REFORM IN IRRIGATION MANAGEMENT SYSTEMS IN SRI LANKA: FARMER BURDEN OR FARMER RESPONSIBILITY?

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INTRODUCTION

Irrigation management combines both technical and social processes -- often referred to as "hardware" and "software". It is thus a classic case of socio-technical processes. Technologies are embedded in institutional frameworks through which they are manipulated to achieve socially defined objectives. Irrigation engineering is thus a necessary but not sufficient component of irrigation management. Management of irrigation systems is done by human beings and presumably for the benefit of human beings, but all these humans have different interests and perspectives. Thus, irrigation management is a sociological phenomenon as much as -- I argue more than -- it is a technical process.

Until recently many people held the view that irrigation is a purely technical field. This narrow perspective is a major cause of the inability to adapt to changing needs and demands in the management of irrigation schemes. The premise of this paper would have seemed radical 10 years ago, but would now be accepted by most irrigation management professionals: in the socio-technical equation, the "socio" component is prior. By this is meant that if the institutions are ineffective, no amount of technological improvement is likely to improve performance significantly (though costs may be greatly increased). On the other hand, even if the technology is not the most advanced or perfect, if the institutions are effective, the maximum potential output from that technology can be achieved. Put more concretely, investments in modern irrigation technologies will achieve little if the agencies responsible for their operation and maintenance are ineffective, inefficient, or simply not interested in O&M.

Sri Lanka has about 580,000 hectares of irrigated land. Compared to other Asian countries, this is not much. But compared to some of its larger neighbors, Sri Lanka has a complex irrigation management institutional landscape. There are the Irrigation Department, Irrigation Management Division, and various Mahaweli agencies in the Ministry of Lands, Irrigation and Mahaweli Development; the Departments of Agriculture and Agrarian Services in the Ministry of Agricultural Research and Development; and now the situation is more complex with the establishment of the provincial councils which are establishing their own irrigation departments. These different agencies have not been guided by an overall policy or strategy; they have different and sometimes overlapping and competing responsibilities and missions.

Nevertheless, the Sri Lankan government is presently embarked on a change process that will lead to radical reforms over time in the irrigation sector. In an article published recently in the Economic Review I have outlined some of the background to these changes

(Merrey 1991), so I shall not repeat them here. The central thrust of the changes, will be to decentralize and devolve authority and responsibility for management of irrigation systems to strong farmers' organizations.

Irrigation systems will be classified into two types: "self-managed" and "jointly-managed." Management of self-managed systems will be entirely the responsibility of the farmers served by the systems, through farmers' organizations. This category will probably eventually include all of the smaller and medium sized systems, and most of the larger systems coming under the provincial councils -- say, those systems that are about 400 ha or less (but there will be no fixed size limit). Government would continue to provide various supporting services, such as technical advice, training, and financial as well as technical assistance for major emergency repairs and for rehabilitation and modernization. The key defining feature of self- or farmer-managed irrigation systems is that the farmers control the water source.

The larger and more complex systems, including the inter-provincial ones, will come under joint-management. This means that the government departments and farmers' organizations will share management responsibility in two senses. First, the distributaries and field channels will be turned over to farmers' organizations for operation and maintenance. Second, while government agencies will retain direct responsibility for managing the headworks and main canals, farmer representatives will actively participate in the overall decision-making at project level through project management committees. These are committees that include both representatives of various government agencies and farmer representatives from all the distributary farmers' organizations (with farmers being in the majority) which make overall policy decisions for system management. These committees are already in operation on about 35 schemes; the farmer representatives on these committees can effectively control policy decisions -- and will even control system level finances in future.

These proposed changes may seem radical, and you may be wondering if these are yet another boondoggle imposed by foreign consultants and donors. I assure you this is not the case. First, these changes build directly on more than a decade of very active experimentation in Sri Lanka, some with foreign assistance, and some indigenous. Second, they are already contained, in vague form, in government policy: they are part of a Cabinet Paper on participatory management of irrigation schemes accepted in early 1988.

Third, these ideas are being elaborated at present in a unique participatory policy planning process presently underway, called the Irrigation Management Policy Support Activity (IMPSA). Under this activity, funded by USAID, a group of experienced Sri Lankan specialists are implementing a process of studies, consultancies, literature reviews, and consultations with people at all levels, from farmer representatives to policy makers, in order to spell out more clearly what the overall policy goals should be, what should be the strategy to achieve these policy goals, and what agency reforms, training, legal provisions, and resources would be required to achieve them. The overall process is guided by a top-

level Irrigation Management Policy Advisory Committee (IMPAC). IIMI is providing some technical backup and assistance to this process. A recent issue of the Economic Review, a special issue on irrigation management, contains a description of IMPSA.

Past experiences in Sri Lanka with developing local organizations for rural development have been mixed. We can learn lessons from this experience, and avoid the more serious errors. A key factor is that most past efforts were partial ones, in the sense that government retained control of the local institutions, and kept them in a state of dependency. In irrigation management, Sri Lanka is a pioneer in institutional experimenting, and now in the boldness of the proposed reforms. Thus, we can only draw limited insights from other countries' experiences to guide the program.

I should draw your attention to one particularly unique aspect of Sri Lanka's program. As is true in other developing countries, one of the pressures for reform is budgetary: government cannot allocate sufficient funds for adequate irrigation system O&M, leading to a vicious cycle of deterioration, poor performance, rehabilitation, deterioration, etc. Donors have also pressured Sri Lanka and the other countries on this point, insisting on the collection of O&M fees from farmers. Comparative studies have shown that those agencies directly dependent for their income on farmers' paying fees tend to provide better services than those funded through the Treasury. Sri Lanka is in the latter case.

Sri Lanka has had a very dismal experience with trying to collect fees from farmers to cover O&M costs. Therefore, it has chosen another path: shifting a portion of the O&M costs to farmers through institutional reform, i.e., getting farmers to take direct authority and responsibility for managing their systems. Will farmers accept this? Will this turnover process simply add more burdens onto farmers already suffering from very low financial returns to agriculture? Or is this an opportunity for farmers to break out of a low-productivity dependency syndrome, and move from being "peasants" living at a barely subsistence level in a stagnant traditional agricultural economy, to being commercial small farmers with increasing incomes, participating in a dynamic modernizing agricultural economy? This is the question to be addressed in the remainder of this paper.

PREVIOUS EXPERIENCE: WHAT DO WE KNOW?

There is already a wealth of experience from pilot projects and applied research of various kinds which have emphasized establishing farmers' organizations, getting farmers involved in irrigation system rehabilitation and planning and doing O&M, and getting irrigation engineers and other officials to work with farmers in support of their efforts. In the early years, the greatest resistance came not from farmers but from officials in agencies. But today, we see a "revolution" in the thinking and perceptions, as well as behavior, of many of those involved in management of irrigation systems.

We have learned many lessons during the past decade. We have learned how to organize farmers, with the use of specialized catalysts, such as the institutional organizers in the Gal Oya and ISM Projects. We have learned how to effectively implement system rehabilitation, and use the rehabilitation process as an institution-building exercise. We have some understanding of how to assist agency staff to adapt to the new mode of management. We have found that system performance can be improved through greater participation of farmers. We have confirmed some of the assumptions underlying the efforts: it has been demonstrated that farmers can organize themselves and carry out O&M and even rehabilitation contracts effectively; farmers are interested in getting more and more involved in these activities, and using them as a base for other profitable activities beyond irrigation management; the government will agree and will change in order to adjust and support such devolution of authority and responsibilities.

What we do not know is whether this new mode of management will become institutionalized and sustainable over time. This we will learn as the process is carried through. But one indicator of the likely sustainability will be whether the benefits to the farmers, and to society in general, sufficiently outweigh the costs to make it attractive. On this point we lack sufficient systematic data to be precise; but we have enough indicative data to be reasonably confident that the benefits will far outweigh the costs. The next section reviews some of these data.

BENEFITS OF PARTICIPATORY MANAGEMENT

Potential Benefits from Improved System Management

On two major irrigation systems, IIMI has attempted to analyze the changes in total agricultural income (gross value added) that would be generated if improved system management practices are adopted. In both cases, the analysis was part of a larger multi-disciplinary study. In both, the analysis examines various scenarios which are regarded as feasible, and which could be achieved through adopting management innovations without making additional heavy capital investments beyond those already underway. They suggest the order of magnitude of improved incomes possible through improved management. The two cases are Kirindi Oya, a new settlement scheme combined with an older system, and Walawe, a mature settlement scheme currently being rehabilitated.

In Kirindi Oya, at present, one finds that the old areas have increased their cropping intensities from about 1.3 to 2.0 per year since Lunugamvehera Reservoir was completed in 1985, with rice grown both seasons. In the newly settled area, farmers tend to grow mostly rice, with some non-rice crops, but the cropping intensity has not even reached one crop per year. However, by shifting to a mixed cropping pattern including selected high-value crops, and by more equitable and efficient distribution of water between the old and new areas, and within the new areas, it is possible to increase the cropping intensity throughout the system to about 2.0, -- that is, two crops per year -- and to increase incomes

by 30 to 180 percent, depending on the particular cropping pattern (see IIMI 1990a: chapter 6).

In Walawe, IIMI carried out a similar analysis (IIMI 1990b: chapter 5). At present, Walawe shows a cropping intensity of about 1.3 per year, mostly in rice. There is a very high degree of inequity in water supplies between the head reaches and the tail reaches. By reducing inequity in water supply, but retaining the present rice-based cropping pattern, and no increase in cropping intensity (i.e., by equalizing rice yields on the system) total system income can be increased by about 30 percent. But if as in Kirindi Oya, management is improved so that there are both equitable and more efficient water supplies and adoption of a mixed cropping pattern including high value crops, annual cropping intensity could be increased to 2.0, and income by 50 to 80 percent. These are realistic objectives, achievable with no additional capital investment.

IIMI is presently working very closely with the various government departments responsible for management of these two systems to test management innovations that would improve their performance. Some of these innovations are to be implemented by the departments but some involve increasing the effectiveness of farmers' organizations' contributions to system improvement and management. We plan to try to assess the benefits and costs of implementing these improvements. The analysis summarized here has indicated that the potential for improving incomes in the near future is very high.

IIMI has also analyzed the benefits and costs and gross returns to constructing new irrigation systems compared to several completed rehabilitation and water management improvement projects. These are the Gal Oya Water Management Project, the Tank Irrigation Modernization Project (TIMP) funded by the World Bank in 1977-1983, and three water management and institution-building projects. Two of these were implemented by a local nongovernment organization (NGO) at Nagadeepa and Pimburettewa and one by an Irrigation Department technical assistant as part of an IRDP-funded rehabilitation at Kimbulwana. The results, summarized in Tables 1 and 2, are very interesting (see Aluvihare and Kikuchi 1991). The benefits come primarily from increased area cultivated (new area brought in or higher cropping intensity) as a result of the interventions.

New construction (given presently available technologies) has had a benefit cost ratio of less than one (i.e., a negative ratio) since about 1980. TIMP, a capital intensive project that also made several erroneous assumptions about what farmers would accept, and did not attempt to organize farmers or do any institution building, also has a low rate of return. We plan a field study later this year which we believe will show the returns are even less than shown here. In contrast, the Gal Oya project, which included a package of building farmers' organizations for participation in both rehabilitation and O&M, and cost-effective "pragmatic rehabilitation", has a high benefit cost ratio (2.3) and high internal rate of return.

Two of the water management projects, Kimbulwana and Pimburettewa, show even higher benefits -- b/c ratios of 13.4 and 7.4 and internal rates of return of 83 and 77 percent

respectively. Nagadeepa on the other hand shows a very low return -- lowest of all the cases. Why? We believe the answer lies in the fact that at Nagadeepa no parallel investment was made in physical improvements in what is a badly deteriorated system. Institution-building alone could not produce results. But in Kimbulwana and Pimburettewa, modest investments in physical improvements were integrated with the institution-building process, and the resulting synergy is striking.

But you may wonder whether the absolute amount of benefits generated by such projects is high enough to justify such investments. Aluvihare and Kikuchi (1991) examine this question with regard to Gal Oya, Kimbulwana, and Pimburettewa (Table 2). The data show that the net present value of the rehabilitation and water management projects in all three cases is very high. So we conclude that such investments in institution-building, in association with some assistance to upgrade the physical systems, does have high returns to farmers. In these cases, the benefits accrue precisely through the institution-building activities, particularly building farmers' organizations through which farmers can participate actively in system improvement and subsequent O&M.

Potential Costs and Benefits to Farmers

If, as is envisioned, farmers are asked to take full financial responsibility for O&M at the distributary levels and below, with government retaining financial responsibility for the main system and headworks, will this place a heavy burden on farmers? After all, their incomes are low, and the profitability of rice cultivation in particular has been squeezed in recent years. We have some recent data analyzing the costs of maintaining systems at a "sustainable" and "adequate" level. These are presented in this section.

Under an agreement with IIMI, TEAMS (1991a) recently completed a study on five major irrigation systems examining the costs of operation and maintenance and how the funds are allocated, used, and monitored at present; and the likely cost of improved levels of maintenance. Table 3 summarizes a few of their findings. Looking at actual expenditures during recent years, there is a considerable range among the five systems, with an average of Rs 330/= (in 1989 rupees) being the amount presently spent per hectare on both operation and maintenance. At the distributary level -- the level at which farmers are expected to take over responsibility -- the costs are estimated at about Rs 126/= (based on two systems). Average expenditure for <u>maintenance only</u> is far lower -- as low as Rs 38/= per ha for the distributary. This is only 8.5% of the amount estimated as required for "sustainable" maintenance of distributaries (see below)!

These expenditures are grossly inadequate for sustained O&M of systems. TEAMS' engineers did an analysis of what the cost would be per ha for "adequate" maintenance, defined as maintenance adequate to ensure no rehabilitation is necessary for 10-15 years; their average figure for the whole system is Rs 927/= per ha (in 1990 rupees). Half of this, about Rs 464/=, would be required for the distributary subsystem, the rest for the main canal and head works. For an even better level of maintenance, defined as being good

enough so that no rehabilitation would be required, the average annual per ha cost would be Rs 1,727/=; or about 864/= per ha for distributary subsystems only.

Another study by the Irrigation Department and Sheladia Associates (ID/SAI 1991), more field-based and specific, has initiated a "walk-through" methodology for identifying maintenance needs and developing annual plans at the main canal, and the distributary subsystem levels. This study also assumes a level of maintenance that would result in no rehabilitation being necessary for the foreseeable future. The data from this still-incomplete study are presented in Table 4. As it is incomplete, and based on only one major system, the figures must be considered indicative.

These data show a total cost of Rs 346/= in 1991 prices for good maintenance of the main canal, and an average of Rs 444/= per ha for distributaries, giving a total average cost of Rs 790/=. An interesting aspect is that a large proportion of the estimated costs are for labor -- 75% for the distributary level, and 63 percent for the whole system. Thus the cash outlay necessary for farmers to maintain their distributary subsystem would be only Rs 113/= per ha.

Can farmers afford this in the present situation? Table 5 provides some data on maintenance costs as percentages on estimated income. Farmers' incomes are being squeezed very badly, especially if they depend completely on growing rice. Rice is not very profitable. The ID/SAI study analyzes the maintenance costs as a percentage of the gross income and net profit from growing rice. Assuming an average yield of 398 bushels per ha over two seasons (i.e., annually), at a price of Rs 125/= per bushel (in fact it has risen recently), the gross value of the rice is about Rs 49,750/= per ha; the net annual profit is estimated at Rs 19,900/= per ha. If these figures are correct, then farmers would be asked to pay less than 1% of their gross income per ha for distributary maintenance, or 2.2 of their estimated net profit. For the total cost of maintenance of the entire system, it would come to about 1.6 percent of their gross income, or 4% of their estimated net profit. The cash outlay component of distributary maintenance at an average of Rs 113/= per ha is only 0.6% of the net profit.

You will note the figure arrived at by ID/SAI of Rs 790/= per ha is a bit lower than TEAMS' figure for the cost of technically adequate maintenance of Rs 927/= per ha, and quite a bit lower than TEAMS' estimate of Rs 1,727/= per ha for "well-maintained" level -- which should have been comparable to ID/SAI's figures. In fact, since TEAMS included Giritale system in its sample, we should look at TEAMS' figures for this system -- which are Rs 997/= ha for "adequate" and Rs 1,363/= for "well-maintained". Thus, the SAI/ID figures, which were arrived at independently using quite different methodologies, are very comparable.

If we take the worst case scenario, using ID/SAI's figures for gross income and net profit per ha, and TEAMS' average figure for "well maintained" (Rs 1727/= per ha), the maintenance costs rise to 3.5% of the gross returns, and nearly 9% of the net profit.

One big gap in all this is that we do not have good data on the costs to farmers themselves of getting involved in organizations, and the time, effort, foregone income from other activities, etc that would be important costs if farmers take over management of irrigation systems. This is a serious gap, which some of our work in Kirindi Oya and Walawe will try to fill over the next two years. But we do have some indications. The ID/SAI study has assumed a 5% DCO administration cost in the figures given above, which would cover some out-of-pocket expenses. The fact that farmer representatives are willing to spend a lot of time at meetings in many projects, for which they are not normally reimbursed, suggests they do perceive the benefits as exceeding the costs. On the other hand, a recent draft report (TEAMS 1991b) on a study of the turnover process in Polonnaruwa mentions a reluctance of young educated farmers to come forward as leaders because they claim they cannot afford to give so much time.

What are the conditions under which farmers perceive participatory management as being in their interest? This issue has been addressed in a study done in Gal Oya (Uphoff, Wickramasinghe, and Wijayaratna 1990). Their data confirm their hypothesis that where participation in decision-making, resource mobilization, communication, conflict resolution, etc is likely to result in improved net benefits over non-participation, farmers will favor a participatory approach. Where there is nothing they can do either to optimize the allocation of resources or to increase the total resource available, they will favor decisions being made by an outside authority. Thus, under conditions of abundance of water supply, farmers will not be willing to invest their time and efforts; and under a condition of absolute scarcity where there is no hope of reducing that scarcity, i.e., obtain more water, they will prefer an authoritarian external party to handle water management through a "rationing" process. It is under conditions of relative scarcity -- in which the allocation and distribution of water and thus benefits can be "optimized" -- that farmers will be most likely to participate in irrigation management activities.

There is a provision under the Agrarian Services Act for farmers to pay a small amount of paddy to their vel vidane for his services; this is often set at a quarter bushel per acre per season (0.62 bu per ha). Whether it is paid or not varies considerably. But there has been some effort by farmers' organizations themselves to set and collect fees at about this level for the organization in Polonnaruwa; and proposed amendments to the Irrigation Ordinance would regularize the right of a farmers' organization to collect such fees, in lieu of the government collecting them. It is too early to say how all this will develop.

CONCLUSION

Let us return to the question in the title of this paper: will these proposed reforms, in which farmers will be assisted to form strong organizations and asked to take over from the government much of the responsibility for managing their irrigation systems, be yet another burden on them? Or will it provide an opportunity for them to control their own destinies, and use their new powers to improve their incomes and livelihoods?

Irrigation is essential to successful agriculture in Sri Lanka. We know that the government is simply unable to operate and maintain the major irrigation systems adequately to allow farmers to maximize their production and income, and to sustain the irrigation systems over the longer term. We also know that farmers are capable of taking over far more responsibility for system management, and doing a better job than has been done in the recent past by government.

The data that we have seem to show that the actual cost of system maintenance is well within the farmers' means, even with the present low incomes. (The cost of operations could add another 25% to the costs, still within an affordable range.) One important trend not discussed here is the shift to a more diversified cropping pattern, including far more profitable crops. As this shift gains momentum, farmers' incomes will improve considerably, making it easier for them to bear the costs of irrigation system O&M.

Beyond these observations which relate specifically to irrigation management, it seems clear that farmers are also beginning to recognize the value of organizing in order to achieve other objectives. In Polonnaruwa for example, we see an increasing number of organizations formed initially for irrigation management getting involved in other activities intended to improve agricultural profits, or generate additional incomes. These include such activities as marketing of inputs and produce to get more favorable prices, production of seeds, and agro-processing activities. These trends are compatible with broader changes occurring in Sri Lanka and elsewhere emphasizing a reduction in government economic activity in favor of private initiative. Strong and continuous efforts by government and non-government agencies to assist the organizations to become self-reliant will be needed over the next few years. But Sri Lankan farmers may be seen as having an important opportunity to improve their incomes and livelihoods in the near future.

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REFERENCES

Aluvihare, P. and M. Kikuchi. 1991. Irrigation investment trends in Sri Lanka. Forthcoming Sri Lanka Country Paper. Colombo: IIMI.

International Irrigation Management Institute (IIMI). 1990a. Final report on the technical assistance study "Irrigation management and crop diversification (Sri Lanka)". Volume 2: Kirindi Oya. Colombo: IIMI.

IIMI. 1990b. Final report on the technical assistance study "Irrigation management and crop diversification (Sri Lanka)". Volume 3: Uda Walawe. Colombo: IIMI.

Irrigation Department/Sheladia Associates Inc (ID/SAI). 1991. Annual maintenance plan -- Giritale Scheme. 4 vols.

Merrey, D. J. 1991. Irrigation management institutions in Sri Lanka. Economic Review 16 (11-12) (February/March 1991).

TEAMS. 1991a. Final report on "Study on management and costs of operation and maintenance of irrigation systems under the Irrigation Department, Sri Lanka". 2 vols. Submitted to IIMI, June 1991.

TEAMS. 1991b. Draft final report on "Study of turnover of distributary canals to farmers' organizations in Polonnaruwa." Submitted to IIMI, September 1991.

Uphoff, N. M. L. Wickramasinghe, and C. M. Wijayaratna. 1990. "Optimum" participation in irrigation management: issues and evidence from Sri Lanka. Human Organization 49 (1): 26-40.

Table 1. Rates of return on irrigation investments in the 1980s: Comparison of B/C ratios and internal rates of return of new construction, major rehabilitation, and water management improvement projects, based on 1986 estimates.

		B/C ratio	Internal rate of return (%)
I.	New construction Projects:		
	The average for the 1980s[a]	0.8	9
II.	Major Rehabilitation Projects:		
	TIMP[b]	1.1	11
	Gal Oya	2.3	24
III.	Water Management Projects:		
	Kimbulwana	13.4	83
	Pimburettawa	7.4	77
	Nagadeepa	0.4	6

[a]. For the technology level "New Improved Varieties; N = 120 Kg" and the estimated construction costs (From Table 7, Aluvihare and Kikuchi 1991).

[b]. The rate of return of the Tank Irrigation Modernization Project is based on "would-be" benefits assumed in the project appraisal report. For all other rehabilitation and water management projects, the project benefits are based on the data that show changes before and after the projects.

Source: Aluvihare and Kikuchi (1991: Table 11).

Table 2. Comparison of the Net Present Values of new construction and rehabilitation/water management improvement projects of selected irrigation systems in Sri Lanka, in 1986 prices.

	New construction (1)	Rehabilitation/ water management (2)	(2)/(1)
Gal Oya			
Construction period[a]	1949-61	1980-87	
Command area (ha)	38,000	25,000[d]	
Total capital cost[b] (Rs million)	2,190	450	0.21
Internal rate of return (%)	12	24	2.00
Net Present Value[c] (Rs million)	1,459	1,055	0.72
	(960)[d]		(1.10)
Kimbulwana			
Construction period[a]	1953-62	1979-80	
Command area (ha)	560	666[e]	
Total capital cost[b] (Rs million)	21.8	2.9	0.13
Internal rate of return (%)	16	83	5.19
Net Present Value[c] (Rs million)	53.3	41.3	0.77
Pimburettewa			
Construction period[a]	1969-75	1986-89	
Command area (ha)	1,619	2,153[e]	
Total capital cost[b] (Rs million)	89.0	12.1	0.14
Internal rate of return (%)	25	77	3.08
Net Present Value[c] (Rs million)	168.2	81.3	0.48

[a]. For new construction projects, the end-year is defined as the year by which time 90 percent of the total capital investment was made.

[b]. Capital interest during the gestation period is not included.

[c]. Net Present Value of project = total capitalized benefits (net of O&M costs) minus total capital investment costs. Costs and benefits are compounded/discounted by an interest rate of 10 percent.

[d]. For the Left Bank only.

[e]. The command area after the project.

Source: Aluvihare and Kikuchi (1991:Table 12).

Table 3. Data on operation and maintenance costs in five major irrigation systems[a]

item	range	average
Actual Expenditures		
Average Total O&M Expenditure per ha for whole system (1985-1989)	248-452	330
Average Total O&M Expenditure per ha for distributary only (2 systems) (1987-89)	125-127	126
Average Maintenance Expenditure per ha maintenance only for whole system (1985-89)	72-133	104
Average Maintenance per ha maintenance only for distributary (2 systems) 1987-89	21-55	38
Estimates for Improved Maintenance		
Estimated Average for Maintenance Only of whole system at a technically "Adequate" level	812-1065	927
Estimated Average for Maintenance Only of whole system at a technically "well-maintained level	1363-2142	1727

a. The five systems are Giritale, Ridibendi Ela, Gal Oya Left Bank, Inginimitiya, and Mahakandarawa; data are extracted from TEAMS (1991a). Values are in 1989 rupees.

Table 4. Estimated annual full maintenance costs on Giritale System per hectare[a]

Subsystem	labor	materials/equipment	Total
Main System	166	180	346
DC 1	333	90	423
DC 2	397	139	536
DC 3	263	109	372
Average for 3 DCs	331	113	444
Average DC plus main system	497	293	790

a. Based on a series of annual maintenance plans produced by the Irrigation Department with assistance from Sheladia Associates Inc under theISM Project (ID/SAI 1991). These plans are intended to achieve maintenance at a level adequate to ensure long term sustainability of the system. At present the data are available for only three distributaries; the other nine will be completed very soon. Values are in 1991 rupees.

Table 5. Irrigation system maintenance costs as a percentage of gross and net income per hectare of rice[a]

cost item	percentage of estimated gross income (Rs 49750/ha)	percentage of estimated net profit (Rs 19,900/ha)
ID/SAI (Giritale)		
Distributary maintenance - total (Rs 444/ha)	1.0	2.2
Distributary maintenance - cash outlay (Rs 113/ha)	0.2	0.6
Whole system maintenance	1.6	4.0
TEAMS		
Five system average -- "adequate" level (Rs 927/ha)	1.8	4.7
Five system average -- "well maintained" (Rs 1727/ha)	3.5	8.7
Giritale whole system -- "adequate" (Rs 997/ha)	2.0	5.0
Giritale whole system -- "well maintained" (Rs 1363/ha)	2.7	6.8

[a] Sources are TEAMS (1991a) and ID/SAI (1991). The income estimates are those used by ID/SAI for Polonnaruwa.