CHAPTER 2

Achieving Cost-Effective Rehabilitation and Modernization of Irrigation Systems: Research Results from Sri Lanka

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REHABILITATION AND MODERNIZATION

THE WATER DELIVERY performance of every irrigation system deteriorates over time. Rehabilitation and modernization (R&M) projects are aimed at arresting or reversing this process. Rehabilitation of an irrigation system refers to restoring the capacity lost over time. Modernization of an irrigation system refers to changing the existing design to make it cater to new demands or to incorporate new technologies to make it more efficient. It is now generally accepted that rehabilitation and modernization (R&M) should be undertaken at the same time. One basic element in all R&M projects is that the water conveyance and distribution system is improved; however, an R&M project is distinguished from maintenance in that the R&M project focuses on the whole system at once.

R&M projects have been a major form of investment in irrigation for more than 20 years. Over that time, a great deal has been learned about how to make such projects effective. A key unanswered issue is how to ensure that an R&M project is *cost-effective*. This paper uses data on projects for the R&M of major irrigation systems in Sri Lanka in an attempt to answer that question. As will be shown, the answer lies in the process through which R&M projects are planned, implemented, and managed.

REHABILITATION AND MODERNIZATION OF IRRIGATION SYSTEMS IN SRI LANKA

Irrigation in Sri Lanka

Irrigation is extremely important for agriculture in Sri Lanka; almost all rice — the staple food — is produced on irrigated land. Sri Lankans classify irrigation systems into "major systems" with command areas greater than 80 hectares, and "minor systems" with command areas of 80 hectares or less. Over two thirds of Sri Lanka's irrigated land is under major systems. Major systems are managed by government agencies while minor systems are managed directly by farmers.

In Sri Lanka, construction of new irrigation systems has largely ended. The best locations have already been developed and the costs of construction of new systems have risen sharply while the value of the major product — rice — has declined (Aluwihare and Kikuchi 1991). Therefore,

the Government of Sri Lanka has adopted a policy of investing in the rehabilitation and modernization (R&M) of existing irrigation systems (IMPSA 1992). Since 1975, investments in R&M have grown while those in new construction have declined.

Although R&M of minor systems continue to remain an important component of public and private investment in agriculture, this paper concentrates solely on R&M of major systems. The lessons learned from R&M of major systems, while applicable to minor systems, will need to be reformulated to fit the different management organizations of minor systems.

R&M Projects in Sri Lanka

R&M of major systems have been undertaken primarily through large-scale projects partially funded by foreign donors. There have been five such projects:

1. Tank Irrigation Modernization Project (TIMP): 1976–1983
2. Water Management Project at Gal Oya (WMP): 1979–1985
3. Walawe Irrigation Improvement Project (WIIP): 1985–1993
4. Major Irrigation Rehabilitation Project (MIRP): 1985–1993
5. Irrigation Systems Management Project (ISMP): 1987–1992

Altogether these projects have undertaken R&M work on 18 major irrigation systems. The total cost of these projects have ranged from US$18 million (WMP) to over US$30 million (MIRP). Most of the funding has been provided by foreign donors. WMP and ISMP were largely funded by USAID loans and grants, TIMP and MIRP were partially funded by World Bank loans, and the WIIP was mostly funded by loans from the Asian Development Bank.

Data on these five projects form the basis for the analysis in this paper and they have been drawn primarily from the following sources:

1. A literature review commissioned by IIMI under its agreement with USAID to manage the research component of ISMP; this study covered all five of the projects and was prepared by Dr. W.A.T. Abeysekera (Abeysekera 1992).
2. A field study and analysis of four of the five projects also commissioned by IIMI under its agreement to manage the research component of ISMP; this study covered four projects — TIMP, WMP, MIRP, and ISMP — and was undertaken by a team from Engineering Consultants Ltd. and Associated Development Research Consultants (ECL/ADRC 1992).
3. IIMI studies of WIIP under its agreement with the Asian Development Bank to provide assistance to the project (IIMI 1990; Nijman 1991).

Two of the projects, TIMP and WMP, have been studied in great detail and have an extensive literature.

This paper and much of the data are the products of the research component of the Irrigation Systems Management Project (ISMP). One goal of ISMP was contributing to knowledge about how to achieve cost-effective R&M. ISMP itself was originally designed to contribute to

knowledge about R&M processes by providing different levels of funding for construction in different irrigation systems for comparison of cost-effectiveness. During implementation, the design was changed so that the original comparison could not be used. However, the ISMP research component has included studies of several aspects of R&M, including farmer participation and the use of existing structures for flow measurements, as well as the studies on which this paper is based. Also, the implications of the various ISMP studies for the conduct of R&M projects were discussed by top-level Sri Lankan irrigation professionals at a national workshop organized by IIMI in June 1992. The workshop resulted in a set of guidelines for future Sri Lankan R&M projects to be published shortly by IIMI.

THE FINDINGS ON REHABILITATION AND MODERNIZATION PROJECTS

Evaluation of the Sample Projects

This analysis compares various aspects of the five projects to determine which features help ensure cost-effectiveness. For purposes of analysis, the five R&M projects are categorized on the basis of cost-effectiveness using traditional economic analysis.

Table 2.1 gives estimates of the benefit/cost ratios and internal rates of return (IRR) for the five projects. These figures are not definitive. The data needed to conclusively judge the economic soundness of these projects, three of which are not yet completed, are not available. However, these figures support the following categorization of projects:

1. TIMP was probably not cost-effective. The two systems listed include Mahawilachchiya whose performance is considered excellent by many specialists but whose construction costs were very high. Mahawilachchiya also has good water availability. In the other scheme, Mahakanadarawa, cultivation has failed in most seasons for lack of water. Analysis of the three other systems rehabilitated by TIMP might change the picture but that would probably not change the conclusion.

2. WMP focused on only one system — Gal Oya Left Bank — then the largest system in the country. These figures show that WMP was cost-effective, a conclusion that agrees with the end-of-project evaluation (ISTI 1985).

3. MIRP is an ongoing project rehabilitating four systems; hence, the figures given here cannot be taken as final. However, these figures show that MIRP has had significantly different results under different conditions. In particular, the Huruluwewa Scheme has severe water availability problems while Rajangana, on the other hand, has no shortage of water.

4. As shown by the figures, ISMP is probably a cost-effective project. However, rehabilitation constructikn on the ISMP systems will continue for some time though the main portion of the project has been completed. The two systems listed here are reasonable representatives of the six systems where ISMP work has been carried out. Analysis of the others would probably not change the conclusion of the authors. The difference between the two schemes can be explained by the greater improvement in equity of distribution in Kaudulla than in Minneriya. Historically, Kaudulla has had greater head-tail problems than Minneriya.

Table 2.1. Economic evaluation of the projects.

Project	Scheme	B/C ratio	IRR
TIMP	Mahawilachchiya	0.56	—[1]
	Mahakanadarawa	0.21	—[1]
MIRP	Rajangana	1.30	16.4%
	Huruluwewa	0.67	—[1]
WMP	Gal Oya Left Bank	1.57	33.0%
ISMP	Kaudulla	2.24	30.0%
	Minneriya	1.29	16.5%
WIIP	Uda Walawe	—[2]	8.0%

[1]The IRRs for these schemes were negative. [2]No B/C ratio calculated.

Notes: B/C ratio = Benefit/Cost ratio.
IRR = Internal rate of return.

Sources: For TIMP, MIRP, WMP, ISMP: ECL/ADRC 1992
FOR WIIP: IIMI 1990

5. WIIP is still underway but it will probably not be cost-effective, in large part because the work done and planned will not bring any significant additional area under cultivation. Unlike the other figures, the IRR figure shown for WIIP is not a current estimate but one made by IIMI in 1990.

Based on this evidence, WMP and ISMP are categorized as cost-effective, TIMP and WIIP as not cost-effective, and MIRP as unsure. The following subsections explain some reasons for these results.

R&M Project Components

Balance between hardware and software

A key finding is that the five R&M projects have placed very different emphases on different components. All five of the projects included the following major components:

1. Physical works including earthwork on canals, the rebuilding of concrete and masonry structures, and the building of new structures.
2. Design of a new operations system.
3. Design of a new management structure, sometimes incorporating some farmer involvement (institutional development).

In addition, some projects have included other components some of which are:

1. Agriculture improvements (TIMP, ISMP, MIRP).

2. Roads and other rural infrastructure (TIMP, MIRP, WIIP).

3. Research (ISMP, WMP, WIIP, MIRP).

All of the projects also included training and other support for the major components.

However, the resources allocated to the components have differed significantly among the various projects. Table 2.2 shows an estimated breakdown among major components for the five projects.

Table 2.2. Major cost components of the projects (in percent).

Major component	TIMP	WIIP	MIRP	WMP	ISMP
1. Physical works	67	90	70	63	63
3. Institutional development	0	0	7	18	15
4. Others	32	8	15	6	9
Total	100	100	100	100	100

Note: The authors have found it very difficult to allocate project costs among these various components because accounting has not been done in these components. The figures given in the Table are based on information available on component breakdown and the authors' estimates of efforts put into each component.

Table 2.2 illustrates several important points:

1. Physical irrigation works dominate the budgets of all the projects.

2. The five projects fall into three categories with regard to expenditures on components:

   - TIMP and WIIP put very little resources into the software items, i.e., O&M systems and institutional development.

   - WMP and ISMP put significant funds into the software items.

   - MIRP is intermediate.

3. Only TIMP put a large amount of resources into other activities. TIMP invested a great deal in the purchase and distribution of tractors and other agricultural equipment and inputs to promote a new cropping system. The proposed cropping system turned out to be unacceptable to the farmers for a variety of reasons. As a consequence, none of the later projects has dedicated significant resources to agricultural development. Without this large investment in agricultural development, TIMP's distribution of funds would be similar to that of WIIP.

ISMP and WMP, classified as cost-effective, are the two projects that put the most resources into the software components. TIMP and WIIP, classified as not cost-effective, put the least into the software components. MIRP is intermediate to both categorizations.

Clearly, this finding shows that investment in software components is an essential complement to investment in physical works. The implications are: a) that a balance between software and hardware components is necessary; and b) that WMP and ISMP were closer to the ideal balance than were the other projects.

This finding agrees with other analyses which suggest that investments in operation and maintenance (O&M) and institutional development together with investment in physical works are likely to have a bigger payoff than investment in physical works alone (Aluwihare and Kikuchi 1991). The basic reasons for this conclusion are well-known:

1. R&M are attractive when the performance of a system declines significantly. The decline may be due to (a) increased demands (enlargement of the command, increased cropping intensity, etc.), or (b) deterioration in the physical system that makes effective operations impossible. The former implies a need for improved operations; the latter, a need for improved maintenance. Reconstruction of existing structures and construction of new structures alone without improvement of O&M will not solve the basic problems leading to the need for R&M.

2. Improvement of O&M systems requires significant investments. It is not enough for engineers to work out a new operational plan; the plan must be tried, negotiated with farmers, and modified as needed for the particular scheme. Moreover, the use of new technologies, as implied by modernization, generally means that system operators themselves need training and learning time to make the new O&M systems function well.

3. Inadequate maintenance and poor water distribution generally imply, at least in Sri Lanka, that farmers are not taking sufficient responsibility for management. In some cases, they may interfere with agency plans; in others, agencies lack the funds and trained manpower to handle the maintenance and water distribution needs. In either case, there is a need for the development of institutions among the farmers so that they can effectively and responsibly contribute to overall system management. However, institutional development cannot be accomplished without resources.

Thus while physical works are a key element of an R&M project, the physical works must be supported by investments in O&M systems and institutional development to ensure that needed O&M changes take place.

For example, all of the projects except TIMP have incorporated greater control over water flows by adding measuring and other control structures and have proposed operating plans that require the use of these structures. This approach has been in line with expert opinion from outside Sri Lanka. However, development of the management systems to make use of increased control over water flows has lagged. WIIP simply assumed that the system managers and management systems could make effective use of this control (Nijman 1991). WMP and ISMP, on the other hand, expended a fair amount of resources on improving the management systems and managers' capabilities so that the increased control would be effectively used. Again MIRP has been intermediate.

The failure to provide funding for an item does not mean that the project planners omitted the item. Thus, although no funding was provided by TIMP for institutional development, its plans called for the establishment of Tank Committees with farmer representatives to manage the schemes after R&M. However, it was assumed by the planners that whatever costs there would be would be covered through regular government budgets. Similarly, most of the TIMP funding for agricultural development went for the purchase of tractors; it was assumed that the additional

extension work required to get the farmers to adopt a new cropping schedule as proposed by the project would be met from regular funds. The experience in Sri Lanka is that extra government funding has rarely been made available unless explicitly provided for in the project budget. The lesson is that R&M project budgets must make explicit provision for the key items.

Farmer organizations

Effective management decisions require farmer input. On major systems with thousands of farmers, farmer input is possible only when the farmers are organized. Thus the creation or strengthening of farmer organizations is a key element in institutional development for R&M.

All the projects incorporated the idea of farmer organization and involvement in O&M. TIMP - and WIIP assumed that adequate organizations existed and dedicated no resources to creating organizations. WMP, ISMP, and MIRP explicitly made creation of farmer organizations one of the goals, although the resources dedicated to this end under MIRP were, initially, meager. All three projects have had considerable success in creating effective farmer organizations. WMP was the earliest of these and the methods developed for WMP came to serve as models for both of the later projects. A large part of the success of both WMP and ISMP must be attributed to the participation of the farmers through their organizations.

Farmer organizations can provide assistance to the R&M process itself as well as help with O&M after the project. It takes time, however, to create farmer organizations from scratch. Results from WMP suggest that it takes up to two years to create effective farmer organizations. Since the creation of organizations has been part of the R&M projects, this lead time means that farmer organizations could not participate in project planning and initial implementation.

Based on experiences in WMP and others, in 1988, the Government of Sri Lanka adopted a "participatory management" policy for the management of major irrigation systems. This policy calls for the turnover of operating and management responsibilities for the lower levels of major irrigation systems to farmer organizations. To support the policy, the government has created programs to organize farmers in major irrigation schemes. Unfortunately, except where funds from R&M projects have been available, the government has not been able to dedicate adequate resources to achieve fully functioning and effective farmer organizations.

R&M Project Planning

Planning, including selection of systems for R&M work, and selection of the main elements of the project, also differed significanply among the five projects. Three key aspects of planning are considered here: planning studies, selection of technology, and provision for modifications during implementation.

Planning studies

One common trait of all five projects is that basic planning was done early in the project and was based largely on studies by consultants, generally foreign consultants. Three of the projects, TIMP, MIRP, and ISMP, were intended to rehabilitate and modernize multiple schemes; hence, the studies were necessarily superficial. The basic studies for WMP were also superficial. For WIIP, there were multiple studies (IIMI 1990; Nijman 1991) but all were superficial and they came to different conclusions.

These studies do not attempt to justify selection of these particular schemes rather than other schemes. They do attempt to show that R&M of the selected schemes constitute a good investment. Even in the latter type of analysis, the superficiality of the studies, particularly in the area of water availability, has sometimes defeated the purpose of project planning.

The most obvious example is that of Mahakanadarawa, one of the TIMP schemes. This scheme has long had a history of crop failures due to lack of water in the tank. Yet, Mahakanadarawa was selected for TIMP, a project that proposed costly lining in most of the canals. Without water to distribute through the canals, there could be no increased crop production to justify the costs. The water availability problem at Mahakanadarawa was known to many people, including the system operators and the farmers, yet it was dismissed by project planners on the grounds of uncertainty.

The Huruluwewa Scheme, now being rehabilitated by MIRP, has similar but less extreme water availability problems. Here it was assumed that the water availability problems would be solved by the construction of a feeder canal to the reservoir, an activity outside of the R&M project. The poor evaluation of MIRP performance at Huruluwewa (see Table 2.2) is largely due to the water availability problems.

Planning for changes during implementation

Analysis of WMP shows that although the original plans were drawn up by foreign consultants based on inadequate studies, the plans themselves made provision for changes during implementation. For WMP, R&M work was planned on the following basis:

1. One of the two main factors considered responsible for the decline in performance of the scheme (Gal Oya Left Bank) was physical deterioration of the system. Therefore, rehabilitation was intended to bring the scheme back to its original operating capabilities. The scheme was not to be redesigned although some clear errors and problems were to be corrected.

2. The second major factor considered responsible for the situation was that farmers were not adequately performing their channel maintenance and water distribution functions. Based on USAID's experience with the On Farm Water Management Project in Pakistan, it was proposed that farmers would be organized for two purposes: a) to contribute free labor to rehabilitate the field channels; and b) to enable the farmers to maintain field channels and distribute water among themselves more adequately.

3. A Master Plan was to be developed to address various problems of the scheme during implementation of the rehabilitation work. It would incorporate a new operating system. Research work by contractors and outside agencies was planned to help with this effort.

4. Explicit provision, including scheduling an outside midterm evaluation, was made for monitoring and evaluating the progress and impact of the project. These provisions are discussed in detail below.

As shown by the last two items, WMP explicitly incorporated the idea of learning lessons and planning future operations based on those lessons. Major changes were made during implementation of WMP, many of them following a midterm evaluation that suggested some of the changes. The following are some of these changes:

1. The original purpose of rehabilitation was modified. The goal became "pragmatic rehabilitation" whose objectives were installing adequate controls to deliver the water as

planned and ensuring the stability of the system. This was a much cheaper approach since it did not mean reconstructing most of the canals.

2. The goals of the farmer organization program were broadened to include farmer participation in operation and maintenance, in solution of conflicts over water, and in seasonal planning through the organizations. This change occurred as the implementors learned that farmers could take a great deal more responsibility than was originally thought.

3. The Master Plan approach was junked when it was found that it had little to offer. Instead, attention was focused on selecting an operating plan and developing the capabilities of the Irrigation Department officers to implement that or any other plan successfully. For this purpose, a computer-based information system was developed and put into use.

Like WMP, all the projects suffered from inadequate planning studies. They differed considerably in approach to modifications during implementation. The differences can be briefly summarized as follows:

1. TIMP did not explicitly provide resources and opportunities for learning lessons and making changes. Some important changes were made during TIMP implementation because of the extremely high costs of some items.

2. WIIP, like TIMP, did not explicitly provide resources and opportunities for learning lessons and making changes. Few changes have been made during the implementation of WIIP.

3. MIRP made weak provisions for change during implementation. As a result, the major changes that have been made in implementation, such as a great increase in support for farmer organization, have come only late in the project in response to reported success in ISMP.

4. ISMP, like WMP, explicitly provided for learning lessons and making changes. Major changes occurred during implementation, particularly after a midterm evaluation.

Selection of technologies

Selection of technologies for R&M projects is fundamental to planning and this selection has generally been based on current theories of how improvements can be made rather than on detailed local studies of needs. TIMP offers an instructive example. TIMP was based on ideas that were rather radical at the time. The basic elements of the project were:

1. The rehabilitated systems would be redesigned so that most farms would be served from one-cusec canals.

2. These canals would be lined to minimize losses and prevent farmers from tampering with them.

3. Farms would be served through rotations on the field channels.

4. Farmers would adopt a new cropping schedule calling for dry plowing and early sowing to make maximum use of rainfall.

These ideas were drawn from a variety of sources. Both the one-cusec canal and the rotation idea appear to have been derived from the idea, common among irrigation engineers worldwide at the time, that most of the inefficiencies were at the tertiary level. The value of lining was also widely accepted by experts at the time, and the cropping schedule idea was based on experiments carried out on a small scale within Sri Lanka itself. These elements were adopted without extensive consultation with system operators and with no consultation with farmers (Murray-Rust and Rao 1987).

During and after implementation it was found that:

1. The one-cusec canal design within TIMP may be effective in simplifying operations. This seems to be the case in Mahawilachchiya. However, this feature is very expensive because it requires the reconstruction of many canals and the construction of many parallel canals to reduce all field channels to the one-cusec size.

2. Because of its cost, canal lining was controversial. In Mahawilachchiya, the ECL/ADRC team found that the lining was in very good condition ten years after completion of the work and that the system was functioning very well. Lining had reduced maintenance needs although it complicates maintenance activities when needed. Despite this finding, it cannot be considered cost-effective because the cost of the lining was so high. In TIMP itself, only selective lining was used in the later TIMP schemes.

3. The planned rotations were developed by a foreign consultant working largely by himself; these have since been significantly modified, mostly simplified, through experience. The actual enforcement of rotations on field channels has been left to farmers who change the rotations as they see fit.

4. The proposed cropping schedule was not accepted by farmers. Although the plan was agronomically sound, it led to labor problems for farmers. Also, in those systems where water availability was uncertain, farmers felt that it increased their risks unacceptably.

Since TIMP was the first of the projects, some of its lessons were incorporated into subsequent projects. Thus none of the more recent projects have recommended large-scale field-channel or distributary-channel lining and none have adopted a single agricultural plan. The one-cusec canal design and low-level rotations were adopted in WIIP and, partially, in MIRP.

For TIMP, the basic technologies, including both the operating system and the structures for that operating system, were predetermined by the project plans drawn up by experts with no provision for modifications during implementation. The same approach was used for WIIP with equally poor results.

In contrast, as was shown in the section on *Planning for changes during implementation* (p. 32), WMP left the choice of technology largely to the project implementors. WMP also explicitly provided for review of plans to allow for changes. WMP approach has had much greater success than has the approach adopted for TIMP. The WMP approach has been taken for the ISMP and MIRP. This success has largely been due to the greater knowledge the implementors had of individual system needs.

The implication is that choice of technology must be based on detailed knowledge of local needs that can be gained only over time. In turn, this implies that the persons who have extensive experience on the system — the system operators and farmers — should play a major part in selection of technology. A second reason for consulting system operators and farmers is that these are the people who must use the technologies after completion of R&M. If they do not agree with

the selected technologies, they may well misuse or modify the new works and systems to fit their felt needs.

Lessons for planning of R&M

Four major lessons can be drawn from this analysis:

1. Much of the knowledge necessary for success in R&M is knowledge about the individual scheme. Not all of the lessons from one scheme are applicable to another. There is a need to individually tailor R&M plans to individual schemes.

2. Adequate studies of the individual schemes, including good assessments of water availability, are needed for project planning. These studies cannot be entrusted solely to consultants, foreign or otherwise, who can spend only a few weeks on the studies, unless they are supported by strong background work. These studies should pay careful attention to the knowledge and experience of the farmers and operators on the scheme.

3. The most successful projects have made explicit provision for modification during implementation as lessons are learned about the scheme. WMP and ISMP not only included resources for research and planning, but also provided for midterm reviews that justified major changes. These midterm reviews based their findings primarily on the opinions of and information from the personnel implementing the project, including farmers.

4. Selection of technology should not be left solely to outside experts. It is important that system operators and farmers be consulted not only to make use of their detailed local knowledge of the scheme but also to ensure that they are agreeable to making proper use of the newly installed systems following R&M.

R&M Project Implementation

These five projects also offer lessons concerning several aspects of project implementation. Many of these are highly technical and of interest only to work in Sri Lanka. For example, experience has shown that it is more effective to base design water levels on historical water levels than on the original design. These local technical issues will not be discussed here. However, three issues of major importance are discussed: a) the involvement of farmers in design, b) the involvement of farmers in construction, and c) the involvement of system operators in project implementation.

Involvement of farmers in design

Under TIMP and WIIP, the design process explicitly excluded farmers. Design was felt to be a matter solely for the technical personnel (engineers and technical assistants). One result has been poorer performance and complaints and destruction by farmers when the systems did not solve their problems or work as the farmers felt they should.

Farmer involvement in the design of field channels was explicitly provided for in WMP, MIRP, and ISMP. However, there have been problems with achieving effective involvement. One has been time pressure. Meeting farmers to discuss designs takes time, particularly if the farmers want something not envisioned by the engineer. An engineer under pressure to complete designs quickly often feels that he cannot afford the time. In all three projects, engineers learned that when

they did not spend the time to involve farmers, farmers gave greater problems at the time of construction or afterward. Thus, greater efforts were made to involve farmers in design as these projects progressed.

Involvement of farmers in construction

WMP, ISMP, and MIRP made it a goal to involve farmers in construction work. There were several reasons: to lower costs by getting free labor from farmers, to ensure good quality construction because farmers have an interest in quality, to give the farmers experience with and greater knowledge of the system, and to help farmer organizations by providing opportunities to raise funds.

As with design, achieving effective involvement of farmers has taken time. Not only must the farmers have the organizational capability to manage construction work, they must also have the technical knowledge. For the latter, experience shows that support from the agencies is critical to success. Not only must the farmers learn how to carry out construction work, the agency personnel must learn how to provide the necessary technical support. The involvement of farmers in construction work in WMP was not as successful as hoped, largely because of inexperience. There has been greater success in both MIRP and ISMP but the results are too new to be evaluated fully.

TIMP attempted to involve farmers in construction, but only as laborers with no say in how it was conducted. This approach was taken in large part bacause TIMP did not try to organize farmers. Although not included in WIIP plans, giving contracts to farmer organizations is now the policy of the project because of successes in MIRP and ISMP. However, it is not working well yet, in part because the agency involved has little experience in working with farmers, and in part because the farmer organizations are very new.

Involvement of system operators in project implementation

A clear difference can be seen in the implementation strategies of TIMP and WIIP on the one hand, and those of WMP, MIRP and ISMP, on the other. TIMP made few efforts to ensure interaction between project implementors and operators, although they were separate persons from the same agency. In WIIP, project implementors and operators are from different agencies so there has been very little interaction. In both TIMP and WIIP, there was little opportunity for operators to influence system redesign and other aspects of project implementation.

In contrast, in WMP, MIRP and ISMP, there was a great amount of interaction between project implementors and system operators. Under MIRP and ISMP they have largely been the same persons. In WMP, although implementors and operators were generally different persons from the same agency, explicit efforts were made to ensure interaction. In these three projects, system operators have had significant influences on design and construction. The greater amount of interaction has meant that WMP, ISMP and MIRP could adjust to individual system needs more effectively thus making the projects more effective.

Overall approaches to implementation

TIMP and WIIP projects were very top-down. Technologies were selected by planners and design and construction were carried out with little consultation with system operators and with no consultation with the farmers. This approach had two detrimental effects on these projects:

1. It has been very difficult to incorporate local knowledge held by system operators and farmers into the selection of technology and the designs.
2. It lessened the commitment of both operators and farmers to the project. In the case of farmers, this is expressed through increased numbers of complaints and, sometimes, through damage to or destruction of newly built structures.

In the other three projects, both system operators and farmers were consulted on design and the farmers were explicitly involved in construction. The results were that: a) there are fewer problems with new structures and management systems, and b) both groups are more cooperative.

R&M Project Management

The five projects also offer lessons in project management.

Project scheduling

First, none of the five projects have completed construction as scheduled. TIMP, WMP, and MIRP were all extended to allow for completion. ISMP ended officially after finishing only about two thirds of the construction work. Although it has been extended, WIIP will probably not complete the planned physical works.

The basic problem appears to have been that the construction schedules were very optimistic so that it would appear that the projects would be completed within time limits set by the donors. In every case, factors not considered, such as civil disturbances and others, affected the schedule, often severely.

Nor could projects complete their non-construction components on time. For example, despite extension, WMP never finished farmer organization work. Also, ISMP has not yet completed operating system development. Often, judgement of "completion" of these software components is subjective or is based solely on expenditure of the funds.

One important factor always was that no time was allowed for getting all the persons and agencies to work together. These have generally included officers from the irrigation agencies and various agricultural agencies, consultants, local and national administrators at different levels, and others. Not only was it necessary to spend time and effort getting everyone "on board," but also failure to do so slowed implementation. Beginning in 1989, ISMP began a practice of holding annual workshops to prepare the annual plan for the following year. This practice is said to have helped the various implementors greatly in achieving project targets.

Monitoring and evaluation systems

Although none of the projects have had perfect monitoring and evaluation systems, there were major differences that affected project success.

In all of the projects, construction progress has been monitored with reasonable efficiency through periodic reports from the responsible officers. The progress of other components has also been monitored through the same mechanism, although generally less effectively. Unfortunately, this type of monitoring does not include impacts, nor does it include outsider evaluations of performance, both of which are essential for project evaluation. Thus this approach to monitoring generally fails to help with adaptation of activities to local needs.

The performance of the projects with regard to providing data for learning lessons during and after implementation has differed considerably:

1. TIMP included a baseline study and a less elaborate impact assessment at the end of the study. The results of the baseline study came out too late to be of use in project planning. The impact assessment and other studies have provided lessons for subsequent R&M projects.

2. WMP made explicit plans for outside monitoring of performance and impact of the project. The Agrarian Research and Training Institute (ARTI) carried out continuous monitoring of irrigation and agricultural performance throughout the project's life. Also, baseline, midterm and final impact studies were carried out by ARTI and its collaborator, Cornell University. Several special studies on particular subjects were carried out by ARTI researchers and Cornell graduate students. Unfortunately, there was little periodic reporting of results, although the data were used in many individual studies. None of the results were used in activity planning. The major importance of these efforts was that ARTI and Cornell researchers and consultants were also involved in WMP's farmer organization program and thus could use these data to support changes in the R&M plans and procedures. Also, the publication efforts have had a major impact on the government agencies, government policies and farmers.

   USAID commissioned independent midterm and final evaluations by outside consultants. The midterm evaluation was important in reorienting the project in more useful directions.

3. WIIP plans did not incorporate baseline or midterm studies or evaluations. However, the donor asked IIMI to undertake studies to help with selected aspects of implementation. The results of the first phase of IIMI's work were made available only in 1990, long after many aspects of the project planning were firmly set. Thus they have had little influence on the R&M process.

4. MIRP did not include baseline or midterm studies or evaluations. A final evaluation is being carried out at present. Changes that have occurred have largely been due to pressures from outside agencies and from the observable success of ISMP.

5. Documentation of lessons learned was explicitly built into the design of ISMP. Different combinations of inputs were to be used in different schemes and a comprehensive monitoring system used to document the differing processes and results. During implementation, changes were made in the project design that negated the value of the planned experiment.

   A two-year, highly detailed pre-project study was carried out to provide both baseline and diagnostic data on the systems where R&M were to be carried out. Unfortunately, the results came too late to help with project planning and since no final impact assessment is planned, they will not be useful as a baseline study.

   ISMP incorporated a research component that completed individual studies on particular issues of general relevance to irrigation management in Sri Lanka rather than solve problems for ISMP. However, two of the studies funded by ISMP were directed toward learning lessons from all the R&M projects. These studies form the basis for this paper.

ISMP designed a monitoring system for irrigation system management that would also produce data for project management. Although the first version was put in place in 1989, it proved unworkable. A much improved system was put in place in 1991, very late in the project.

Finally, USAID commissioned an internal review and an external midterm evaluation that together caused important changes in implementation. No USAID-commissioned final evaluation will be carried out.

None of these efforts have provided effective monitoring and evaluation of the progress and impact of the project as a whole during the whole implementation period. However, the multiplicity of efforts has made ISMP a well-documented project that could learn lessons and adapt to its needs as it progressed.

Only WMP and ISMP had explicit mechanisms by which progress and impact could be evaluated while the project was underway. These mechanisms allowed important lessons learned to be incorporated into project implementation. All the others made at least some token provision to document lessons learned.

At first glance, it may appear that allocation of funds for elaborate data collection and evaluation efforts is not worthwhile. The evidence from these projects shows that, when combined with appropriate management mechanisms, these efforts allow for adjustments to local conditions and thus greatly improve cost-effectiveness. The two most cost-effective projects are those that made the greatest efforts to monitor and evaluate impacts.

Donor Funding

In Sri Lanka, as in many other developing countries, most R&M activities have been financed in part with foreign funds. One result is that donors have greatly influenced the projects. The results of foreign intervention in Sri Lanka have been mixed:

- Many ideas underlying the successful approaches to R&M have come from foreign technical assistance. For example, the concept of "pragmatic rehabilitation" introduced in WMP was created by foreign experts and local project implementors working out the problems in Gal Oya. Similarly, the computer-based O&M systems introduced under WMP, ISMP, and MIRP originated with foreign experts.

- On the other hand, the donors have also imposed management conditions that have caused problems. One of the main problems has been donor insistence on five-year projects. None of the five R&M projects were completed within the planned five-year span, generally for good reasons. In addition, in every project, design efforts were begun very soon after the start of the project to complete the design and construction as fast as possible. Thus, even where farmer involvement was desired, it was neglected in favor of getting the construction work finished quickly.

As good financial managers, donors are concerned to know how much funding is needed and on what the funds will be spent before they authorize the expenditures. This means that they would prefer that planning be completed before committing the money and beginning the project. A need

to complete R&M plans to get financing is a root cause for the superficial planning studies reported above.

SYNTHESIS OF THE FINDINGS

Characteristics of a Cost-Effective R&M Project

Based on the findings reported above, a cost-effective R&M project would have the following characteristics:

1. An appropriate balance between software, including both institutional development and O&M system development, and hardware to support the O&M systems; this balance is necessary to ensure that the management changes are made to make the physical system changes functional.

2. Adequate diagnostic studies of the individual schemes, including good assessments of water availability; these are needed for selection of a scheme for R&M and for project planning; these studies should not be entrusted solely to consultants who can spend only a few weeks on them.

3. R&M plans tailored to individual schemes not only through adequate studies but also through consultation with farmers and operating system personnel.

4. Explicit provisions for reviewing and changing plans during implementation as lessons are learned about the particular scheme and the strategy being followed; for this purpose, mechanisms that evaluate the progress and impact of the R&M and feed the information back to project implementors, funders, and overseers are needed.

5. Mechanisms that allow for the participation of operating personnel in selection of technology and design and mechanisms that provide for the participation of farmers in design and construction to ensure that their interests are adequately reflected in the outcome.

6. Effective farmer organizations created before planning begins so that farmer participation can be fully effective.

7. Realistic time scheduling that makes adequate provision for project start-up and that allows for unforeseen disturbances and delays and for changes.

This listing is not new. It agrees substantially with the listing of characteristics given by conferences in 1986 (Haider 1987) and 1989 (Hydraulics Research 1989) and others. What is spelled out here is what these findings mean for R&M projects in Sri Lanka. In the next section, therefore, the way a cost-effective R&M project should be planned and implemented is considered in more detail.

Achieving Cost-Effective R&M

Table 2.3 shows a framework which embodies the conclusions reported above. For Project Planning, Project Implementation, and Project Management, Table 2.3 lists steps and principles which, if followed, should ensure cost-effective R&M. This section expands on this framework.

Project Planning

SELECTION CRITERIA FOR R&M. The performance of all irrigation systems deteriorates over time. The general goal of R&M is to improve system performance. Therefore, systems should be selected for R&M when there is both the need and opportunity to significantly improve performance through R&M.

There are clear tradeoffs between maintenance and rehabilitation; greater investment in maintenance implies slower deterioration of performance and longer periods between R&M. On the other hand, changing demands on the system from a larger number of users or from changing cropping patterns may require system-wide changes only possible through R&M. Also, R&M is usually required to benefit fully from the opportunities to improve performance by using new technologies.

Table 2.3. Conceptual framework for achieving cost-effective R&M.

Project Planning

1. Selection criteria for R&M determined.
2. Diagnostic studies conducted: current status measured against goals of farmers and operators.
3. Operational and maintenance constraints identified.
4. Water availability studies carried out.
5. Suitable technology identified in consultation with system operators and farmers.
6. Desired institutional and management changes identified.
7. Adequate farmer contribution to costs negotiated.
8. Adequate funding for the different components allocated.
9. Agreement with farmers and operating agency reached and incorporated into final report.

Project Implementation

1. Farmer organizations created and strengthened.
2. Orientation and training for agency personnel and farmers conducted.
3. Operating agency strengthened for implementing rehabilitation.
4. Farmer involvement in design, construction, operation and maintenance planned and implemented.
5. Development of the O&M system to be used after the project.
6. Use of appropriate design principles and construction methods.
7. Flexibility in implementation methods.

Project Management

1. Work plan and schedule developed: sequencing of activities and allowing sufficient time.
2. Financial management, including tendering and procurement.
3. Progress and impact monitoring, evaluation and feedback.
4. Flexibility in planning and oversight to respond to lessons learned and local conditions.
5. Midterm external evaluation for project changes.
6. Final evaluation and completion of report to document lessons for other projects.

Ideally, therefore, R&M of a system should be planned well ahead of time to take advantage of the tradeoffs involved (less maintenance to save resources for R&M, etc.). This is simply the irrigation expression of planning for capital replacement (depreciation) that is standard practice for businesses and other agencies around the world.

Unfortunately, such planning is rarely done. Without individual system planning of this sort, agency personnel or others charged with implementing R&M projects must evaluate systems as candidates for R&M investments. It is assumed that, in a developing country, R&M work will be initiated by a government or private agency rather than by the farmers themselves. In this case, the funding or implementing agency must develop criteria for systematically identifying schemes that are candidates for R&M.

As will be made clear, the principles proposed here delay the conclusive decision to undertake R&M of a system until the full planning process has been completed. Therefore, the initial identification of candidate irrigation systems can be made on any reasonable basis, including visible physical deterioration, expressions of interest from farmers, political expediency, etc.

A major problem is to select one candidate scheme over others; that is, it may be necessary to decide which candidates will be better investments. This issue is not discussed in depth here; instead what is focused is how to achieve cost-effective R&M once a scheme is selected.

DIAGNOSTIC STUDIES. Once a system is designated as a candidate for R&M, diagnostic studies must be initiated to get the necessary information for evaluation of the potential effects of R&M and for planning R&M.

Evaluation of a system for R&M requires answering two key questions:

- What is the performance level of the system now and what could it be following R&M?
- What are the costs and benefits of alternative R&M strategies?

First, it is necessary to define "performance" and decide how to evaluate it. No general definition of "performance" can be given because the objectives of each scheme are unique to that scheme. For example, irrigation system performance necessarily incorporates ability to deliver water to farmers' fields, and remove it when there is excess. However, the standards by which water delivery performance is to be judged depend upon the crop needs and the availability of water. For example, a water-abundant system may not require high reliability in scheduling but may require good drainage if farmers are growing crops that do not tolerate excess water. In another system, farmers may grow water-tolerant crops, such as rice, which do not require drainage. In a third system, water availability may be low and reliability of water delivery may be very important.

It follows then that the first task in selecting a system is to confer with the farmers (and other users, if any) to determine their performance goals for the system. Once the goals are determined, determination of current performance levels relative to those goals is straightforward.

OPERATIONAL AND MAINTENANCE CONSTRAINTS. The next step is the determination of the causes for lower-than-desired performance levels. This step requires investigation of: a) faults and problems with the water acquisition and conveyance system, b) faults and problems with the systems for making seasonal and daily operating decisions, and c) faults and problems with other support systems.

In the past, there has been a tendency to assume that deterioration of the conveyance system is the cause of poor performance. In fact, however, nonfunctioning structures may have been broken by farmers in an attempt to compensate for poor operations. Eroded canals may be a symptom of failure to undertake even simple and cheap maintenance efforts. Fixing the structures

without simultaneously fixing these management problems will clearly not result in the expected benefits. Thus, the investigation of causes must not be limited to physical inspection of the system but must also include an inquiry into O&M systems and the institutional structure that supports O&M.

The investigation should rely heavily on interpretations given by system operators and farmers since they have extensive experience with the system.

WATER AVAILABILITY STUDIES. Particular attention must be paid to system hydrology. The Sri Lankan experience is that several R&M investments have been wastes of money because of faulty estimates of water availability. If adequate water is not available, R&M should not be considered. As with investigation into O&M problems, weight should be given to the experiences of farmers and system operators who have had to deal with system water problems. The hydrological investigations should not rely primarily on the investigations carried out for the original design of the system. The hydrology has almost certainly changed with development of the area for agriculture.

SELECTION OF SUITABLE TECHNOLOGY. Once the underlying management and structural problems have been determined, selection of technologies is necessary to solve the problems. The selection of a solution must take into account the opinions and knowledge of farmers, who will have to live with the system and may have to pay for the R&M work, and of system operators who must make it work. However, outside experts can play a significant role in identifying technological alternatives that farmers and system operators may not be aware of.

The best approach then is:

1. Experts identify and cost alternative solutions to the system problems.

2. Experts discuss the alternatives with the system operators to learn what would be appropriate for them and what additional support they would need to make the various options function.

3. Experts negotiate with farmers over which approach is most cost-effective.

This approach means that all three sets of experiences are brought to bear on the problem to ensure the suitability of the approach to local needs.

INSTITUTIONAL AND MANAGEMENT CHANGES. Adoption of particular technologies requires concurrent adoption of appropriate O&M management practices. To ensure that the appropriate balance between software and hardware components is maintained, proposals for new technologies to solve system problems must also describe the concomitant changes needed in O&M systems and in supporting institutions. Thus the discussions between experts and system operators and farmers must include discussion of the management changes needed and the costs of those changes.

FARMER CONTRIBUTION TO COSTS. To ensure cost-effectiveness, the farmers should have a financial interest in the R&M activities; that is, farmers should be made responsible for paying at least part of the cost. The amount should be such that they cannot make their contribution solely with labor; labor is a relatively low valued commodity. If farmers must commit some part of storable resources (cash or others), they are likely to be much more careful in what expenditures they approve. In the Philippines' successful program for the R&M of communal irrigation systems,

farmers are made responsible for covering significant portions of the R&M construction costs. This provision has made the responsible agency very careful with its recommendations and planning (Isles et al. 1987).

Therefore, the negotiations between the experts and the farmers should include negotiation of the costs that will be paid by the farmers. It should be noted that it is generally not possible to conclude a negotiation with farmers unless the farmers are represented by an organization. *An effective farmer organization is therefore a prerequisite to completion of this step.*

ALLOCATION OF ADEQUATE FUNDS TO PROJECT COMPONENTS. The Sri Lankan experience is that unless funds are specifically earmarked for a particular purpose in the project document, the government can rarely provide extra funding for necessary activities. Thus, if the selected R&M strategy requires extra assistance in agriculture, project funding for this assistance must be explicitly allocated. Funds should be explicitly provided for O&M system development, training of the O&M staff and farmers, for institutional development of both the farmer organizations and the agency, and for project monitoring and evaluation.

AGREEMENT WITH FARMERS AND OPERATING AGENCY. The findings of the diagnostic studies, the planned O&M systems, the agreed technologies to support the O&M systems, the proposed initial budget, and the agreement of farmers to the plans and to pay their share of the costs should be incorporated into a final report. Only if all these are accomplished and a formal agreement is reached with the farmers should the scheme be taken up for R&M.

If the interests of both farmers and system operators are satisfied and the farmers are agreeable to paying a significant portion of the costs, the R&M proposal can be said to be "cost-effective." That is, if the negotiations with farmers are done seriously, it is the farmers who can judge whether the benefits are worth the costs. In this case, further pre-project economic analysis may not be necessary. *Concluding a formal agreement with the farmers is thus the key step in this process.*

However, if the farmers are not paying the full cost or if the agency will be lending funds to the farmers, there remains the question whether the proposed R&M work should be done on this scheme or on another. For this purpose, it may be necessary to prepare an economic analysis of the proposed project to satisfy the funding agency.

Project Implementation

At completion of the planning process described above, not only will it have been determined that the particular scheme will have an R&M project, but also that the initial strategy for R&M will have been selected, that a budget will have been prepared and funded, and that both the system operators and farmers will have become aware of and committed to the project.

FARMER ORGANIZATIONS. As pointed out already, the existence of an effective farmer organization is a prerequisite for the completion of project planning. In Sri Lanka, however, not all schemes have effective farmer organizations. Although government programs exit to create farmer organizations, the programs have not been very effective except where R&M project funds have been made available.

There are two possible solutions:

- Separate programs for the creation of farmer organizations from R&M projects should be developed. If the government cannot adequately fund the farmer organization programs, it could seek donor funding specifically for that purpose.

- A period should be provided at the beginning of the project to create or strengthen farmer organizations to a level where they can play their parts in an R&M project. This would delay the planning of R&M for particular schemes for one to two years. This was the approach adopted by the Philippines in their successful R&M project for communal irrigation systems.

The authors prefer that the farmer organization program be separated and that the existence of effective farmer organizations be made a precondition for consideration of a scheme as a candidate for R&M. In other words, it is recommended that the agency not even put a scheme on its list of candidates for R&M unless effective farmer organizations exist.

ORIENTATION AND TRAINING FOR PARTICIPANTS. A key problem in prior R&M projects is that implementation was delayed by lack of coordination among various agencies and between agencies and farmers. Efforts made at the beginning of the project and at intervals during the project to get all the participants together to inform them of what will happen and to develop common understandings are worthwhile. These efforts might include planning workshops and the use of other interactive methods.

Also, a training needs assessment should be carried out from the very beginning of the project so that any special training needs can be catered to expeditiously.

OPERATING AGENCY STRENGTHENING FOR IMPLEMENTING R&M. Close coordination between system operators and staff implementing the R&M is essential so that operators' needs and experience can be fully incorporated into the project. Therefore, the R&M project should not be undertaken by an outside agency but by the operating agency itself.

However, system operating staff can rarely undertake an R&M project in addition to their operational duties. Therefore, additional personnel and additional equipment and transport must be provided. Training of personnel, if needed, should be provided early in the project.

FARMER INVOLVEMENT IN O&M, DESIGN, AND CONSTRUCTION. Farmer involvement in O&M, design and construction is necessary to ensure that farmer experience with the system is incorporated into the work, to let farmers help ensure the cost-effectiveness of the project, and to ensure farmer commitment to making the project work.

Farmer involvement in O&M is discussed in many of the sources and will not be discussed at length here. Techniques used successfully in Sri Lanka for effective farmer involvement in design include: a) joint walk-throughs of field and distributary channels in which engineers and farmers discuss and resolve issues prior to undertaking detailed designs, and b) meetings with farmers to present and discuss the details of proposed designs prior to their completion. Awarding contracts to farmer organizations for R&M construction on their own channels has proven to be an effective way of getting farmer involvement in construction.

The use of these techniques may require changes in procedures and job activities for irrigation agency personnel. When changes are needed, the procedures involved must be planned, and the field personnel must be trained.

The use of these techniques also requires more time, particularly for design work, than if these activities are carried out without farmer involvement. The authors have argued earlier that farmer involvement will ensure good results. It is suggested, although it cannot be proved, that well-managed farmer involvement in design will make construction flow more smoothly and more rapidly. Thus, some of the extra time spent on design may be recovered during construction.

O&M SYSTEM DEVELOPMENT. One key finding is that O&M system development is crucial to effective R&M. In some R&M projects, O&M system development has been neglected in favor of design and construction work. The O&M strategy to be followed after completion of the project must be determined before beginning design activities. Such determination of the O&M system first not only ensures that design criteria match O&M requirements but also ensures that appropriate attention will be paid to O&M system development.

USE OF COST-EFFECTIVE DESIGN PRINCIPLES AND CONSTRUCTION METHODS. Construction normally absorbs the bulk of the resources for R&M. It is important that the specifics of design and construction be appropriate to needs and be based on experience in the local setting. For Sri Lanka, for example, WMP established that rubble packing is as effective as retaining walls for some purposes and is far cheaper. ISMP established that, in some conditions, the use of historical water levels for design is more accurate than the use of levels calculated from original design criteria. The latter are likely to call for greater canal capacity thus calling for greater expense. Similarly, ISMP showed that drop structures could be used as effectively for discharge measurements as separate measuring structures thus reducing the number of structures required and so reducing costs.

The particular cost-effective techniques to be used are necessarily adapted to local conditions and a complete list cannot be given. However, not only should project designers and managers constantly search for new ideas like those mentioned, but also they should encourage the agency staff and farmers to make suggestions. Many location-specific cost-saving techniques originated from the staff and farmers on the spot.

FLEXIBILITY IN IMPLEMENTATION. Making major and minor modifications in implementation methods and procedures in response to lessons learned is a key characteristic of cost-effective R&M projects. Project managers must be prepared to modify methods and procedures to fit different local conditions in different parts of the scheme and to use more effective methods and technologies discovered as experience grows. A flexible approach to implementation also helps to encourage innovation by staff and farmers since they know that good ideas will be adopted.

Project Management

WORK PLAN AND SCHEDULE. As for any major project, it is essential that early in the project a detailed work plan be developed. As pointed out earlier, this should be done with the involvement of all the participants so that it reflects the real implementation requirements and all are familiar with the plan.

The biggest problem the authors found with project work plans was that inadequate time was allowed for project activities. Scheduling should incorporate the following commonly neglected principles:

- Sufficient time must be allowed for project start-up so that all participants can be informed and trained properly. Project start-up activities often require six months to a year.
- Time should be allowed for unforeseen delays, particularly in construction work. A rule of thumb might be to add 50 percent to the time estimated for optimistic construction schedules.
- Farmer involvement in design will require more time than having it done by technical specialists alone. Extra time must be allowed.

FINANCIAL MANAGEMENT. Financial management is a key ingredient of project management. For an R&M project planned and implemented as recommended here, financial reports should be provided to farmer organizations because the farmers have a financial interest in the conduct of the project.

Also, tendering and contracting procedures have sometimes been a major cause of delays; streamlining such procedures may be important in keeping to the schedule.

PROGRESS AND IMPACT MONITORING, EVALUATION AND FEEDBACK. It is essential that an adequate monitoring and evaluation system is created early in the project. This system should not only report on the progress of activities but also should provide regular feedback to project managers on the cumulative impact of activities. To ensure that the information is objective some should be prepared by outsiders. This information is essential not only for normal project management but, more importantly, to make it possible to adapt implementation methods and procedures to the lessons being learned during the project itself.

FLEXIBILITY IN PLANNING AND OVERSIGHT. Just as flexibility in implementation methods is needed, willingness to modify the work plan and R&M strategy is necessary. Plans, including basic strategies, should be reviewed and revised at appropriate intervals based on information from experience gained during project implementation, from the monitoring and evaluation system and from outside experts consulted at midterm or another appropriate time.

MIDTERM EXTERNAL EVALUATION. WMP and ISMP have clearly shown the value of a midterm evaluation carried out by external experts. When done properly, this evaluation is based more on the ideas and information held by the project participants than on the outside experts' knowledge. The function of the experts is to collect and consolidate these ideas and information and present them in a clearly articulated form so that project participants can make the necessary changes in plans and implementation methods.

FINAL EVALUATION AND COMPLETION REPORT. Finally, it is important that the project implementors prepare a completion report and that a final evaluation be done, preferably by outsiders. While these do not contribute directly to achieving cost-effective R&M on the particular scheme reported on, they do provide information that will be of use elsewhere, including particular technical approaches learned during the project and particular management lessons learned. An economic evaluation should be part of the final evaluation not only to satisfy funding agency requirements but also to provide a check to the ideas presented in this paper.

Implementing the Process with Donor Funds

The approach to achieving cost-effective R&M outlined above does not allow specification of exactly which systems will undergo R&M until after detailed investigations and negotiations with farmers. Also, flexibility during implementation is advocated. But changed plans mean changes in funding requirements. Both conditions make it difficult to be precise about funds needed and what they will be spent for prior to beginning the project. This approach does not agree with the usual approaches taken by donors.

It is suggested that the solution has three parts:

1. The irrigation agencies should set up small units whose function is to investigate systems that are candidates for R&M and begin tentative negotiations with farmers. This can be an ongoing process.
2. The output of these units should be used to decide which systems will be proposed for R&M funding from a donor.
3. The government should demand of donors that the required flexibility be incorporated into project plans.

It is suggested that if the government makes the effort to plan R&M in this way, rather than waiting until there is an expression of interest from the donors, the government will be in a strong negotiating position. There will still be a place for foreign technical assistance to provide advice on new technologies, but the fundamentals of the R&M plans for each system will be set by the Sri Lankan agencies and farmers on that system rather than by outside consultants.

CONCLUSION

In this paper the authors have analyzed Sri Lanka's 15 years of experience with projects for the rehabilitation and modernization of major irrigation systems to define a set of principles and a process that they believe can ensure *cost-effective* R&M. Although the data have been drawn only from Sri Lanka, the factors focused on are aspects of process and management rather than location-specific technical factors. Therefore, the authors believe that these principles are valid not only for Sri Lanka but also for many other developing countries.

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