



International Programme for Technology and Research in Irrigation and Drainage

Issues Paper No. 2
June 1999

Realizing the value *of* irrigation system maintenance



Food
and
Agriculture
Organization
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United
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EXECUTIVE SUMMARY

The aim of this paper is to show that maintenance of irrigation schemes is economically more efficient than the cycle of system decline, underfunded restoration and early rehabilitation that often prevails in parts of the developing world. It is contended that good maintenance stabilizes projects, safeguards investment, sustains output and secures livelihoods. On the other hand, inadequate maintenance actually costs more over the design lifetime of a project and leads to production losses, unnecessarily absorbs scarce capital that might be used in other sectors of the economy, and requires the repayment of foreign currency loans. Insufficient attention to maintenance leads to adverse social and environmental effects, accentuates inequities in income and exacerbates problems such as waterlogging and soil salinity.

Many irrigation schemes have failed prematurely due to inadequate maintenance and a large part of the international investment in irrigation now goes to rehabilitating schemes which could have been performing at a higher efficiency for the want of a relatively modest investment in proper maintenance. This paper identifies issues that need to be addressed if the effectiveness of maintenance is to be improved.

The paper focuses on large government-run irrigation schemes typically found in the rice irrigation systems of Southeast Asia. Some of the issues, though, apply equally well to smaller schemes. In all cases there are many deficiencies in the way that maintenance is planned, funded and carried out. A *common-sense* approach for timely and properly funded maintenance is much needed.

Little information is available concerning the impact of maintenance on the economics of irrigation scheme performance. However, using the example of road and water supply projects, it is possible to show how maintenance can sustain the proper functioning of infrastructure. The benefits and costs arising from *satisfactory* and *poor* maintenance on two irrigation projects that had been rehabilitated under international funding are analysed. *Satisfactory* maintenance would have given a positive incremental net present value relative to poor maintenance, thus avoiding the need for early rehabilitation. The savings in expenditure on a medium-sized scheme of 20 000 ha could have, for example, provided safe drinking-water supplies for over 7 000 people.

The paper is the second in a series of issues papers for the International Programme for Technology and Research in Irrigation and Drainage (IPTRID). The series aims to promote debate on important issues related to the development and sustained operation of irrigated agriculture.

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Investment in irrigation

Irrigation provides some 40 percent of the world's food from only 17 percent of the global cropped area. It is estimated that 2 400 million people depend on irrigated agriculture for food and livelihood. The high level of investment by multilateral development banks and national governments indicates the importance attached to irrigation by funders. In the period 1980-90, the World Bank and the Asian Development Bank were together lending some US\$1 500 million annually for irrigation. Lending by the Banks supported national spending programmes. In the early 1980s, India was investing some US\$2 400 million in irrigation annually.

Although irrigated agriculture still receives a large amount of funding, expenditure over the last decade has fallen significantly due to the following factors:

- World food prices are close to historic lows, reinforcing a perception of food sufficiency which developed when global grain stocks stood at over 100 days supply, following the Green Revolution in the 1960s. Stocks are now declining, currently standing at 45 days supply.
- Donors now perceive the economics of irrigation development as less favourable than hitherto. The unit cost of development increased as the most suitable areas were exploited, while food prices were falling. Nonetheless, a review of 585 irrigation projects found that the average economic internal rate of return (EIRR) was 15 percent, substantially above the 10 percent opportunity cost of capital. Projects in the irrigated agriculture subsector generally perform as well as other types of investment (World Bank, 1994).
- Most investment is now for the rehabilitation of existing schemes. The per hectare cost of rehabilitation is considerably less than for a new project. When conventional economics writes off the cost of the original work, rehabilitation appears an attractive option.
- Competition for available water supplies among different users is growing. Many planners view irrigation as a low value, low efficiency and highly subsidized use of water.
- Environmental and social issues, involving actual or potential problems with resettlement, human health or land degradation, have delayed, modified or, in some cases, halted irrigation developments.

Though the rate of increase of the global population now seems to be slowing from the more pessimistic estimates, irrigation must play an increasingly important role in sustaining the world's food supply. FAO (1996) estimated that 60 percent of the extra food required must in future come from irrigation. It is therefore essential to continue to invest in irrigation, and to safeguard existing investments. According to Carruthers (1996):

“Most irrigable areas are already developed and therefore an improvement in the maintenance of the existing infrastructure will inevitably be an important component of any future irrigation development strategy.”

In the face of increasing competition from other water users, irrigated agriculture must make better use of a diminishing resource. In common with programmes to reduce leakage from potable water supply networks, effective and timely maintenance on irrigation schemes can improve the efficiency of water distribution and help to manage demand.

Neglect of maintenance – consequences

Many irrigation systems constructed within recent decades are failing within their design lifetime. About two-thirds of recent international lending has been for systems which have suffered premature technical failure. Many millions of dollars invested in the original infrastructure are being written off and anticipated returns have not been achieved because maintenance is inadequate (Skutsch, 1998).

Jones (1995), summarizing the World Bank's experience in irrigation, concluded that operations and maintenance procedures were unsatisfactory in 55 percent of completed projects:

“... O&M¹ problems can be seen in the Bank's financing of so many rehabilitation projects. Almost all of them, when scrutinized, turn out to be deferred maintenance projects ...”.

Benefits to people in irrigated areas

Country	Actual spending US\$/ha	Recommended US\$/ha	Year	Source
India (average)	4-8 (O&M)	10-17	1992	Jurriens & Jain (1993)
Some Indian states				
Bihar	3.3	N/A	1991	Jurriens & Jain (1993)
Haryana	2.6	N/A	1991	as above
Madhya Pradesh	3.0	N/A	1991	as above
Punjab	1.4	N/A	1991	as above
Uttar Pradesh	4.2	N/A	1991	as above
Pakistan	2.7	5.7	1993	World Bank (1994)
Indonesia	5-13	18-28	1991	Gerards (1991)
Sri Lanka	8	28-38	1993	Geijer <i>et al.</i> (1995)
Mexico	18-26	18-26	1993	Johnson (1993)

Note: Budgets generally include sums for operation, maintenance and a large component for establishment costs. The figures above, unless otherwise stated, are for expenditures on maintenance work, excluding operations and establishment costs.

The variations among countries and regions in the table above reflect differences in the costs of living and also the extent to which mechanization is used. For example, excavators and draglines are used for canal maintenance in Mexico, whereas much of the maintenance in South and Southeast Asia is carried out by hand. The figures for *recommended* expenditure reflect engineering judgements as to the spending needed to keep a system in good operating condition.

¹ Operation and maintenance.

Such judgements are necessarily subjective, but the table generally shows a consistent trend to underspend on irrigation maintenance. McLaughlin (1988) suggests that the target levels are not excessive.

“... With no exceptions to this writer’s knowledge, historical efforts to estimate the funding needs for adequate O&M have chronically underestimated such full funding requirements ...”.

It would seem economically efficient to fund only that maintenance necessary to ensure that the system design lifetime is achieved, but the information required to select a level of spending which permits *managed decline* is not available. Some argue that a high level of maintenance leads to postponement of the date at which a system should really be modernized.² It is contended here that, if major changes to the system design appear necessary after as little as 15 years, then the original design brief was inadequate. Such issues are not further considered here except to note that, in a context where maintenance practices are poor, the implication that underfunding should be accepted, with the objective of undertaking early modernization, appears to send the wrong signals to maintenance agencies. To endorse prevailing cycles of *build-neglect-rebuild*, and to institutionalize unplanned obsolescence, would seem to conflict with the concept of sustainability.

Consequences of neglect – examples of roads and other infrastructure

The World Bank (1994) concluded that US\$4 500 million of investment in roads in the developing world had been lost over the preceding 20 years. The money could otherwise have been used to provide, say, 300 million people with a safe supply of drinking-water. In a study of the performance of 121 completed water supply projects, the World Bank concluded that supplies were well maintained on those projects where there had been a high degree of commitment and participation by beneficiaries.

The problems are not just confined to the developing world. In 1996/97, the Government of the United Kingdom slashed its spending on road maintenance, which had already been reduced to a level at which pavements were showing rapidly increased wear and tear. Road engineers estimated that the consequent future reconstruction works would cost three times the immediate savings.

Schemes in arid and semi-arid areas, where crops are entirely dependent on irrigation under managed rotations, are particularly at risk from poor maintenance. In the humid tropics, schemes growing paddy rice under continuous irrigation, supplementary to substantial monsoon rainfall, are inherently less sensitive to maintenance defects (World Bank, 1996).

Conventional economics, using a high discount rate for future costs and benefits, fails to show the importance of maintenance in sustaining the life of a system and the livelihoods of farmers. Capital, often readily available from international sources, is taken as the scarce resource, whereas in practice it is the recurrent funding from local sources that is scarce. Tiffen (1987) points out that since costs and benefits occurring in the future are highly discounted, little benefit is

² Physically updated while management and institutions are improved to meet upgraded objectives, rather than rehabilitated to original standards.

apparently to be derived from extending the life of a new project beyond 10-15 years. The result of this thinking is that a project with a low initial cost, which deteriorates quickly and is dependent for continued survival on timely and properly funded maintenance, is preferred to one that is constructed to need less maintenance, because it appears cheaper. Yet for a farmer, and also for a nation, it is important that a scheme endures. Tiffen concludes that overall economic criteria should be supplemented by calculations of the costs and benefits to farmers, and to project administration, to ensure that the costs of O&M can be covered.

The World Bank has frequently expressed concern that projects may not be sustained, and that governments must face increased recurrent costs. Yet Price (1993) comments: "... the idea of sustainability, by giving absolute importance to future generations, is the ideological opposite of discounting ...". Others – Finney (1997) and Carruthers (1996) – have made efforts to modify conventional analysis to overcome the economic bias against sustainable development but, in the absence of consensus, economic justification for projects continues to follow existing methods.

Carruthers and Morrison (1994) summarized the effects of poor O&M on project performance, as follows:

- systems work below capacity, erratic water supplies reduce the cultivated area and depress yield;
- farmers shift to lower value crops, to reduce risk, limiting the use of inputs and reducing investment.

There are also longer-term consequences:

- premature rehabilitation results in a major loss of production while systems are shut down for several cropping seasons;
- international loans for rehabilitation need to be repaid in scarce foreign currency earned from exports;
- local funds for rehabilitation are not available to other sectors of the economy, so important programmes are postponed;
- loss of productive capacity may require food imports, which must be paid for in foreign currencies.

The resulting cycles of *build-neglect-rebuild* have had serious social and financial implications for farmers. Those in the more favoured parts of the system may continue to receive an adequate water supply, while those at the tail-end can face ruin. Poor maintenance thus directly aggravates existing inequities within the farming community. It initiates a vicious circle of decline: reduced water supply; lost output; farmers' anger, despair and reduced investment; reduced water fee collections; vandalism and conflict. Smallholder farmers operate on a narrow margin between relative success and failure. Land is often mortgaged against the following harvest to pay for the cost of agricultural inputs. A single disastrous cropping season can mean the loss of a farmer's land and enforced migration to the cities to seek work.

Poor maintenance can also produce adverse consequences for the environment, such as waterlogging and salinity resulting from impeded drainage, and for health, through the increased incidence of water-related diseases associated with blocked channels and stagnant waters.

Considering that farmers are the principal victims of poor maintenance, it may seem illogical that they commonly withhold payments for O&M, thus aggravating the problem of underfunding. However, in many countries farmers' experience over many years is that governments have implicitly accepted declining O&M payments, and that sometimes politicians have actively courted support by promising reduced fees. The O&M system is now widely seen as entirely the responsibility of government, a public good. The stark fact that, in the current financial climate, developing country governments are no longer able to shoulder the responsibility unaided has yet to be appreciated.

There are a number of reasons why system maintenance has been widely underfunded by governments:

- Maintenance has a low priority. The physical effects of underfunding do not appear for several years beyond the horizon of financial planners and the economic implications are not understood. Functional failures are not dramatic and publicized. Irrigation system staff can operate canals for a while by infringing on freeboard³ and cropping systems show some resilience. So projects may appear to function adequately for a time, even though they are deteriorating and action to stem decline is therefore postponed.
- Irrigation departments must justify their budgets to the finance ministry, which views maintenance as a net drain on national resources. The returns from water fees – commonly collected by the revenue department and remitted direct to central government – fall far short of the costs, owing to inflation and poor rates of collection. More profitable areas of the economy invariably take precedence in the competition for scarce resources. The sum ultimately allocated for O&M is unrelated to the amount collected in water fees. There are thus no incentives for an agency to improve its performance which is, in the absence of adequate monitoring arrangements, effectively unquantifiable.
- The international lending agencies are reluctant to fund recurrent costs owing to concern about lack of accountability, and a belief that support for O&M will merely postpone the time when nations must assume responsibility for their own projects.

For example in India, underfunding of O&M costs has led to a situation where some US\$2 300/ha (1988/89 prices) is spent on the development of irrigation facilities, whereas existing irrigation potential is underutilized for the lack of US\$20/ha for maintenance (Gulati, Svendsen and Choudhary, 1995). Without funds to meet this small recurring cost the productivity of the entire system which has been built up at enormous cost, will fall to abysmally low levels.

³ The volume of the canal above the normal operating level and the top of the embankments.

Shortage of funds is one reason for inadequate maintenance, but it is very far from being the only cause. The difficulties are compounded by other problems:

- Maintenance suffers by being grouped with Operations within the O&M budget. Available money is generally allocated in the following order: support of an overstaffed establishment, operations (such as the cost of power for pumping), and then maintenance.
- Available funds are not necessarily targeted to areas of greatest need, since there is no formal prioritizing of work. Regional offices probably allocate funds in proportion to the area served for want of better procedures.
- O&M offers poor rewards and prospects to engineering and technical staff who probably have been trained in design and construction. Staff are therefore often poorly motivated.
- New projects attracting soft international loans have a high profile for all concerned. No political capital is to be derived from maintaining existing systems.

The need for institutional changes in funding, organizing and managing maintenance is discussed later.

Returns to maintenance

Despite the fact that engineers have wide experience of system deterioration, in irrigation, as in other sectors such as roads and water supply/sanitation, there appear to be virtually no quantitative data linking the physical and economic performance of irrigation schemes with maintenance programmes. The World Bank (1994) estimated that the rates of return to satisfactory maintenance on projects in India could be as high as 40 percent, but no supporting analyses were presented.

A large number of technical, social, institutional and economic/financial variables may affect the performance of irrigation schemes. It is therefore not a simple task to tie scheme output to a particular variable, such as maintenance. Furthermore, the maintenance needs of different types of schemes are affected by a large number of factors. For example, paddy rice production under supplementary irrigation in humid areas is less sensitive to system condition (World Bank, 1996) than upland crops grown in more arid areas, where irrigation provides most of the crop water needs.

In response to the lack of knowledge, Skutsch (1998) set out to identify the economic returns to maintenance on two irrigated areas that had recently been rehabilitated under international funding. One project is located in a semi-arid region of South Asia; the other is in the humid tropics. Rehabilitation was undertaken as a response to falling output linked to inadequate maintenance. Detailed information on scheme maintenance spending prior to rehabilitation was not available, but good estimates were derived from government areal maintenance allocations. Crop output norms under medium farm inputs, costs, prices, and farm budgets in 1992 for each area were based on information from the project feasibility reports.

Analysis of returns to maintenance

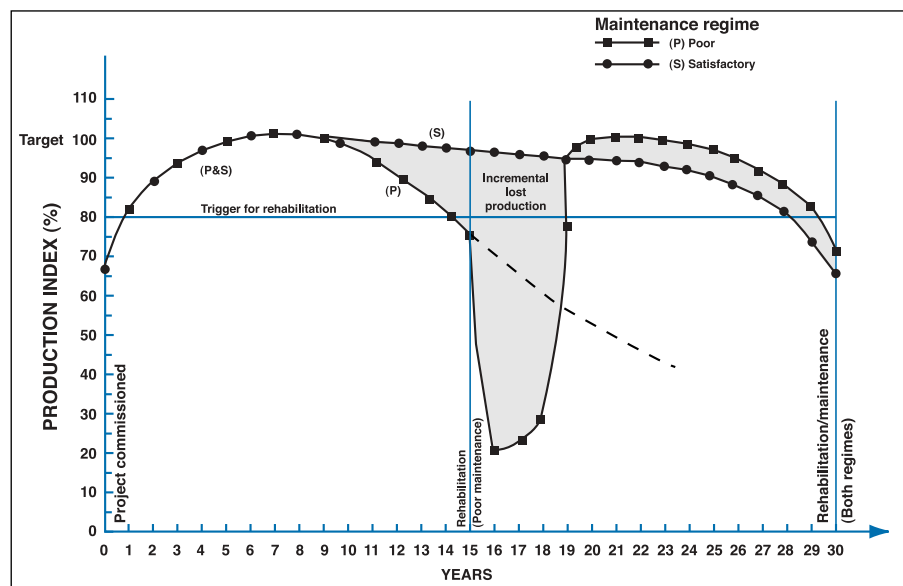
The costs and returns for two levels of maintenance, termed *poor* (P) and *satisfactory* (S) are calculated. *Poor* maintenance had led to premature rehabilitation of the projects. The costs of *satisfactory* maintenance – needed to sustain system operation for the design life of 30 years – were based on published recommendations specific to each country. High and low value-cropping patterns appropriate to each region were applied under both *poor* and *satisfactory* maintenance regimes, giving a total of eight cases. A *Production profile* was developed as a basis for comparing benefit streams. The *Production index* is a dimensionless measure of scheme-wide or average output relative to target output. There will, of course, be considerable differences in unit output across the area, particularly between the head and the tail of a scheme. Water shortages may either cause reduced yields in disadvantaged parts of the area or an absolute reduction in cropped area. *Poor* maintenance, which fails to maintain the conveyance capacity of a system, may lead to increased inequity and loss in productive area, particularly at the tail of a system. The extra water that is thus theoretically available at the head will only produce marginal returns, if any. The loss of production in the system, which is assumed in the comparison of maintenance regimes, is not targeted to a particular part of the system, but represents the average shortfall over the designated command area. The potential unit crop output was taken as constant over the period, on the implicit assumption that farmers did not change their practices. This simplification should not materially affect the comparison of output under the two maintenance regimes.

The output profiles in the Figure are based on judgements about the way in which projects behave. In the initial period after project commissioning, output will be

the same under the two maintenance regimes. It is assumed to take five years before the target output of the scheme is realized, as farmers gradually improve their practices. The assumption may be somewhat optimistic, but it does not affect the comparison between the two regimes. Overall, output trends are indicated by smooth transitions. In practice, annual output would fluctuate in response to seasonal conditions (climate, pests, diseases, market prices, etc.) but, again, the simplification will not affect the comparison.

Under *satisfactory* maintenance, output declines slightly from Year 10 onwards, but reasonable performance is sustained until Year 28, at which point rehabilitation or modernization would be required. *Poor* maintenance does not initially affect output, owing to reserve capacity in the system, but after Year 10 output declines rapidly as reserves are used until rehabilitation is triggered when output is 20 percent of the target, Year 13. Rehabilitation is assumed to start two years later. In practice, it is not unknown for projects to undergo rehabilitation even earlier.

Relative output over project life: two maintenance regimes



Again the assumption may be optimistic, but it results in a conservative estimate of the benefits stemming from satisfactory maintenance. During the three years assumed necessary for rehabilitating the system, a small output is maintained. Rehabilitation is particularly disruptive to farmers, who must seek water wherever available. Improved output is then sustained until Year 28, when rehabilitation would again be required.

The net benefits of *satisfactory* maintenance over *poor* maintenance are conservatively taken as the value of extra crop output, plus the cost savings from postponing rehabilitation. In fact, further unquantified benefits would include the use elsewhere in the economy of funds needed for rehabilitation; savings in foreign exchange repayments; plus intangible social and environmental benefits resulting from a sustained and more equitable supply.

To avoid the dominating effect on the cost streams of the initial construction cost, differential cost and benefits streams were calculated for each pair of *poor* and *satisfactory* maintenance cases at a discount rate of 10 percent. The incremental net

present value (NPV) attributable to good maintenance, that is the difference between the (benefit – cost) streams for the two maintenance cases, was derived from the production profiles, the unit costs and benefits.

In all cases, *satisfactory* maintenance showed a positive incremental NPV relative to *poor* maintenance, varying from US\$470/ha (low value crop) to US\$950/ha (high value crop). The equivalent annual incremental net benefits varied from US\$50 to US\$100/ha. To set the figures in context, the annual costs of satisfactory maintenance were US\$13.5 and US\$23/ha in the two cases, for *poor* maintenance the corresponding figures were US\$6 and US\$9/ha. The savings in expenditure on a medium-sized scheme of 20 000 ha under *satisfactory* maintenance would have been in the range US\$1.0-4.0 million, based on discounted per hectare cost advantages of nearly US\$50/ha (Scheme 2, humid area), and US\$200/ha (Scheme 1, semi-arid). The capital thus saved on the schemes might have been used, for example, to provide a supply of safe drinking-water to either 7 000 individuals (Scheme 2), or 25 000 individuals (Scheme 1). Sensitivity analyses showed that the findings were robust when tested against the simultaneous introduction of four discrete and adverse changes, namely:

- discount rate increased to 12 percent;
- crop prices reduced by 20 percent;
- maintenance costs increased by 20 percent; and
- rehabilitation delayed by two years.

No attempt was made to calculate "optimal" levels of annual maintenance because it was considered that there were insufficient data to draw robust conclusions. The chosen discount rate of 10 percent, as used by the World Bank, appears conservatively high for projects which must be sustained over many years in conditions where local funding is in short supply. In particular, low rates of growth in Africa over the last 30 years, and depressed agricultural prices, which do not truly reflect regional demand, may justify a lower discount rate.

The economic returns to sustained irrigation system performance are also illustrated by an earlier Wallingford study by Chancellor, Lawrence and Atkinson (1996). In this case, a vortex tube extractor was constructed at the head of an existing irrigation system in the Philippines to remove water-borne sediment. Under conventional maintenance procedures, sediment had been removed by dragline, but the annual budget was only sufficient to cover partial clearance of the accumulated material. The vortex tube succeeded in safeguarding supply to the irrigated area, which had decreased progressively over time under inadequate maintenance. The benefits assigned to the structure were taken as the net value of the output from the area that would otherwise have been lost to production. For the seven-year project life, the NPV was calculated at US\$1.5 million and EIRR at 61 percent.

Despite the use of relatively high discount rates and conservative estimates of expected benefits, both studies demonstrated that there is a high economic return to limited measures, which stem the decline of systems. *Poor* maintenance

causes loss of productive capacity, but also diverts scarce local resources from other sectors of the economy, sets back social progress and worsens existing inequities which, as Howsam and Carter (1996) suggest, limits sustainable growth.

Financing and organizing maintenance

In a changing economic climate, international lenders are increasingly exerting pressure on governments to reduce fiscal deficits. Resources to fund the activities of large, overstaffed irrigation departments have become increasingly scarce. In their turn, governments are applying pressure to their own departments to seek funds from other sources, principally farmers, to help finance operation and maintenance activities.

Farmers see system maintenance as the responsibility of governments. If farmers are required to allocate greater resources to maintenance, either in terms of increased payments or of increased responsibility (see *Turnover*, p. 15), they must see a clear incentive in better cash returns, reduced costs or improved control over water. Particularly on rice-growing schemes in monsoon climates, farmers may see little urgency in paying today to avoid increasing problems tomorrow, particularly if the government has traditionally stepped in to rehabilitate defective systems. Realistically, a set of clear and enforceable sanctions against non-contributors and transgressors is also needed. Sagardoy (1999, personal communication) has suggested ways in which governments could establish incentives for good maintenance and penalties for neglect:

- A regular review of individual scheme maintenance standards. Funds for improvements would be allocated only to schemes where maintenance is reasonably carried out.
- Stricter criteria for scheme selection for rehabilitation. If a limiting per hectare budget is established, based on schemes in better condition, those that have been allowed to deteriorate could only undertake work on the most important structures.
- Modernization projects would only be considered for those schemes with a good maintenance history.
- Farmers should be required to contribute an agreed number of maintenance days per year.

One way of creating an incentive for farmers to contribute their labour for maintenance could be to offer a rebate in water charge fees. A simple system of vouchers earned against workdays could be traded for a discount on fees.

Irrigation schemes suffer generic problems resulting from the neglect of maintenance, but the nature and scale of problems vary from scheme to scheme. An Indian Working Group on Major and Medium Irrigation programmes concluded that "... the system of setting O&M rates as a fixed rate per hectare without considering the nature and type of project is not rational...".

It is particularly important to be able to predict the expenditure required to keep a scheme functioning well. If the financial commitments are too heavy in relation to the benefits, farmers will be unwilling or unable to take over new responsibilities, so the scheme may disintegrate. In some areas of the world, small farmers who depend on growing rice for their livelihood may be barely able to survive, let alone increase their contributions to the upkeep of their system, in the face of recent steep

falls in international cereal prices. On Indian schemes during the first part of this century, the costs of operation and maintenance, and sometimes also part of the initial capital costs, were fully met from water charges. Gulati, Svendsen and Choudhury (1995) related the required water fees in India to gross revenue. Fees would need to be raised to 5-12 percent of farmers' income, depending on crop type, to meet the annual costs of O&M, assuming a high rate of collection could be achieved. Another problem was that the recovery ratio, the ratio of water charge receipts to working expenditure, had fallen from over 100 percent in 1960 to less than 50 percent by 1990. At the same time, the proportion of the collection spent on administration had increased substantially, from 35 percent to 48 percent in the case of one region, over the same period.

Other methods of increasing the funding for O&M have been proposed by Easter (1990):

- feed back the funds obtained from increased fees;
- turnover systems to farmers;
- maintenance by private or autonomous self-accounting agencies;
- lending agencies to provide financial support for a limited transitional period following construction.

Arguments for and against each method are discussed in the following sections.

Fee collection – experiences

Case studies indicate that fees on government schemes are set at uneconomic levels, less than 8 percent of the value of the benefits derived from irrigation (FAO, 1994). In six Asian countries Repetto (1986) estimated that the effective average subsidy was 90 percent of O&M costs. The rate of collection was strikingly low, for example only 20 percent in Nepal.

Agencies need an incentive to collect water fees. In the Philippines, the rate of fee collection increased dramatically when local offices of the National Irrigation Administration were required to carry out O&M using funds collected from farmers. Collections had formerly been remitted to central government.

On communal or private schemes, poor farmers often pay large amounts for water. In Bangladesh, water charges are set at around 25 percent of the crop value. Small and Carruthers (1991) found that Nepalese farmers made cash and labour contributions at similar levels. This proves that they are willing to pay substantially for water when a direct benefit is perceived.

Funding from increased fees

The proportion of the total O&M budget contributed by government varies greatly among countries. At one extreme, the Governments of Chile and Mexico provide a small proportion of the total annual O&M cost, while in South Asia national finance pays for between 50 and 70 percent of the total. The cost of collecting fees may be a significant percentage of the total collection, for example 8 percent in the Philippines and 15-20 percent in India.

The World Bank (1997) identified five key conditions to be satisfied before fees are increased:

- the managing agency should detail all costs, levels of service and benefits;
- users participate in setting the levels of service;
- users must prove willingness/ability to pay;
- charging mechanism – fees, in-kind contributions or property taxes – to be agreed;
- fees linked to level of service.

The Bank recognized that where local conditions or pricing policies are unfavourable, governments will need to continue to cover part of the costs of O&M.

Easter (1990) considers that fees should vary according to the project. Collection should begin when the project is new or reconditioned, when farmers are likely to be more willing to pay. A recognized system of sanctions for non-payment needs to be enforced. A worthwhile improvement in rate of collection requires at least the following conditions:

- an effective information system capable of defining water use in detail;
- a dependable delivery system;
- an agency willing and able to collect fees;
- fees are fed back to improve the system.

System management needs to be transparent to discourage corruption and to promote fairness and equity.

Another method of increasing revenue is to introduce a system of water markets. Rights to water may be traded among users. At the outset, the agency allocates rights and charges holders, who may then sell on the right. In principle, the system not only raises money but also encourages more efficient use of water, as surplus water may be resold by users rather than go to waste. The system requires fairly sophisticated institutional arrangements. Formal procedures in Mexico and Chile, and informal arrangements for trading ground and surface waters in parts of India and Pakistan, appear to work well.

Turnover

With the backing of international banks and funding agencies, proposals to increase fees are frequently linked to policies for turnover⁴ of government systems to farmers. However, there is little information to guide governments contemplating such policies. Turnover involves major changes to existing practices, which will require time, patience, consultation and resources to implement successfully. Turnover may be viewed as a process of moving services closer to the user; more cynically, it may be seen as a way of reducing government expenditure and responsibility. Many questions remain about the design and implementation of suitable structures. No single model will work in widely differing socio-economic circumstances.

⁴ The transfer of government-backed irrigation schemes to water user groups who are then responsible for O&M.

In Mexico, much of the irrigated land has been turned over to farmers' organizations (*módulos*) typically farming around 10 000 ha. Turnover is judged a success on the basis that expenditure on maintenance has increased and the condition of infrastructure has improved. There appears to have been no great expansion of the irrigated area, nor increase in unit yields following turnover. Farmers appear to have favoured turnover because it gave them better control over water. The conditions prevailing in Mexico differ from those in many parts of the developing world where turnover is being tried.

In Sri Lanka, attempts to turn over O&M of distributary channels and below, and to increase water charges, were not successful. Farmers had only low returns from small plots of rice and paid little for their water. They saw no incentive to take on extra tasks that had previously been managed by government. The Government was forced to pay them to carry out maintenance at distributary level to avoid the collapse of the systems. In China, "townships" are normally responsible for maintaining distributary channels. Increasingly, irrigation agencies may need to fund works to secure the system against deterioration.

Irrigation system turnover – case studies

A number of countries in the Americas, Africa and Asia have followed the lead of Mexico in turning over systems to farmers, with varying success. Indonesia had turned over 400 systems by 1992 (FAO, 1994) but many of the water user associations were found to be performing poorly.

Vermillion and Garces-Restrepo (1996) investigated two schemes in Colombia. Output had improved after turnover, although O&M spending remained roughly the same. Farmers felt that operations staff were more responsive to their needs. The system was judged to be in reasonable condition. No funds had been set aside for long-term rehabilitation, as farmers considered that to be the responsibility of government.

Vermillion (1997), reviewing the findings of 29 studies, concluded that turnover could have both positive and negative effects. However, there were no substantive data indicating the impact of turnover on the condition of the infrastructure nor the competence/readiness of the farmers to maintain the system.

There is some evidence that turnover is more likely to be successful where farmers face some water scarcity, but severe scarcity of supply leads to anarchy, rather than cooperative working. Despite studies such as those by Gerards (1991, 1996), Johnson (1993), Geijer, Svendsen and Vermillion (1995) and Vermillion (1997), the circumstances under which farmers will be both willing and able to take over responsibility for the maintenance of a given system remain a matter for conjecture. There is a danger that they will adopt a short-term view, to the detriment of the system. Turnover, as envisaged in many countries, leaves the government responsible for expenditures on much of the main system, representing a large component of the total O&M cost and the greater part of the problem. Farmers have little reason to make turnover work unless they get an improved service from the main system. At present there appears to be no concerted effort to improve the way maintenance is undertaken in the main system. Bank-supported policies to increase water fees and to turn over systems in these

circumstances are potentially setting at risk huge investments in irrigation infrastructure.

O&M by private firm or autonomous agency

A third party, either a private company or an autonomous government agency, could manage operation and maintenance of the main system. Under financial autonomy, the irrigation agency or company would be responsible for obtaining resources and controlling their use.

It is unlikely that established private companies would be interested in the returns to be made from rice cultivation, although there may be potential with higher value crops. Attention needs to be given to the potential offered by autonomous maintenance agencies. The experience of the World Bank with rural road maintenance organizations suggests that decentralization can be successful. Success depends on providing appropriate incentives, acquiring and keeping the right staff.

It is likely that government would need to provide some subsidy to make an autonomous maintenance organization viable on rice-growing schemes. Realistic assessments of the fee for water would be needed. The organization's income, including any subsidy, would need to allow a fair profit, provided that a high rate of collection was achieved to allow for the costs of regulation. Formal contracts between farmers and the agency would allow a measure of control, since the agency would derive a large part of its income from users. However, the organization would enjoy a monopoly position so would need regulation against performance targets. For example, it would be required to irrigate the full feasible service area and to reinvest in the infrastructure. Otherwise, there would be a temptation to maximize revenue by, for example, reducing investment and providing a reliable supply to a limited area at times of shortage, rather than trying to spread water equitably across the command.

Assistance from lending agencies

The reluctance of donor agencies to fund recurrent costs stems from concerns about accountability and a recognition that support for O&M would merely delay the time when nations would have to assume responsibility for the expenditures.

It has been suggested (Carruthers and Morrison, 1994), that lending arrangements might include a transitional period after construction during which initial support for O&M was provided, but progressively decreased over time. The loan would be conditional on the establishment of appropriate domestic institutional arrangements to manage O&M. Experience of such arrangements, for example in Pakistan, does not seem to be positive. It has been suggested (Easter, 1990) that donors might link new funding to the performance of existing projects, focusing greater attention on project monitoring and *ex-post* analysis. It is likely that such ties would be unacceptable to some recipients, and banks might also have difficulty in introducing corresponding uncertainties into their lending programmes. Lending agencies have generally turned away from transitional support in favour of turnover policies.

Improving the effectiveness of maintenance

Maintaining irrigation systems at a *satisfactory* level is consistently more economic, for both high and low value cropping patterns, than allowing systems to deteriorate under *poor* maintenance.⁵ If this *common sense* approach is applied at the outset then money could be more productively employed in other areas of the economy rather than prematurely rehabilitating the system. The extra spending on a medium-sized project of, say, 20 000 ha might otherwise have been used to provide a safe supply of drinking-water to a small town.

To improve the effectiveness of maintenance, irrigation planners, managers and their political masters must recognize the impacts of neglect, adjust policies, and think about incentives, institutional changes, design and planning procedures.

Recognizing the impacts of neglect

The true consequences for national economies of the present *build-neglect-rebuild* cycles need to be more widely publicized. By safeguarding existing investments, good maintenance sustains systems, outputs and livelihoods. A lack of or ill-timed, poorly funded maintenance leads to greater expenditure over the lifetime of a project, and to extra foreign currency repayments on loans for premature rehabilitation. It can also magnify existing social inequities by endangering the water supply to farmers at the tail of a system. Conventional project economic analysis, using a relatively high discount rate for future costs and benefits, does not capture the longer-term benefits of maintenance, and may suggest that unsustainable development is preferable. New project analysis methods are needed to emphasize sustainability.

Policy

Governments are under pressure to reduce spending. Fees for water generally need to be raised and the rate of collection improved. Such changes are difficult to introduce without organizational change. Guidance in restructuring inefficient institutions to manage maintenance better is needed as there is little informed advice on the consequences of different policies. Turnover, as a strategy to reduce government spending, is being pursued without a proper understanding of what the impact of maintenance by farmers will be. Larger systems have been designed on the assumption that an agency employing trained staff would be responsible for O&M to the level of the tertiary offtake, and that the same body would have some measure of control/influence over O&M at the tertiary level. Under turnover, that will no longer be the case. Different groups of farmers will undertake O&M as they see fit, in different parts of the system. Guidelines for governments based on case studies, practical training for farmers and simple manuals are needed to ensure that the infrastructure is maintained, and to identify the support that farmers will need.

Incentives and penalties

Innovative ways of introducing incentives to carry out maintenance, together with clear penalties for failure, are needed. Schemes mostly remain under the

⁵ Valid under a range of sensitivity tests in which costs, prices and interest rates were varied.

management of irrigation staff who may be frequently transferred, and therefore have limited interest in future improvements. Farmers should not be penalized for the poor performance of the agency. One way of encouraging maintenance of the lower levels of the system could be to offer a rebate in water fees against the number of days a farmer works on maintenance. A simple system of vouchers for the number of days worked could be traded for a discount on fees.

Institutional change

Partial turnover to farmers will not address problems of maintenance on the main canals of most large systems. It is crucial to undertake organizational changes at that level of the system as farmers are unlikely to cooperate unless they are convinced they will get an improved service. In many parts of the world it is increasingly difficult to retain experienced field staff on government-run irrigation schemes. Cadres of experienced staff and workers are reaching retirement age. The outlook for sustaining the infrastructure in a workable condition appears serious. Unless incentives and training for staff and workers can be improved, the situation can only get worse.

The potential for decentralizing maintenance to autonomous, self-accounting units needs wider consideration. An organization dependent on water charges for much of its budget has a strong incentive to improve collection rates. Some government subsidy may be required on rice-growing schemes to make enterprises financially attractive, and units will need to be regulated to ensure that they are investing in the whole system. The government contribution would be dependent on *satisfactory* performance by the unit. Experience from a number of countries suggests that effective decentralization of a huge bureaucracy may require a period of decades. Changes are needed now, so franchising arrangements might be necessary.

Design

Designs for low maintenance giving easier and less costly management, reduced maintenance, lower service fees and greater effective life need more importance during project preparation. In the future, systems will be operated and maintained by farmers. Engineers and planners need robust information, comparable to that now available in the roads sector, on the links between design, maintenance spending, performance, whole life cost and sustainability. Field studies in a number of countries/regions are needed to provide facts on the deterioration of irrigation systems and maintenance performance, so as to get rational policies.

Planning procedures

Better identification of maintenance works and priorities are required to make the best use of limited funds. In the face of growing water shortages and increased competition for available water with other parts of the economy, managers will need to introduce improved practices and planning methods, drawing on asset management procedures being widely introduced in other parts of the water sector.

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One of IPTRID's priority activities is to create awareness among the interested public and the professional community on irrigation and drainage issues, particularly on the positive benefits of irrigated agriculture. It is hoped that the reader will be able to appreciate better the role of irrigation and drainage and understand how such developments can be improved with minimal environmental impacts and maximum livelihood benefits.

Realizing the value of irrigation system maintenance is the second in a series of issues papers to be published by IPTRID. The first paper, *Poverty reduction and irrigated agriculture*, was published in January 1999. Further papers are planned on:

- Priorities for drainage, and
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