ASSESSMENT OF PARTICIPATORY MANAGEMENT OF IRRIGATION SCHEMES IN SRI LANKA: PARTIAL REFORMS, PARTIAL BENEFITS

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INTRODUCTION

The worldwide interest in, and support for, transferring the management of irrigation schemes from public agencies to water user groups and other non-governmental organizations, has prompted considerable research on various aspects of irrigation management reforms and their impacts. This has resulted in a wide range of opinion on the subject.,[1] The need for strong political support for the program, clear policy direction, alternate strategies for irrigation management, well defined water rights and clarity about the process of creating farmer organizations and conditions for successful management transfer are some of the major issues discussed in the literature (Johnson III et al, 1995; Geijer *et al*, 1995; Meinzen-Dick et al, 1997; Vermillion, 1997). Yet, there is little systematic, comparative evidence to date on the impact of reforms on irrigation management performance, government finances and the farming community (Vermillion, 1997). With some exceptions (e.g. Svendson and Vermillion, 1994; Vermillion and Garces-Restrepo, 1996) most studies that deal with impacts of irrigation management reform refer to short-term and immediate results.

To support systematic documentation of international experience with irrigation management reforms and their impact on the performance of irrigated agriculture, the International Irrigation Management Institute (IIMI) developed a standard methodology to assess and compare irrigation management trasnfer (IMT) in a variety of settings.[2] This paper reports the results of application of the methodology to assess the impact of irrigation management reforms in Sri Lanka. The study was designed and implemented with two objectives in mind: first, to field test the proposed methodology and second, to determine what effects management reforms had on the performance of irrigation management and irrigated agriculture in Sri Lanka.

The paper begins with overview of irrigation management reform program in Sri Lanka. We then ouline the methodology. The next section presents the results of applying the methodology in Sri Lanka. The final section reviews the methodology and concludes with some general comments on the Sri Lankan case-study.

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[1] At the first major international conference on irrigation management transfer held in Wuhan, PR China in September 1994, over 100 papers were submitted on wide range issues relating irrigation managment reforms.
[2] The proposed methodology is described in detail in Vermillion *et al* (1996).

IRRIGATION MANAGEMENT TRANSFER IN SRI LANKA

In 1988, following a decade of field experiments, the government of Sri Lanka formally adopted a policy of transferring full responsibility for the operation and maintenance (O&M) of irrigation facilities below the distributary canal head of medium and major schemes to farmer organizations. Government retained its control of the headworks and the main canal system. The program, labelled as "Participatory Irrigation System Management" was implemented in a large number of irrigation schemes in the country.[3] The main objectives of the are;

- relieving the financial burden on government of funding recurrent expenditures for irrigation,
- improving the maintenance of irrigation facilities and the irrigation service,
- enhancing the productivity of irrigated land and water and,
- promoting a sprit of self-reliance among fanners in irrigation schemes (Abeywickrema, 1986; Brewer, 1994).

Farmer organizations based on hydrologic boundaries are fundamental to participatory irrigation system management. Their main functions are to deal with irrigation matters, but statutory provisions permit FOs the right to formulate and implement agricultural programs for their area, market farm produce and distribute production inputs (GOSL, 1991). Owner cultivators and occupiers of land in the designated area are eligible for membership in FOs. In most localities, cultivating a plot of land irrigated by a particular distributary canal, regardless of the tenure pattern, is a sufficient qualification for membership. Only one person per plot of land is conferred membership. FOs can become legal if they register with the Department of Agrarian Services and the registration is approved by the Commissioner. Once they are registered, FOs get authority under the Irrigation Ordinance to formulate rules on maintenance, conservation and management of irrigation infrastructure under their jurisdiction, to devise procedures for distributing water within the area under their command and to impose and levy fees to recover the costs of operation and maintenance (IIMI/HKARTI, 1997).

OVERVIEW OF THE METHODOLOGY

Objectives and Hypotheses

The general objective of the methodology is to determine what effects irrigation management transfer has on the performance of irrigation managment and irrigated agriculture. Performance is measured from several perspectives: cost to government and to farmers of operating and maintaining

[3] It has been estimated that participatory management has been introduced in about about 85% of the 200 schemes included under these three major government sponsored programs: The Integrated Management of Irrigation Schemes (INMAS), Management of Irrigation Systems (MANIS) and the Mahaweli Development Project (IIMI/HKARTI, 1997).

irrigation systems; quality of the irrigation service; maintenance of the irrigation infrastructure and agricultural productivity levels. The principal hypotheses tested are:

- IMT leads to a reduction in government expenditure for operation and maintenance.
- Where farmers did not incur any costs for irrigation before transfer, IMT will lead to an increase in the cost irrigation to farmers.
- IMT will lead to improvements in the quality of irrigation services to farmers.
- IMT results in improved maintenance of irrigation facilities
- IMT will result in higher agricultural productivity per unit of land and water.

The research design

The proposed methodology bases key evidence about impacts on differences in performance before and after IMT, and with and without IMT. The rationale for this approach are:

- variability among irrigation schemes (which also causes differences in performance) is controlled for through comparing performance before and after turnover in the same irrigation system,
- where governments implement IMT selectively, differences in performance may be introduced between schemes in the selection process itself. This could make with and without comparisons misleading,
- comparison of performance of systems which have or have not been transferred is to control against the possible effects of other time related factors such as economic trends, which could cause generalized changes in performance over time.

The assessment is based on two sets of data. The first set is from an intensive study of two irrigation schemes (Nachchaduwa and Hakwatuna Oya) and the other from an extensive survey of 50 schemes. The intensive component consists of a rigorous and detailed analysis of changes in performance in the two irrigation systems before and after management turnover, and validating a set of performance indicators which could be used in the extensive component. Figure 1 gives location of the schemes selected for the study.

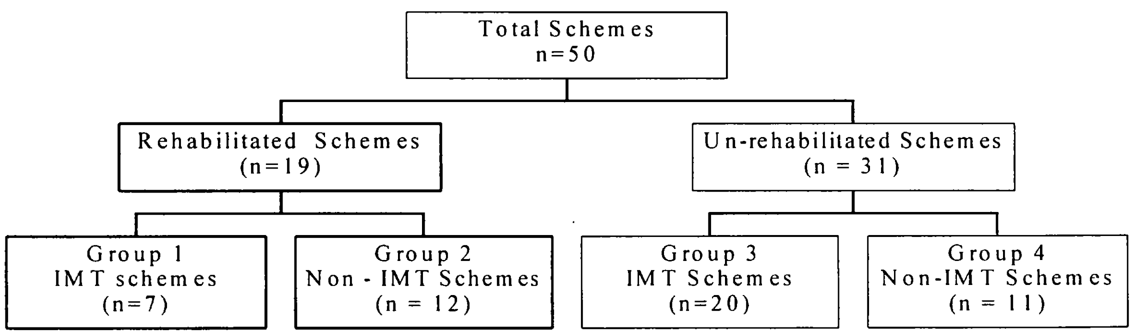
The analysis is based on both time series and cross-sectional data. Time series data covering a period often years (five years before transfer and five years after) was collected to measure changes in performance over time at the scheme level. Cross-sectional data was collected for two reference years to measure impacts at the farm level before and after transfer. The agricultural year immediately preceding the year of transfer was taken as the "before" period (Pre -IMT reference year) and the latest complete agricultural year for the "after" situation (Post-IMT reference year), provided it is at least four to five years after the year of transfer.

Two common intervening variables which could confound assessment of the impacts of management turnover are rehabilitation and rainfall. Where rehabilitation occurs along with turnover, it is nearly impossible to distinguish between the effects of transfer versus rehabilitation. Similarly abnormal rainfall in the chosen reference years could affect agricultural production and mask the effects of IMT.

To control for the effects of rehabilitation, schemes selected for the extensive survey , were first straitified into two groups: rehabilitated and un-rehabilitated.[4] Each group is sub-divided into IMT and non-IMT groups, as illustrated in Figure 2, and analyzed separately. The confounding effects due to rehabilitation would be the same in groups 1 and 2. It is assumed that differences in performance between these two groups would be due to IMT and stochastic factors. Similarly, differences in performance in the schemes in the un-rehabilitated schemes (groups 3 and 4) are assumed to be due to IMT and other factors. For the intensive component, two schemes were selected: one which had been rehabilitated and turned over and the other, turned over but not rehabilitated.

As for rainfall, the reference year was selected only if annual rainfall did not differ by more than 25 percent (above or below) from the long term average annual rainfall for the area. If this condition was not met, the "normal" rainfall year closest to the reference year was selected.

Figure 2. Stratification of sample schemes - extensive component



Performance indicators

In this study, performance is measured in qualitative and quantitative terms. Qualitative assessment is based on farmer perceptions of changes in selected performance indicators before and after turnover. Quantitative analysis is based primarily on the standard set of indicators formulated by IIMI to assess the performance of irrigation schemes (see Molden *et al,* 1998). The indicators relate to financial, agricultural, hydrological and economic performance across irrigation systems. The

[4] For sampling purposes, we define rehabilitation herein as being restoration or improvement of irrigation scheme infrastructure (i.e., canals and water control structures) wherein annual expenditure levels exceed the average annual O&M budget by at least 50 percent. Where expenditure in a schemes was less than this, it was not considered as rehabilitation.

indicators a require limited amount of data, and their computation is straightfoward. The set of indicators used to assess performance in this study and the level at which they were measured are set out in Table 1.

Table 1. Performance indicators and the level at which they are measured

Performance Indicators	Scheme level	Farm level	Data Source
Financial performance indicators			
Annual operations and maintenance cost per hectare to government	X		Secondary data
Irrigation cash costs per hectare to farmers		X	Farmer survey
Value of family labor contributions for canal maintenance		X	Farmer survey
Total irrigation costs per hectare to farmers		X	Farmer survey
Farmer perceptions of changes in irrigation costs		X	Farmer survey
Operational performance indicators			
Relative irrigation water supply	X		Secondary data
Relative total water supply	X		Secondary data
Farmer perceptions about adequacy, timelines and equity of water supply		X	Farmer survey
Maintenance performance indicators			
Percentage of sample canal lengths with critical and noticeable defects after transfer	X		Field inspection
Percentage of structures which are fully functional, partly functional and dysfunctional after transfer	X		Field inspection
Cost to repair dysfunctional structures relative to annual average budget	X		Analysis of inspection data
Farmer perceptions about canal conditions before and after transfer		X	Farmer survey
Agricultural performance indicators			
Cropping intensities by season		X	Secondary data
Yield of major crops by season		X	Secondary data
Farmer perceptions of changes in paddy yield		X	Farmer survey
Farmer perceptions of fertilizer usage		X	Farmer survey
Economic performance indicators			
Standardized gross value of output per hectare[5]	X		Estimated from Secondary data
Standardized gross value of output per unit of water diverted	X		Estimated from Secondary data

[5] Standardized Gross Value of Output (SGVO) $= \left(\sum_{crops} \frac{A_i Y_i P_i}{P_b} \right) P_{world}$

where: Y_i is the yield of crop i; P_i is the local price of crop i; P_{world} is the international price the base crop; A_i is the area cropped with crop i; P_b is the local price of the base crop. For a detailed explanation of SGVO see Molden *et al,* 1998.

Analyzing trends in performance

A major aim of the analysis was to determine the annual trends in selected performance indicators during the period 1985-1995, which covered 5 years before turnover (1985-90) and 5 years after (1991-1995). A set of regression equations was estimated based on data obtained from the 50 schemes selected for the extensive survey. The analysis was carried separately for the rehabilitated and non-rehabilitated group. The following performance indicators as the dependent variable:

- government expenditure for O&M from 1985-1995,
- cropping intensity(CI), 1985-1995,paddy yield per hectare, 1985-1995,
- standardized gross value of output(GVO) per hectare, 1985-1995,
- GVO per cubic meter of water diverted, 1985-1995.

Seasonal data on cropping intensities, paddy yields, and GVOs per unit of land and water were adjusted for seasonal variations and analyzed as annual values. The analysis is based on the mean value of the dependent variable in each group. As the number of observations in each group are different, the error term variance for the mean value for each group is not constant. In such situations it is necessary to weight the value of the observation (the mean, in this case) by the reciprocal of the observation's error term variance (I/a;) (Neter, Wasserman and Kutner, 1983). As 1/ is proportional to the number of observations in a group, the mean value of the dependent variable for each group was weighted by the number of observations in that group.

Piecewise regression models were fitted to analyze trends in performance in the two time period: period before IMT (1985-90) and the period after (1991-95). The aim was to determine whether a performance indicator shows a particular linear trend from 1985 up to 1990, the year of transfer, but follows a different trend in the post-IMT period. This involves testing whether: a) there is a statistically significant difference in the slopes of the regression lines for the two time periods.

In formulating the model the following assumptions are made:

- the trend in the dependent variable in the pre-IMT period (1985-1990) is the same for all groups (i.e. in the pre-IMT period , the slopes of the regression functions for the different groups are the same),

- in the post-IMT period not only do the regression functions shift (i.e. intercept changes) but also the trend changes (i.e. slopes change)

A common set of explanatory variables was specified in all equations. These includes a *Time* variable (T) which captures the effect of time (measured in years) on the dependent variable, and two *Dummy* variables, one (Dl) to reflect whether the schemes have been transferred or not, and the other (D2) to indicate the two time periods: before and after turnover .

The following regression function was used to analyze trends in performance:

$$Y = a_0 + a_1 T + a_2 D1 + a_3(T-1990)D1 \times D2 + a_4(T-1990)D2(1-D1) + a_5 D1 \times D2 \quad \text{............ (1)}$$

Where: Y = Performance Indicator (O&M/ha; Cropping intensity; yield/ha; GVO/ha; GVO/m^3)
T = Time in years (1985.............1995)
D1 = 1 for schemes which have been transferred
0 otherwise
D2 = 1 if T, >1990
0 if T<=1990
a_0......... a_5 are parameters to be estimated

The model design permits the estimation of: a) the trend in government expenditure for O&M/ha in the pre-IMT period (a_1), b) difference in the intercept terms of the transferred and non-transferred groups (a_2), c) change in trend (slope shift) in the dependent variable in the post-IMT period for IMT schemes with (without in the second stage analysis) rehabilitation (a_3), c) change in trend (slope shift) in the post-IMT period of non-IMT schemes with (or without) rehabilitation (a_4), d) the shift in the dependent variable at the point of transfer in the transferred schemes with (or without) rehabilitation(a_5). The latter (d) was incorporated in the model only when examining the trend government expenditures for O&M. It was expected that there would be a sharp drop in government investments with the transfer of O&M responsibilities to FOs. Parameter ($_5$) was not estimated for the other dependent variables as a sudden shift in the variables were not expected at the point of transfer.

Data sources

A farmer survey, a key component of the methodology, was carried out to collect data on the impacts at the farm level. A sample of 90 farmers from each of the two schemes were selected by stratified random sampling. The sampling unit was a selected parcel of land in the irrigation scheme.The respondents were those identified as primary cultivators of the parcel. Farmers were asked about current performance and their perceptions about changes in selected performance attributes before and after turnover.

Secondary data retrieval was mainly confined to acquiring time series data relating to the performance of the scheme for a period of five years before and five years after turnover. Information was collected on a number of performance measures, including finance, O&M, agricultural productivity, economic productivity and environmental sustainability. Records maintained by various government agencies were the main source of information.

Key informant interviews were conducted primarily amongst farmer organization leaders to obtain information about post-IMT changes in the organization, operations, maintenance, and financing of irrigation management. This provided insights into an important causal linkage between turnover and observed impacts.

Direct inspection of irrigation system structures was done to assess the functional condition of irrigation infrastructure.

RESULTS

Impact on government expenditures for O&M

The government's main interest in transferring management of irrigation at the sub-system level to farmer organizations was to reduce its own recurrent cost of irrigation. This section examines impact of management transfer on government's recurrent costs for irrigation by examining the trend in government expenditure for O&M over the during the period 1985-1995 which covered 5 years before IMT and 5 years after. The hypotheses advanced are:

- there would be a declining trend in government expenditure during the period 1985-95,
- with the transfer of O&M responsibilities to farmer organizations in 1990, the government's recurrent cost for irrigation will be lower in the transferred schemes than in the non-transferred schemes.

The hypotheses were tested by regression analysis using the model described above. The analysis was carried out separately for the rehabilitated schemes and un-rehabilitated group.

Figures 3 and 3a give the trend in government expenditure in the four groups of schemes during the period 1985-1990. The estimated regression coefficients for the rehabilitated group (groups 1 and 2) and the un-rehabilitated group (groups 3 and 4) are given in Tables 2. The results of the analysis indicates that between 1985-90, there is a statistically significant decline in the trend in government expenditure for O&M in all four categories of schemes. The change in trend in the post-IMT period (parameter a_4) is not significant for the non-IMT groups. This suggests that the declining trend continues in the post -IMT period as well. It is noteworthy that after 1990, there is a change in the trend in government investment for O&M in the IMT schemes irrespective of whether they had been rehabilitated or not. However, the change is statistically significant only for the group showing the effects of both rehabilitation and management transfer. The results also indicate that the reduction in government investment in O&M/ha in the year in IMT was implemented (parameter a_5), it was statistically not significant.

Figure 3 Government expenditure for O&M in the rehabilitated schemes with and without IMT

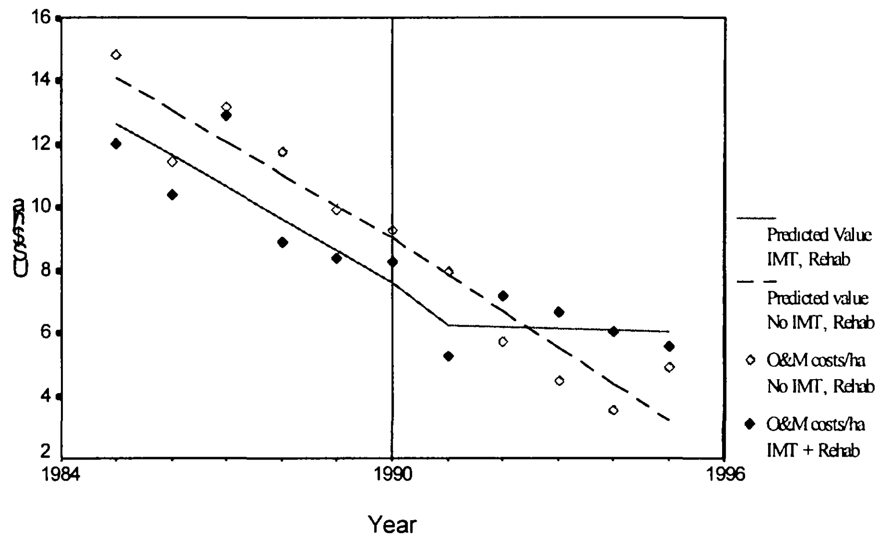


Figure 3a Government expenditure for O&M in the un-rehabilitated schemes with and without IMT

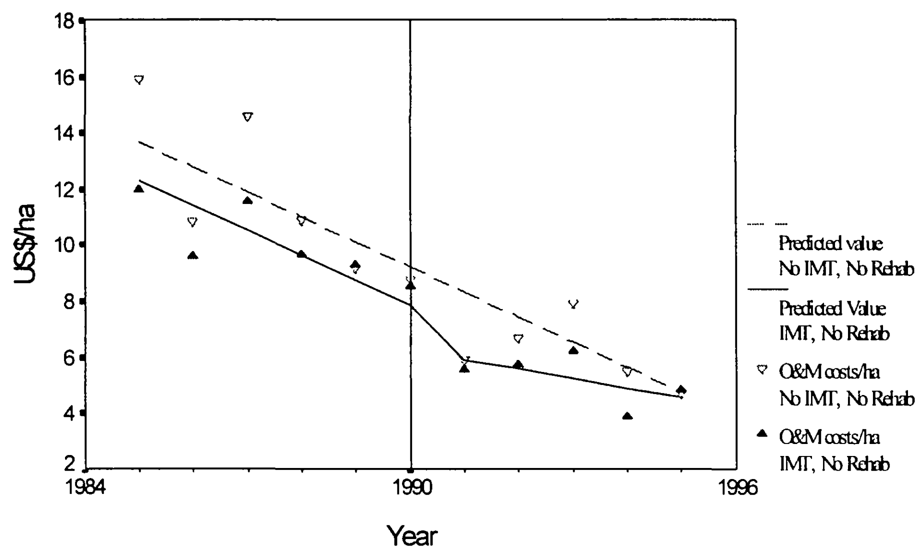


Table 2. Estimated regression coefficients for trends government expenditure for O&M 1985-1995

Variable Description	Coefficients	
	Rehabilitated Schemes (groups 1 and 2)	Un-rehabilitated Schemes (groups 3 and 4)
constant (a_0) 1995 US$/ha	15.09	14.59
Trend in the pre-IMT period (a_1)	-1.011 (-5.581)*	-0.899 (-4.181)*
Difference in the intercept terms between the IMT and Non-IMT in the pre-IMT period (a_2)	-1.414 (-2.079)*	-1.392 (-1.820)
Change in trend in O&M costs/ha in the IMT schemes in the post-IMT period (a_3)	0.964 (2.099)*	0.558 (1.311)
Change in trend in O&M costs/ha non-IMT group in the post - IMT period (a_4)	-0.1531 (-0.452)	0-006 (-0.14)
Drop in government expenditure for O&M/ha in the IMT group at the point of transfer (1990), (a_5)	-1.3425 (-0.853)	-1.610 (-1.123)
adj. R^2	0.88	0.82
F. stat	32.11*	20.57*

* significant at or less than 1% level Figures in parenthesis are t values

Impact on cost of irrigation to farmers

In Sri Lanka, irrigation water has traditionally been supplied free of charge to farmers. Attempts made at various times in the past to levy a fee from farmers for the irrigation service were largely unsuccessful. The government expected that by transferring O&M functions to FOs, the farmer organizations would recover the cost of O&M from its membership (Ratnayake, 1995). The hypothesis advanced here is, where farmers did not incur any cost for irrigation before transfer, the adoption of participatory management will lead to an increase in cash costs and labor contribution for irrigation. The hypothesis was tested by computing the current cost of irrigation to farmers, and farmer perceptions of how current costs compares with costs before turnover.

The analysis is based on a sample survey of farmers in Nachchaduwa and Hakwatuna Oya schemes. Three kinds of irrigation costs were assessed: cash payments, payments made in kind and unpaid family labor contributions for canal maintenance.[6] In addition, farmers were asked about any "unofficial" payments made to obtain irrigation water. Table 3 gives the actual irrigation costs reported by farmers in the post-turnover reference year (1994-95). The total cost of irrigation is about the same (approximately US$ 15-16/ha) for both schemes. Data show that after turnover farmers generally contributed more in the form of unpaid family labor (60 % in Nachchaduwa and 58 % in Hakwatuna Oya) than in cash or kind for canal maintenance.

[6] In Sri Lanka, farmers are expected to take part in *shramadana* (voluntary labor contribution) activities for weeding and desilting of canals. The activities are arranged by the agency personnel or FOs in transferred scemes. This is usually arranged on a day prior to the commencement of the cultivation season.

In the survey, farmers were asked to compare irrigation costs in the post- turnover reference year with costs of irrigation before turnover. A substantial majority (90%) of farmers in both schemes claimed that there was no cash fee on irrigation before turnover. After the transfer of O&M functions to FOs, some organizations charged a modest fee for canal maintenance.[7] The survey results showed that only a minority of farmers (23 % in Hakwatuna Oya and 16 % in Nachchaduwa) paid the maintenance fee. In both schemes, the irrigation cost to farmers is primarily unpaid family labor contributions for canal maintenance and payments in kind (half-bushel or 11 kgs of paddy per acre) to the person employed by the FO to distribute water.

Table 3. Annual irrigation costs to farmers after IMT (1994-95)

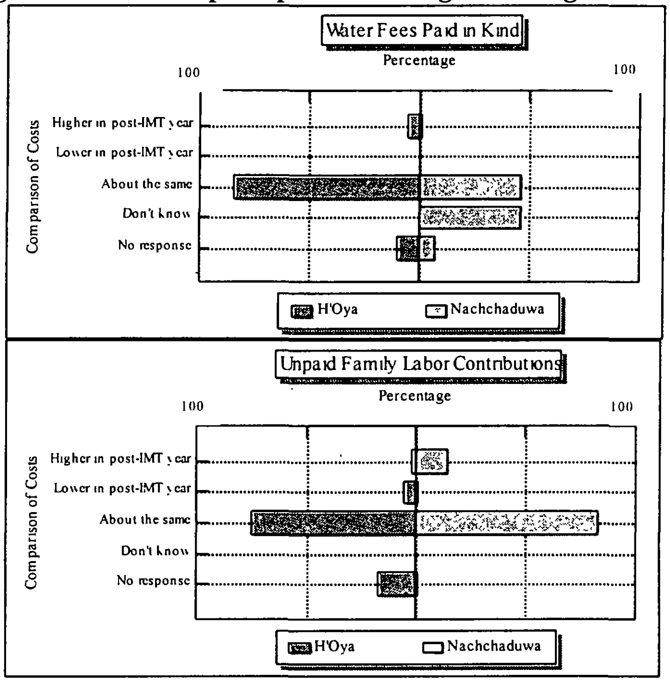
Cost Components	Units	Nachchaduwa scheme	Hakwatuna Oya scheme
Cash costs per hectare[a]	US$/ha	6.34 (36)[b]	6.58 (50)
Value of unpaid family labor contributions for canal maintenance	US$/ha	8.18 (67)	9.00 (74)
Total Irrigation Costs[c]	US$/ha	14.52 (47)	15.58 (54)

Source: Farm Survey (July and November, 1996)
[a] Irrigation cash costs include cash payments plus the monetary value of payments made in kind.
[b] Figures in parenthesis are the coefficients of variation in percentage terms.
[c] Total irrigation cost = Irrigation cash costs + monetary value of family labor.

Figure 4 gives farmers' perception of changes in irrigation cost components before and after turnover. A majority of farmers claimed that water fees paid in kind and unpaid family labor contributions for canal maintenance had remained about the same before and after turnover. In Nachchaduwa, about 18 percent of the farmers claimed that they contributed more labor after turnover than before. In both Nachchaduwa and Hakwatuna Oya well-defined procedures for cost recovery have not been established as yet. Data from the two schemes do not provide evidence of an increase in the cost of irrigation following the introduction of participatory management.

[7] In most cases the amount levied was Rs. 50 per acre each season (approximately US$2.5/ha).

Figure 4. Farmer perception of changes in irrigation costs



Quality of irrigation service

It has been argued that as farmers have a vested interest in the irrigation service, involving them directly in irrigation management would lead to improvements in the quality of the service. This section examines the whether the introduction of participatory irrigation managemen resulted in an improvement in the quality of irrigation service. The analysis is based on data obtained from Nachchaduwa and Hakwatuna Oya schemes. Changes in the quality of irrigation service were assessed by computing Relative Irrigation Supply (RIS) and Relative Water Supply (RWS), and farmer perceptions about changes in the adequacy, timeliness and fairness of water distribution, and incidence of irrigation related conflicts among farmers before and after turnover. RIS is the ratio of irrigation supply to demand and can be considered as an indicator of efficiency and adequacy of targeting water delivery at the scheme level. RWS is the ratio of total water supply (irrigation plus rainfall) to demand. RIS and RWS were computed for both wet (first) and dry (second) seasons for a ten -year period. The estimates were based on the norms used by the Irrigation Department for determining water demand for paddy and other field crops grown in the dry zone irrigation schemes.[8]

[8] The norm adopted by the Irrigation Department to estimate water demand for paddy and other field crops for major irrigation schemes is 15000 m^3/ha in wet season *(Maha)* and 17000 m^3/ha in the dry season *(Yala)* (Irrigation Dept. personal comm.). RWS was estimated on the basis of 60% effective rainfall in wet season and 80 % in the dry season.

Figure 5 gives the trend of RIS and RWS for the period 1985-95. In both schemes there is no obvious change in RIS and RWS in the years before and after turnover. An exception is that in Nachchaduwa there appears to be excess irrigation in the wet seasons of 1994 and 1995. This was due the high rainfall experienced in these years and more water being released into the canals.

Figure 6 displays farmer perceptions about the quality of irrigation service before and after turnover. Most farmers in both schemes consider the water supply to be adequate before and after turnover. However, in Nachchaduwa about one-third of the farmers in the head-reach and about 25 percent of them in the middle and tail-end areas reported that water supply in both seasons had worsened after turnover. Farmers attributed the worsening of water supply to the poor quality of work done during rehabilitation prior to management transfer. The responses of a majority of farmers in both schemes were similar with regard to the timeliness of water supply, fairness of distribution and the frequency of conflicts over water distribution, namely, that these had not changed significantly after transfer. What was negative or positive before remained so afterwards.

Impact on maintenance

In order to assess the impact of IMT on the maintenance of the irrigation infrastructure, a detailed inspection was conducted of the full length of main canals and a sample of six distributary canals in each scheme, and all structures along these canal reaches . Canal reaches and structures were classified as 'functional' (F), 'nearly dysfunctional' (ND) and 'dysfunctional' (D).[9] Canal lengths were considered 'defective' if one of the following problems existed and if it interfered with desired hydraulic operation:

- constriction or enlargement of the canal cross section,
- visible siltation and/or encroachment of freeboard or adjacent road,
- visible seepage,
- slippage, scouring or other defect in embankment, and cracks or other damage to canal lining.

Main and distributary canals were divided into quartile reaches. Table 4 shows for both schemes the percentage of total canal length in each quartile which was defective, for main and distributary canals. Despite rehabilitation in Nachchaduwa, the average percentage of main canal length which was defective was about the same in both schemes, at 15% (which would be considered relatively high for a main canal). However, at the level of farmer investment, the distributary canals in Nachchaduwa were in significantly better condition (only 3.2% defective) than in Hakwatuna Oya (about 15% defective).

Table 5 gives the functional condition of irrigation structures that were inspected. Control, conveyance, measurement or ancillary structures were considered defective (D or ND) if one of the following conditions was present:

[9] A 'functional' structure can currently perform itsdesign function and shows no signs of losing this capacity within about a year. A 'nearly dysfunctional' structure is one which is considered likely to become unable to perform its basic function within about one year's time. A 'dysfunctional' structure is one which was unable to perform its basic function at the time of the inspection. For canal reaches, 'dysfunctional' means it is unable to convey at least 70% of the desired flow capacity. 'Nearly dysfunctional' means it is likely to become dysfunctional within about one year

- scouring of canal around structure,
- approach section, rubble pack and wings of structures are breaking apart,
- water control structure cannot control flow as intended (due to gates or sills missing, eroded or damaged, significant leakage at gates or damaged mechanism of movable structures),
- water measurement structure cannot be used to measure flow due to damaged or missing gauge, recorder or other component, or
- civil works of ancillary structures damaged or poorly constructed.

Only 5% of all structures in both schemes were dysfunctional. In both Nachchaduwa and Hakwatuna Oya more than 60 percent of all dysfunctional structures observed at the distributary level had been dysfunctional less than one year. In Nachchaduwa 72 percent had been dysfunctional for less than two years, in Hakwatuna Oya this was 94 %. There is no indication of significant long term deferral of maintenance by farmer's in Hakwatuna Oya. However, in Nachchaduwa 5 of the 18 dysfunctional structures (28%) had been dysfunctional for three to four years. This is probably because of the extended rehabilitation program and the expectation that the dysfunctional structures would eventually be repaired by the government.

Table 4. Functional condition of canal lengths inspected

Canal Type	Quartile reaches	Nachchaduwa		Hakwatuna Oya	
		Length	Percent defective	Length	Percent defective
Main canals	Q1*	10,007	20.5	4,686	5.4
	Q2	10.007	13.5	4,686	14.9
	Q3	10,007	5.7	4,686	39.1
	Q4	10,007	23.7	4,686	2.1
	Total	40,027	15.9	18,745	15.4
Distributory Canals	Q1	2,453	11.4	8,164	23.7
	Q2	2,453	0	8,164	19.5
	Q3	2,453	1.4	8,164	9.6
	Q4	2,453	0.2	8,164	6.6
	Total	9,812	3.2	32.657	14.9

* Listed from head (Ql) to tail end (Q4) of canals.

Figure 5 Relative Irrigation Supply and Relative Water Supply -1985 - 1995, Nachchaduwa and Hakwatuna Oya Schemes

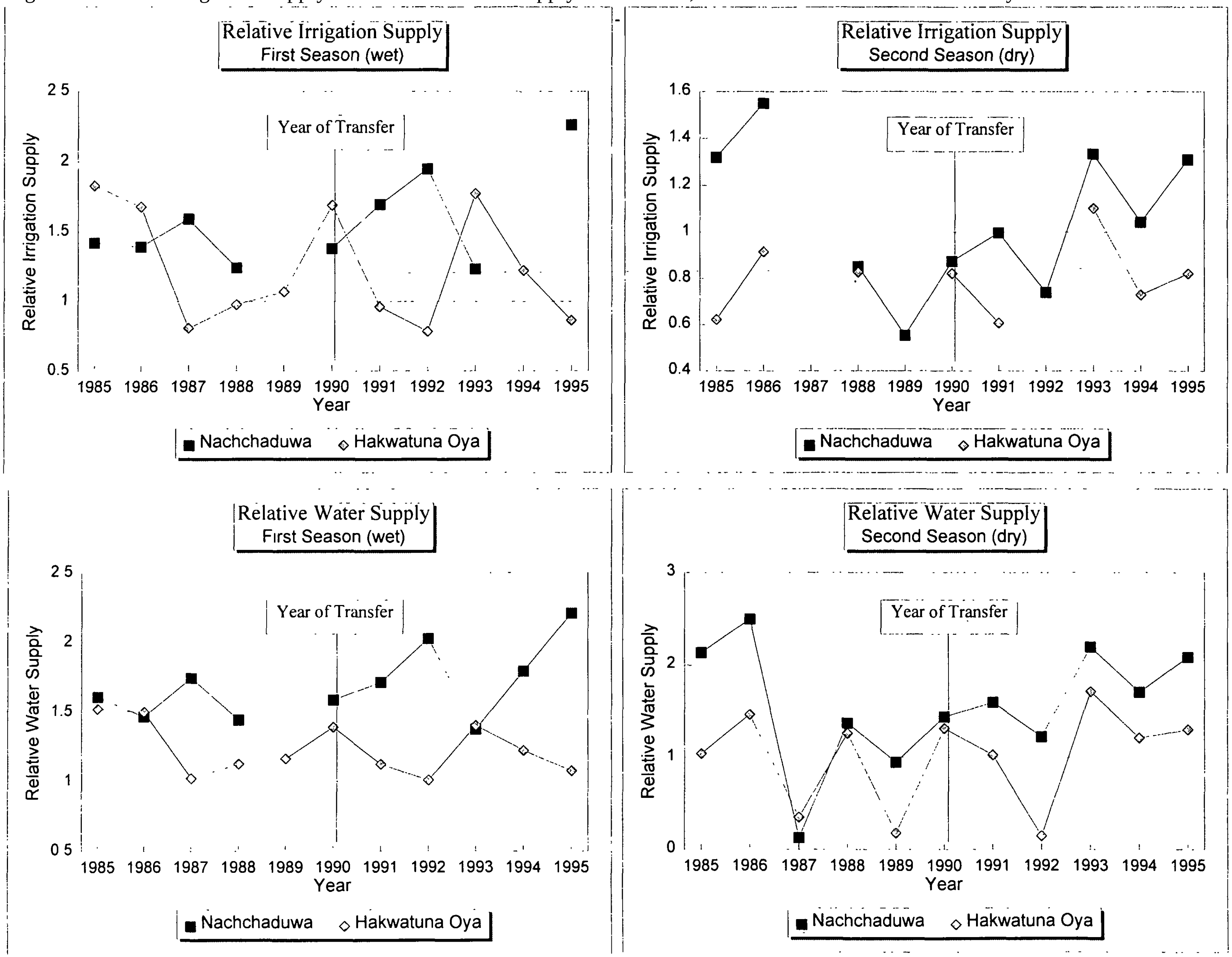


Figure 6: Farmer Perceptions of the quality of irrigation services, before and after turnover

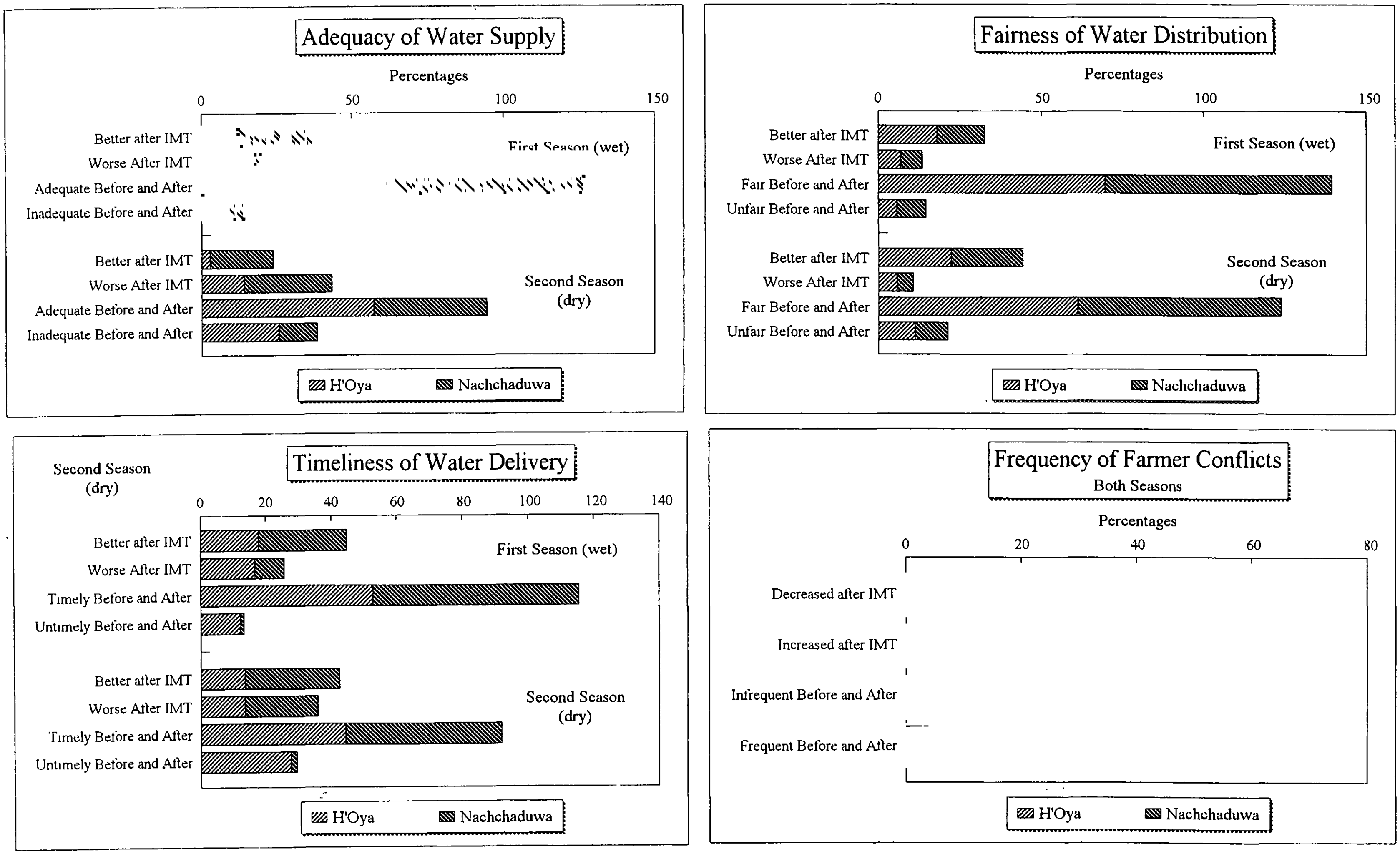


Table 5. Functional condition of structures inspected

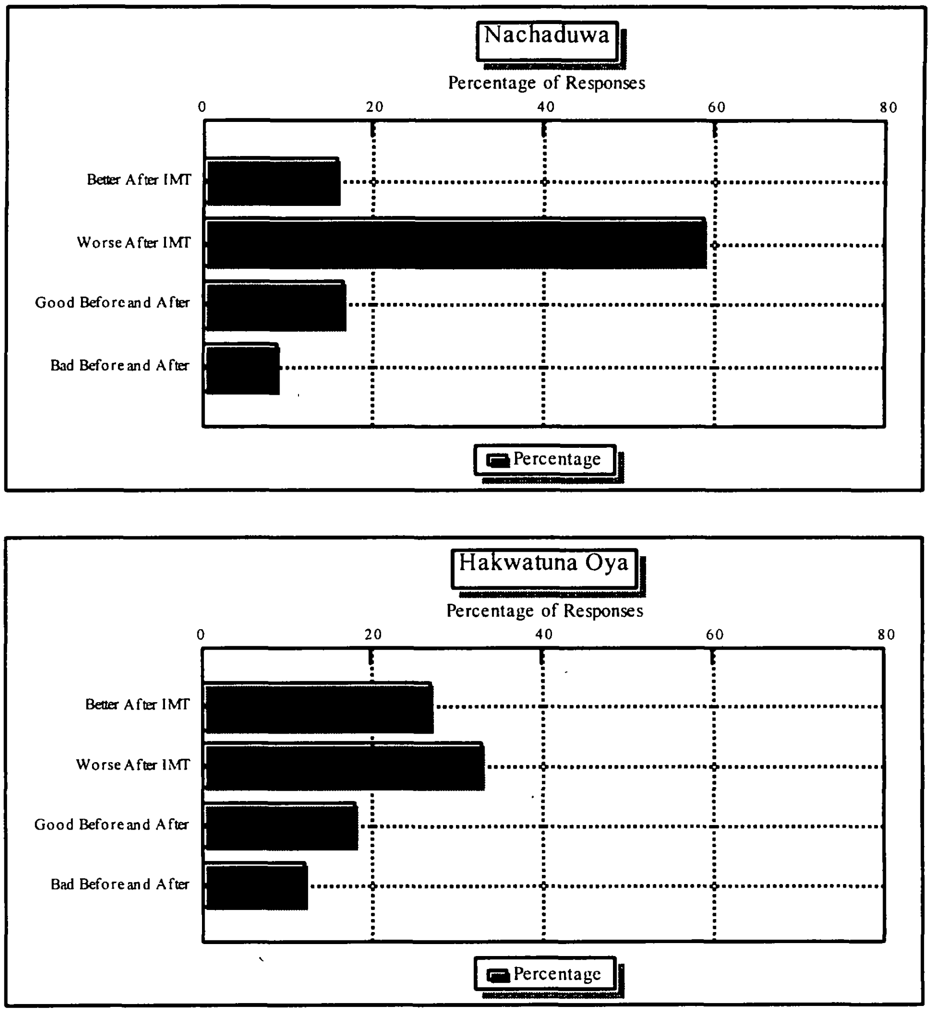
Type of structure	Total structures inspected	Number dysfunctional	Percentage dysfunctional
Nachchaduwa			
Water control	191	44	18.7
Water conveyance	67	1	1.5
Water measurement	0	0	0
Ancillary	267	1	0.4
Total	525	25	5
Hakwatuna Oya			
Water control	164	4	2.4
Water conveyance	180	18	9.1
Water measurement	3	0	0
Ancillary	177	3	1.7
Total	524	25	5

Finally, on the whole, farmer perceptions of the quality of maintenance are more negative in Nachchaduwa than in Hakwatuna Oya (Figure?). In Nachchaduwa nearly 60 percent of all farmers interviewed felt that the functional condition of the canal system was worse after management transfer. This implies extensive farmer dissatisfaction with the rehabilitation, which was done without farmer participation. In Hakwatuna Oya farmers were more evenly split in their views about whether the functional condition of canal infrastructure was better or worse after management transfer.

Impact on agricultural production

An important objective of government investments in irrigation development is to enhance agricultural production in the country, particularly rice production. Currently, some two-thirds of the national rice output are from the irrigation schemes. In recent years there is growing concern about the low cropping intensities and stagnation of yield in the irrigation schemes. If the shift of primary responsibility for water distribution to farmer organization leads to an improvement in the quality of irrigation service, one could expect cropping intensities to improve, farmers to use more inputs due to greater confidence in the irrigation service, which in turn would lead to higher yields. The hypothesis advanced is that irrigation management transfer would lead to higher agricultural productivity. The hypothesis is tested by comparing the trends in paddy yields and cropping intensities in 50 schemes over a ten-year period. The analysis was carried out separately for the rehabilitated and un-rehabilitated schemes with and without the effects of management transfer.

Figure 7. Farmer perceptions of functional condition of canals



Trends in paddy yields

Regression analysis was carried out to analyze the trend paddy yeild during the period 1985-95. The model permits the comparison of trends in paddy yield in the rehabilitated and un-rehabilitated schemes with and without the effects of management transfer. Figure 8 and 8a gives the yield trends in each group. Table 6 shows the estimated coefficients.

Table 6. Estimated regression coefficients explaining trends in paddy yield in the selected schemes, 1985-95

Variable Description	Coefficients	
	Rehabilitated Schemes (groups 1 and 2)	Un-rehabilitated Schemes (groups 3 and 4)
constant (a_0) Kg/ha	4699	4054
Trend in the pre-IMT period (a_1)	-89.63* (-3.0091)	27.83 (0.984)
Difference in the intercept terms between the IMT and Non-IMT group in the pre-IMT period (a_2)	-120.99 (-1.012)	-970.57* (-8.811)
Change in trend in paddy yield in the IMT schemes in the post-IMT period (a_3)	221.94* (3.469)	106.61 (1.884)
Change in trend in paddy yield in the non-IMT group in the post - IMT period (a_4)	152.91* (2.689)	-44.65 (-0.745)
adj. R^2	0.69	0.71
F. stat	19.94*	22.31*

* significant at or less than 1% level
Figures in parenthesis are t values

The results indicate that in the pre-IMT period, paddy yields in the rehabilitated schemes show a declining trend. The negative sign of parameter a_2 suggests that mean yields in the IMT schemes are lower than the non-IMT schemes during this period in both categories. However, the difference is not significant in the rehabilitated schemes. Except for the un-rehabilitated and non-IMT group, there is an upward shift in the trend in yield in the other three categories. The change in trend is statistically significant in the rehabilitated schemes with and without the effect of management transfer. It is noteworthy that the rate of change in yield is higher in the rehabilitated and transferred group (a_3 = 221.9) than the un-rehabilitated schemes (a_4 = 152.9). Yields in schemes without the effects of any intervention show a declining trend.

In contrast, un-rehabilitated schemes which have been transferred show an increasing trend in the post-IMT period. In either case, the change in trend in the post-IMT is statistically not significant. The conclusion which emerges from the analysis is that there has been a significant improvement in yield in the schemes which have the effects of both management transfer and rehabilitation. In the systems which have been transferred but not rehabilitated, the declining trend in yield has been reversed in the post-IMT period.

Figure 8. Paddy yields in the rehabilitated schemes with and without IMT

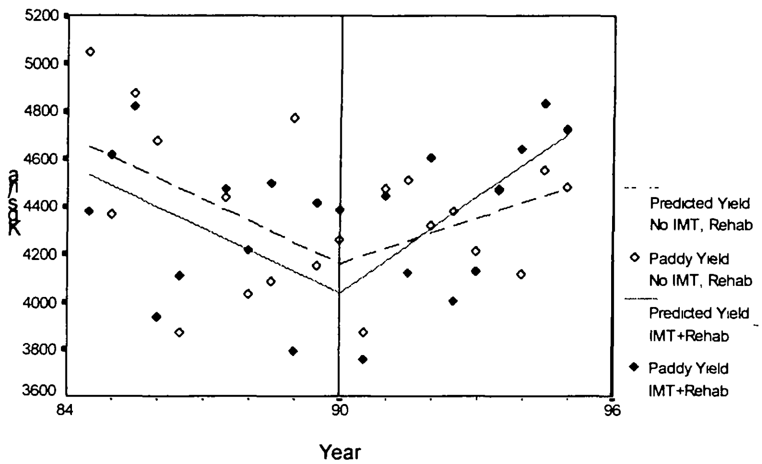
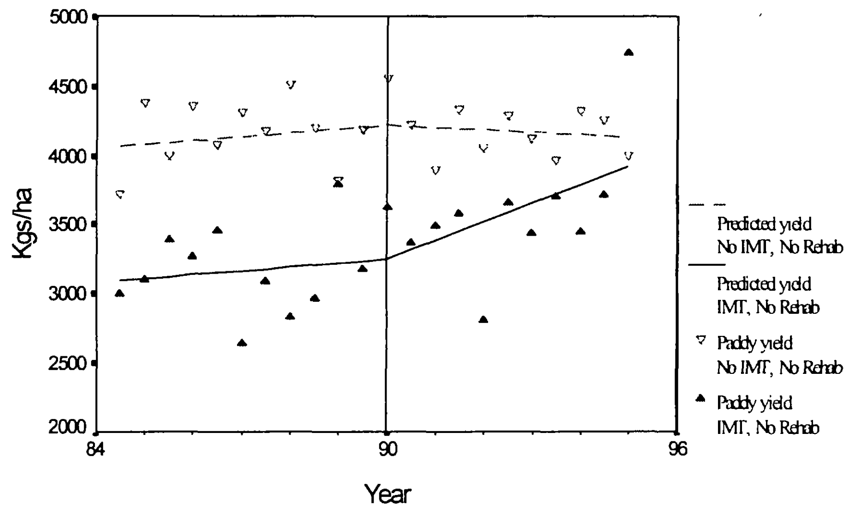


Figure 8a. Paddy yields in the un-rehabilitated schemes with and without IMT



Cropping intensities[10]

The regression model outlined earlier was used to analyze trends in cropping intensities in the different groups of schemes. Figures 9 and 9a ,give the trend in cropping intensities during the period 1985-95. The estimated regression coefficients are given in Table 7.

[10] Cropping Intensity = $\frac{\text{Area cultivated in First (maha) season + Area cultivated in second (yala) season}}{\text{Cultivable Area x 2}}$ X 100

Table 7. Estimated regression coefficients explaining trends in cropping intensities in the selected schemes, 1985-95

Variable Description	Coefficients	
	Rehabilitated Schemes (groups 1 and 2)	Un-rehabilitated Schemes (groups 3 and 4)
constant (a_0) Cropping Intensity (%)	87	70
Trend in the pre-IMT period (a_1)	-0.362 - (-0.1701)	0.154 (0.250)
Difference in the intercept terms between the IMT and Non-IMT group in the pre-IMT period (a_2)	-10.216* (-4.136)	8.399* (3.568)
Change in trend in cropping intensities in the transferred schemes in post-IMT period (a_3)	2.805* (2.131)	0.0732 (0.059)
Change in trend in cropping intensities in the non-IMT group in the post - IMT period (a_4)	-0.7843 (0.680)	-1.686 (-1.274)
adj. R^2	0.36	0.48
F. stat	6.65*	9.16*

* significant at or less than 1% level
Figures in parenthesis are t values

The results of the analysis indicates that in all four types of schmes the trend in cropping intensities in the pre-IMT period had been relatively stable. But, cropping intensities in the schemes which had been rehabilitated and transferred were significantly lower than the cropping intensities in the non-transferred schemes (- a_2). In un-rehabilitated schemes, cropping intensities in the IMT schemes were significantly higher than the non-IMT schemes (+a_2). In the post-IMT period, schemes which had been rehabilitated and transferred show a statistically significant increase in cropping intensities. In the same period, there has been a slight (statistically not significant) decline in cropping intensities in non-IMT schemes.

The analysis presented in this section indicates that there has been an improvement in paddy yields in schemes which have undergone both management transfer and rehabilitation. This was very evident from the analysis of data from the extensive component (group 1) and as well as the qualitative data obtained in the intensive study (Nachchaduwa). The analysis indicates that agricultural production has stagnated in the groups with only one type of intervention (rehabilitation or IMT) and has declined slightly (statistically not significant) in schemes where there has not been any intervention.

Figure 9. Cropping intensities in the rehabilitated schemes with and without IMT

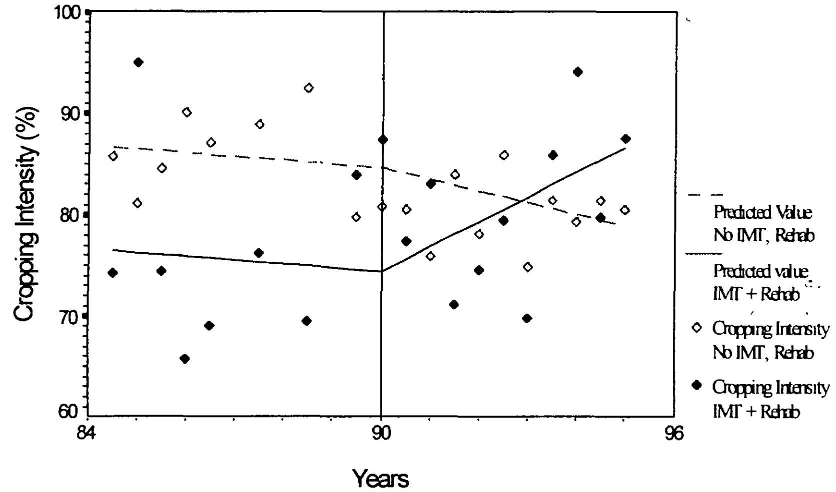
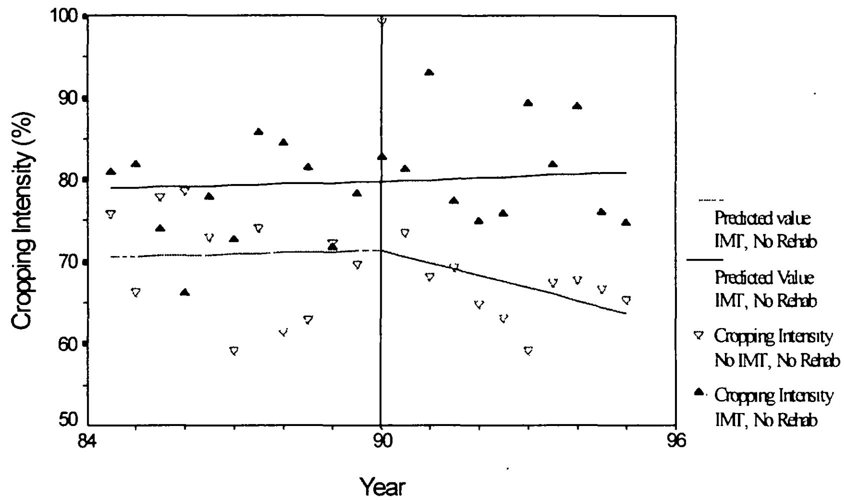


Figure 9a. Cropping intensities in the un-rehabilitated schemes with and without IMT



Economic returns per unit of land and water

This section examines the value of agricultural production over a ten-year period of five years before transfer and five years after. Both the gross value of output per unit of land and per cubic meter of water were estimated. In estimating the gross value of output, the value of all crops produced in the scheme was considered. To permit international comparison the total value of crops was standardized in terms the international price of rice which is the predominant crop cultivated in the irrigation schemes in Sri Lanka, and expressed in terms of constant 1995 US dollars.[11] The

[11] The method of estimating the standardized gross value of output is explained in Perry, 1996.

trends gross value of production were analyzed using the regression model described earlier. The analysis is based on data obtained from the 50 schemes selected for the extensive study. The analysis was carried out separately for the rehabilitated and non-rehabilitated schemes with and without the effects of management transfer.

Figures 12 and 12a displays the trend in the gross value of output per hectare for the four groups of schemes. Table 8 gives the estimated regression coefficients of the parameters used to estimate trends in the gross value of agricultural production per hectare. The results show a declining trend in gross values of output/ha (GVO/ha) in the pre-IMT period.The decline is statistically significant for the rehabilitated schemes and not for the un-rehabilitated group (parameter estimate a_1). In both cases, the mean GVO/ha in the transferred group is lower than the non-transferred group. The difference is statistically significant in the case of the un-rehabilitated group. In the post-IMT period, there has be en a statistically significant upward shift in the value of agricultural production in the transferred schemes (parameter a_3). Data also shows statistically significant upward shift in the GVO/ha of schemes with rehabilitation but not transferred. Yet the rate of increase in the group with the effects of both management transfer and rehabilitation is higher than with rehabilitation alone. The group without any intervention also shows a slight upward shift. The shift is not statistically significant.

Table 9 gives the estimated regression coefficients of the parameters used to estimate trends in the gross value of agricultural production per unit of water. Figure 11 and 1 la displays the trend in the gross value of output per hectare for the four groups of schemes.

Table 8. Estimated regression coefficients explaining trends i n the gross value of agricultural production per hectare in the selected schemes, 1985-95

Variable Description	Coefficients	
	Rehabilitated Schemes (groups 1 and 2)	Un-rehabilitated Schemes (groups 3 and 4)
constant (a_0) US$/ha	1,004.07	871.56
Trend in the pre-IMT period (a_1)	-29.818* (-4.877)	- 4.792 (-0.932)
Difference in the intercept terms between the IMT and Non-IMT group in the pre-IMT period (a_2)	-39.54 (-1.577)	-190.208* (-9.501)
Change in trend in GVO/ha in the transferred schemes in post-IMT period (a_3)	64.09* (4.736)	24.454* (2.452)
Change in trend in GVO/ha in the non-IMT group in the post - IMT period (a_4)	49.416* (4.116)	3.2788 (0.300)
adj. R^2	0.48	0.75
F. stat	21.615*	27.39*

* significant at or less than 1% level
Figures in parenthesis are t values

Figure 10. Gross value of output per hectare in rehabilitated schemes with and without IMT

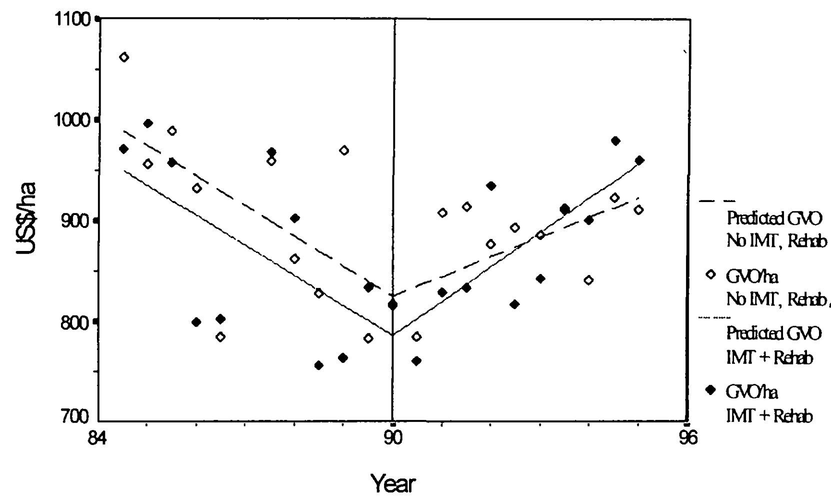
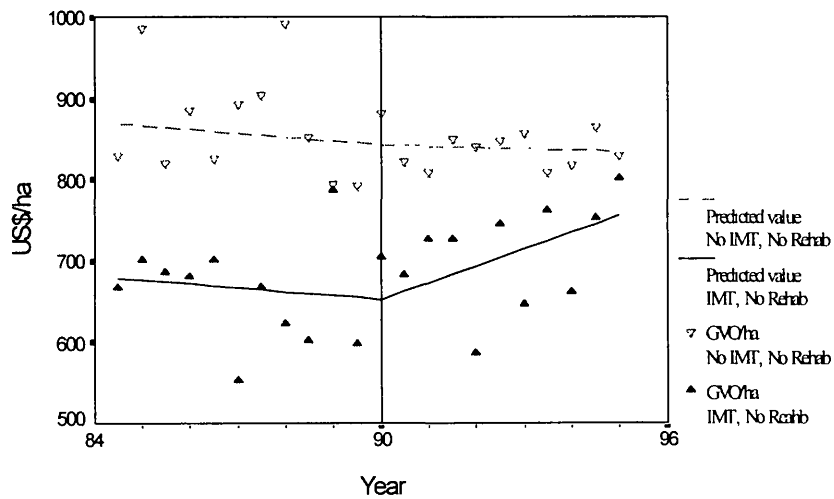


Figure l0a. Gross value of output per hectare in un-rehabilitated schemes with and without IMT



Information contained in Table 9 and Figures 11 and 1 la show that in the un-rehabilitated schemes, the productivity of water in the pre-IMT period is higher than in the group without the effects of transfer (+ sign of a_2). The situation is the reverse in the rehabilitated group, statistically significant declining trend in the productivity of water measured in terms GVO/m3 in the pre-IMT period. In all categories there is a statistically significant upward shift in the post-IMT period. The rate of increase is slightly higher in the rehabilitated schemes with IMT than those with only the effects of rehabilitation.

The conclusion which emerges from the analysis of trends in the productivity of land and water is that the productivity levels are higher in schemes which have been both rehabilitated and transferred, when compared to schemes in which only one intervention is present.

Table 9. Estimated regression coefficients explaining trends in the gross value of agricultural output per unit of water in the selected schemes, 1985-95

Variable Description	Coefficients	
	Rehabilitated Schemes (groups 1 and 2)	Un-rehabilitated Schemes (groups 3 and 4)
constant (a_0) US$/$m^3$[33]	0.10	0.05
Trend in the pre-IMT period (a_1)	-0.005* (-3.241)	0.004* (-2.814)
Difference in the intercept terms between IMT and Non-IMT group in the pre-IMT period (a_2)	-0.03* (-5.130)	0.036* (4.585)
Change in trend in GVO/ha in the transferred schemes in post-IMT period (a_3)	0.0114* (3.823)	0.0067* (2.630)
Change in trend in GVO/ha in the non-IMT group in the post - IMT period (a_4)	0.0112* (3.863)	0.0106* (2.630)
adj. R^2	0.66	0.48
F. stat	17.78*	6.9*

* significant at or less than 1% level

Figures in parenthesis are t values

Figure 11. Gross value of output per unit of water diverted in the rehabilitated schemes with and without IMT

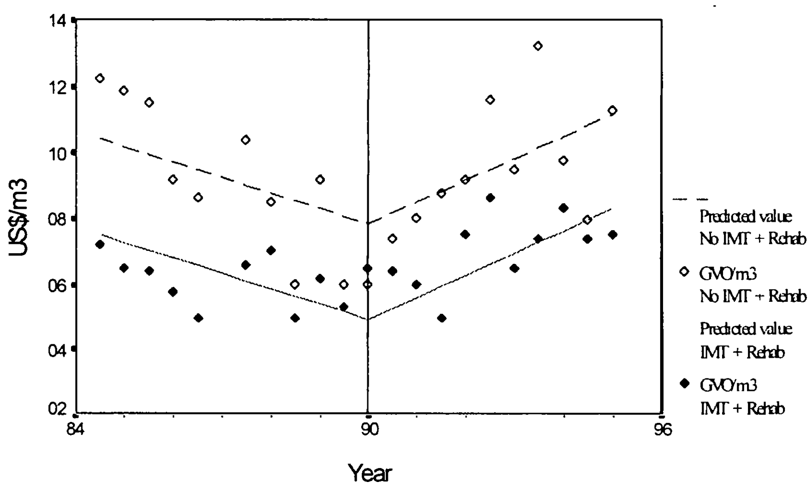
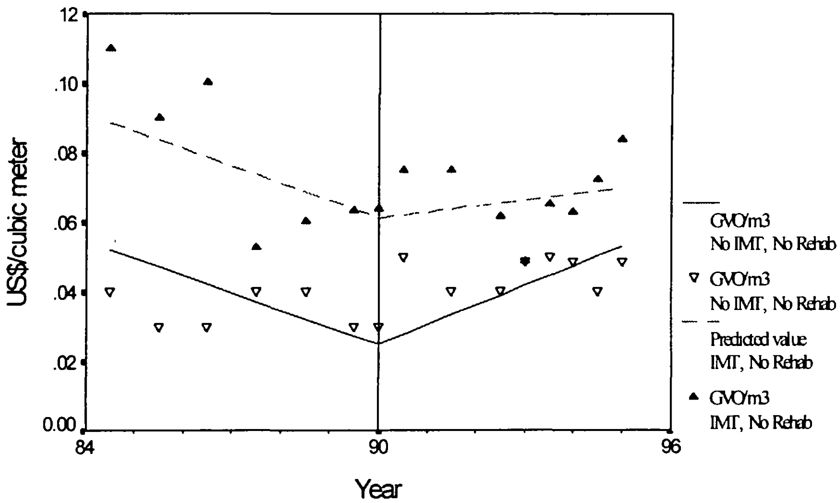


Figure 11a. Gross value of output per unit of water diverted in un-rehabilitated schemes with and without IMT



Conclusions

The principal aim of the methodology used in this text is to gauge the extent to which IMT has resulted in some change in the performance of irrigation systems. The methodology describes a plan for the collection of the data required, and presents an analytical framework that enables an investigator to demonstrate that the changes which occurred over time in the performance measures were primarily a function of IMT and not due to other factors.

Application of the impact assessment methodology to the irrigation systems in Sri Lanka has shown that the combination of performance measures, compared before and after, and with and without the intervention, can yield a comprehensive picture of the impacts of management transfer. The selected performance measures cover financial, hydrological, agricultural and economic aspects. The aim was to measure the direction of change, rather than changes in the absolute value of the performance indicators.

The evidence from this study leads to the following conclusions on the impact of the participatory irrigation management program on the performance of irrigation schemes:

- There has been a substantial decline in government expenditure on irrigation, beginning before transfer. The declining trend is not confined to schemes where IMT had occurred but, is common to non-IMT schemes as well.

- The reforms have not generated an appreciable increase in the costs of irrigation to farmers. Farmers generally make fewer direct payments (in cash and kind), but contribute more labor for canal maintenance.

- Management transfer alone did not result in significant improvements in agricultural production levels or the gross value of agricultural production per unit of land or per unit of water diverted. Neither did rehabilitation alone create significant effects. However, in schemes where both management transfer and rehabilitation occurred, significant effects on agricultural productivity levels and economic returns were observed.

- The infrastructure inspections revealed a serious under-investment in maintenance. To eliminate the backlog of deferred maintenance , both the government and farmers would have to increase investments in maintenance substantially. This raises concerns about sustainability of the schemes under participatory management

Recommendations

1. The following recommendations should be understood as working hypotheses which arise from findings of this study and more general observations about irrigation management transfer. We believe the recommendations merit serious consideration and probably some pilot testing.

2. This study indicates that basic reform is needed in the Irrigation Department so that it will be motivated to support self-reliant farmer organizations. This could include restructuring the agency to become financially autonomous and largely dependent for its revenue on payment of water charges for distributary canal organizations for satisfactory bulk supply of water to the organizations. Also, the agency could be given expanded mandates for water basin management and environmental monitoring and regulation. This could make the agency less resistant to management devolution for irrigation system management.

3. This results indicates that the distributary canal organizations need to be granted stronger and more independent legal status as an entity which can enforce collection of water charges from farmers, settle water-related disputes and apply sanctions of sufficient strength so as to obtain compliance with essential operating rules for efficient operations and maintenance of irrigation. The distributary canal organizations should be given clear water rights, which could be specified either in terms of volume or shares of water.

4. We suggest that the government should clarify its policy about who will be responsible, and under what terms and conditions, for financing and implementing maintenance, rehabilitation and modernization of irrigation system infrastructure in the future. Unclarity about this appears to be resulting in current under-investment in preventative maintenance, especially by farmers, and a complete lack of development of long-term capital replacement funds. We urge policy makers to consider developing a policy which would clearly specify a role for farmer investment in rehabilitation and modernization.

5. Farmer willingness to invest in irrigation management will be enhanced if irrigated agriculture can become more profitable. We urge policy makers to consider strategies to facilitate crop diversification, enhanced marketing and agricultural enterprise development.

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