing increased efforts on organizing and training farmers to do more O&M. Yet Cabanilla, 1985, points to the need to shift budget priorities within O&M. "The bulk of O&M expenditures of NIA have been on salaries and wages of personnel, most of whom are not directly involved in O&M (Cabanilla, 1985, p. 45-46). Still, the high priority given to efficient water use and the shift in emphasis to O&M were important first steps in improving O&M.

Fairness

The Philippines has shown some concern for fairness in its general guidelines for setting water fees. First, fees should be within the farmer's capacity to pay and second, they should not impair the incentive to use water. In fact, capacity to pay was emphasized more in setting the water fees than the O&M cost.

Maharashtra had similar provisions prescribed for determining water fees. The water charge for a crop should be related to the ability to pay from crop returns and it should not be set at a level which would leave any of the irrigation potential unutilized. In contrast, questions of fairness concerning water fee levels will be less important in Nepal and Sri Lanka until they significantly raised their levels of collection.

Yet, the uniform rate charged for O&M across all government irrigation projects in Sri Lanka shows concern for fairness. Even though

O&M costs were not uniform within or among projects, it was felt that rates based on actual costs would be unfair. Since independence, the government has always tended to provide assistance programs on a uniform basis (Shrestha, Tek-Behaduer, et.al, 1985).

Even with higher collections, farmers' ability to pay should not be a constraint. Small et al., (1986) found in a study of five Asian countries that O&M costs could be covered with a range of 5 to 33 percent of net irrigation benefits to farmers. For Nepal, it would take only 5 percent of net benefits to cover O&M costs, while in the Philippines it would require 10 percent. In Maharashtra, the water fees for surface irrigation on food and non-cash crops were set roughly equal to 6 percent of the average yearly gross income from these crops. In the case of cash crops, the charge was set at about 12 percent of the average gross income (Pawar, 1985, p. 17).

In all four countries, farmers appeared to get water fees waived if a natural disaster or lack of irrigation water caused crop failure. However, it was not clear how these rules were applied and if certain farmers or groups of farmers received special treatment.

Conclusion

What can be concluded concerning irrigation and the assurance problem? First, farmers are guided in their decisions concerning O&M by the profit motive, by the stability of expectation (assurance) concerning the contributions of others and the degree of fairness they perceive in the system. Second, the assurance problem, if modified to include the

concern for fairness and commitment, provides an improved explanation of farmer behavior regarding provision of O&M for irrigation projects.

There are a number of ways to provide improved external assurance. The most important is the delivery of a dependable water supply. The other five means of providing external assurance include greater farmer participation, good communication, penalties for poor water management, clear responsibility for O&M and water fees spent in the irrigated areas where they were collected. All five will help improve water delivery. External assurance involves building trust between farmers and the water managers based on good service.

Providing internal assurance can be just as complicated as supplying external assurance, particularly in large irrigation systems. Penalties and other incentives can be used to encourage farmers to pay water fees and contribute to O&M. However, implementing the institutional and organizational arrangements required to establish the incentives and impose the penalties is difficult. Experience in providing collective goods appears to lower the transaction cost involved in obtaining farmer participation in O&M. It may also provide information concerning the benefits of collective goods and costs of "free riding". Internal assurance comes from knowing that other water users will contribute towards O&M.

If farmers participate directly in system planning and management, it will provide both internal and external assurance. The possibilities for participation range all the way from outright construction by farmers as suggested by Coward, 1986, to regular meetings between irrigation officials and farmers to decide on water delivery schedules and

maintenance. The important step is to get farmers to make a commitment to the irrigation project and provide them assurances concerning how it will be managed. If they feel it is only the governments' system, all the well known problems of inadequate O&M are likely to occur.

Finally, some shared notation of fairness within the community of irrigators will influence their contributions to O&M. Rules governing the level of water fees and the allocations of water are two places where a degree of fairness can be introduced into an irrigation system. As one might expect, in those systems that have homogeneous and evenly distributed land resources (small variance in farm size), it is much easier to provide a "fair" system of water fees and allocation rules.

A number of important research questions are suggested by the assurance approach. For example, how is assurance and fairness provided in well operated irrigation systems? Are there cases where the contributions towards O&M result in such high returns that the problems of fairness and assurance are of minor concern? Alternatively, is tight government control a substitute for institutional arrangements that provide fairness and assurance in the operation of an irrigation system? If government control is a substitute, what has been the cost, including transaction costs, of providing such control, compared to the cost of providing assurance? Very likely, the cost of government control increases with the size of the irrigation system. However, this might be offset by economies to scale in the control and policing of irrigation systems. Finally, does external assurance need to extend all the way up to government policies concerning agricultural commodity prices and trade policy?

TABLE 1. INDICATORS OF COUNTRY PERFORMANCE IN PROVIDING ASSURANCE IN IRRIGATION MANAGEMENT, 1984

Indicator	Country: Nepal	Sri Lanka	Philippines	Maharashtra (India)
External Assurance				
1. Link between fees and funds allocated for O&M.	No	Tried in 1984-85	In communal projects	No
2. Penalties on those not maintaining the project.	No	No	In communal projects	Some
3. Encourage high farmer participation.	Pilot Project 1985	Yes	Starting 1976	No
4. Good communication and information flow among farmers and irrigation officials.	No	No	With active WUO	Not clear
5. Dependable water deliveries.	No	No	Improving	Not clear
6. Clear responsibility for O&M.	No	No	Improving	Yes
Internal Assurance				
1. Portion of assessed water fees collected.	20%	8%	62%	58-67%
2. High priority given to fee collection.	No	Starting 1983-84	Yes	Yes
3. Penalties for non-payment of fees.	Not enforced	Starting 1984	Yes	Yes
4. Incentive for high rates of collection.	No	No	Yes	No

Source: Pawar, 1985; Shrestha, 1985; Cahanilla, 1985; ECL, 1985; Small et al., 1986.

TABLE 2. INDICATORS OF COUNTRY PERFORMANCE IN PROVIDING COMMITMENT AND FAIRNESS IN IRRIGATION MANAGEMENT, 1984

	Country			
Commitment	Nepal	Sri Lanka	Philippines	Maharashtra
Indicator				
1. High government priority for efficient water use.	No	Starting 1978-79	Yes	Yes
2. High government priority for maintenance.	No	Changing	Improving	Improving
3. Adequacy of government resources for O&M.	No	No	Improving	Close
Fairness				
1. Ability to pay important in setting water fees.	No	No	Yes	Yes
2. Fee payment waived during natural disasters.	Yes	Yes	Yes	Yes

Source: See Table 1

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