IMPACT OF PARTICIPATORY IRRIGATION MANAGEMENT ON THE PERFORMANCE OF IRRIGATION SCHEMES IN SRI LANKA

M. Samad

(Research Associate, IIMI)

Paper prepared For the National Conference on the Status and Future Directions of Water Research in Sri Lanka, 4-6 November, Colombo, Sri Lanka.

Abstract

This paper presents the results of the study on the effects of participatory irrigation management in Sri Lanka. The assessment on impacts is made on basis of a set indicators developed by IIMI to assess the performance of irrigation schemes. Piecewise linear regression models are fitted to analyze changes in performance during the five-year period before transfer and five years after. The main aim was to measure the direction of change, rather than changes in the absolute value of the performance indicators. The results show that there has been a significant drop in government's recurrent expenditure for irrigation. However, this is not confined to schemes that had undergone management transfer, but is common to the non-transferred scheme as well. The analysis shows that management reforms had not resulted in the improvement in yield, the quality of irrigation services and productivity of water. But management transfer combined with improvements to the physical infrastructure has significant improvements in agricultural performance.

INTRODUCTION

This paper reports the results of a study on the impact of the participatory irrigation management program in Sri Lanka. The study was part of a broader effort of the International Irrigation Management Institute (IIMI) to support systematic documentation of international experience with irrigation management reforms and their impact on the performance of irrigated agriculture.

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 labeled as "Participatory Irrigation System Management" was implemented in a large number of irrigation schemes in the country.[1] Its main objectives are to:

- relieve the financial burden on government of funding recurrent expenditures for irrigation,
- improve the maintenance of irrigation facilities and the irrigation service,
- enhance the productivity of irrigated land and water,

[1] It has been estimated that participatory management has been introduced in 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).

- Promote a sprit of self-reliance among farmers in irrigation schemes (Abeywickrema, 1986; Brewer, 1994).

The aim of this study is to determine what effects participatory irrigation management has had on the performance of irrigation management and irrigated agriculture. Performance is measured from several perspectives:

The principal hypotheses tested are:

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

METHODLOGY

The assessment is made both in qualitative and quantitative terms. Qualitative assessment is based on farmer perceptions of changes in selected performance indicators before and after turnover. For this purpose a questionnaire survey was conducted in 1996/97 among a sample of farmers in two schemes: one which had which had undergone management transfer and rehabilitation (Nachchaduwa) and other (Hakwatuna Oya) which was considered as transferred but not rehabilitated.

The aim of the quantitative analysis was to determine the annual trends in selected performance indicators during the period 1985-1995, which covered 5 years before IMT (1985-90) and 5 years after (1991-1995).

Piecewise linear regression models were fitted to analyze trends in performance in two time periods: the 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 thereafter. The following performance indicators were used

- government expenditure for O&M from 1985-1995,
- Paddy yields (yield/ha) 1985-1995,
- cropping intensity(CI), 1985-1995,
- standardized gross value of output per hectare (GVO/ha), 1985-1995,
- GVO per cubic meter of water diverted (GVO/m^3), 1985-1995.

Cropping intensities, paddy yields, and GVOs per unit of land and water were adjusted for seasonal and location variations and analyzed as annual values.

A common set of explanatory variables was specified in all equations. These includes a *Time* variable (T) to capture the effect of time (in years) on the dependent variable, and a *Dummy* variable (D1) to indicate the periods before and after turnover.

The basic regression equation estimated was as follows:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 (T - T^*) D1 + e \quad \ldots\ldots\ldots (1)$$

Where: Y_t = Performance measure (O&M costs, yield/ha, CI, GVO/ha, GVO/ m^3) in year t

T = Time in years (1985.....1995)

T* = Threshold period (i.e. 1990 the year of transfer)

D1 = 1 if T, >1990

0 if T<=1990

e = random error

β_0..... β_2 are parameters to be estimated

Assuming E(e) = 0, parameter β_1 gives the slope of the regression line or the trend during the pre-IMT period (1985-90) and ($\beta_1 + \beta_2$) the trend in the post-IMT period (1991-95). A test of the hypothesis that there is a change in the trend between the two periods is conducted by noting the statistical significance of the estimated differential slope coefficient β_2.

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 costs for irrigation. This section examines the trend in government expenditure for O&M during the period 1985-1995. The hypothesis advanced is: with the transfer of O&M responsibilities to farmer organizations government's recurrent cost for irrigation will be lower in the transferred schemes than in the non-transferred schemes. The regression model (1) was used to analyze trends in government investment in O&M during the period 1985-95.

Estimates of the parameters of the model for O&M costs for the various groups are given in Table 1. The results indicate that in all four groups, there is a statistically significant declining trend ($-\beta_1$) in government expenditure for O&M during the pre-IMT period. In the post-IMT period, there is a slight reversal in the trend ($+\beta_2$) in all categories schemes except the No-IMT and rehabilitated group. However the change trend is not statistically significant.

The conclusion which emerges is that there has been a decline in government's recurrent costs for irrigation during the period 1985-95 across all categories of schemes irrespective whether IMT programs have been introduced or not, and does not fully support the hypothesis that IMT leads to a reduction in government expenditure for O&M.

Impact on Cost of Irrigation to Farmers

This section examines the implications of participatory management for the cost of irrigation to farmers. The hypothesis advanced is that, as farmers did not pay for most of the cost for irrigation before transfer, the adoption of participatory management will increase cash costs and labor contribution for irrigation.

The analysis is based on the sample survey of farmers in Nachchaduwa and Hakwatuna Oya schemes. Three kinds of irrigation costs were assessed: cash payments, payments made in kind, and the number of person days of family labor contributed for canal maintenance. Farmers were also asked about any "unofficial" payments made to obtain irrigation water. Table 2 gives the actual irrigation costs reported by farmers in the post-transfer 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 transfer 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.

In the survey, farmers were asked to compare irrigation costs in the post-transfer reference year with costs of irrigation before transfer. About 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 (Rs. 50/acre/season or US$ 2.5/ha) for canal maintenance. 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 (about 27 kgs of paddy per hectare) to the person employed by the FO to distribute water.

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 management resulted in an improvement in the quality of irrigation service. The analysis is based on data obtained from Nachchaduwa and Hakwatuna Oya schemes. Computing Relative Irrigation Supply (RIS) and Relative Water Supply (RWS), and farmer perceptions about changes in the adequacy, timeliness and fairness of water distribution assessed changes in the quality of irrigation service, 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.[2] Figure 1 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 to the high rainfall experienced in these years and more water being released into the canals.

Figure 2 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 Agricultural Production

Although irrigation schemes contribute about two-thirds of the national rice output, there is growing concern about low cropping intensities and stagnation of rice yield in the schemes. Problems related to irrigation are considered to be a major reason for the stagnation of agriculture in the schemes (National Development Council, 1996). 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 and farmers to use more inputs due to greater confidence in the irrigation service, which in turn would lead to higher yields. This proposition is tested by examining the trend in paddy yields and cropping intensities in 50 schemes over a ten-year period 1985-95. The analysis was done separately for rehabilitated and un-rehabilitated schemes with and without IMT.

Trends in Paddy Yields

The trend paddy yield during the period 1985-95 is estimated using equation (1). Table 3 shows the estimated coefficients.

The results indicate that in the pre-IMT period, paddy yields in the rehabilitated schemes, irrespective of whether they have transferred or not, show a declining trend ($-\beta_1$). The decline is statistically significant in the schemes with IMT and rehabilitation. During the same period, yields in the un-rehabilitated scheme show a statistically significant upward trend ($+\beta_1$). In the post-IMT period, there is a statistically significant upward shift in paddy yields in the group showing the

---

[2] According to the Irrigation Department 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.

effects of both rehabilitation and management transfer (β_2 = 245.54). There is no statistically significant change in trend in the schemes which had been rehabilitated but not transferred and those which had been transferred but not rehabilitated. In the post-IMT period, paddy yields in the group without the two forms of intervention show a statistically significant declining trend when compared to the pre-IMT period. The conclusion, which emerges from the analysis, is that there has been a significant improvement in **yield** in the schemes, which have undergone both management transfer and rehabilitation. There is no statistically significant change in yield trends in schemes with only one type of intervention, and those without any of the two forms of intervention show a significant decline in yield. These findings are consistent results from the Gal Oya scheme in Sri Lanka (Amerasinghe *et al,* 1998).[3]

Cropping Intensities[4]

The regression model (1) was used to analyze trends in cropping intensities in the different groups of schemes. The estimated regression coefficients are given in Table 4. The analysis indicates that there are no significant differences in the trends in cropping intensities in all four groups of schemes in the periods before and after transfer.

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. Gross values of output per unit of land and per cubic meter of water diverted were estimated. Rice is the major crop grown in the irrigation schemes in Sri Lanka. Although, in recent years there has been an increase in cultivation of non-rice crops particularly in the dry season, there is a lack of reliable data on the area and the yield of other crops grown in the schemes. Therefore, an estimate of the gross value of output per unit of land and water is based solely on the output of paddy.

To permit international comparisons, the total value of the crop was standardized in terms the international price of rice, and expressed in terms of constant 1995 US dollars.[5] The trends in the gross value of production were analyzed using the regression model (1). As a standard price is used to value the output of paddy, the trend in the gross value of output per unit of land corresponds closely with the trend in paddy yields noted earlier, with schemes which have been transferred and rehabilitated showing a significant change in the gross value of output in the post-IMT period compared to the pre-IMT period. [6]

---

[3] Also see in this issue the article by Murray-Rust *et al.*

[4] cropping intensity = $\frac{\text{area cultivated in first (maha) season + area cultivated in second (yala) season}}{\text{cultivable area x 2}} \times 100$

[5] The method of estimating the standardized gross value of output is explained in Molden *et al* , 1998.

[6] The details of the analysis are reported in Samad *et al* (forthcoming)

Returns per Unit of Water

Returns per unit of water were estimated in terms of gross value of output per unit of water diverted. As most of the un-rehabilitated schemes did not have accurate time-series data on irrigation releases, the analysis is confined to the schemes, which had undergone rehabilitation. Table 5 gives the estimated regression coefficients of the parameters used to estimate trends in the gross value of output per unit of water diverted (GVO/m^3). The results indicate that there is a declining trend in the productivity of water in the pre-IMT period in both categories of schemes. In the post-IMT period there is a significant reversal in the declining trend irrespective of whether the schemes had been transferred or not. The results suggests that rehabilitation rather than IMT may be the major contributing factor for the improvements in the productivity of water experienced in the post-IMT period.

CONCLUSIONS

The purpose of this study was to apply the methodology developed by IIMI to assess the impacts of irrigation management transfer. The methodology was applied to analyze the effects of Sri Lanka's participatory irrigation management program on the performance of irrigation schemes.

The results of the analysis lead 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 bring about significant changes in the quality of irrigation services.
- 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.

TABLES

Table 1. Estimated regression coefficients for trends government expenditure for O&M - 1985-1995

Variable Description	Coefficients			
	IMT and Rehabilitated	No-IMT and Rehabilitated	IMT and Un-rehabilitated	No-IMT Un-rehabilitated
Constant (β_0)	87.04	80.11	86.80	96.72
Trend in government's O&M cost/ha in the pre-IMT period (β_1)	- 0.879 (-5.684)*	-0.794 (-4.269)*	-0.885 (-8.271)*	- 0.983 (-5.023)*
The change in trend in government's O&M costs in the post-IMT period (β_2)	0.424 (1.373)	-0.2867 (-0.761)	0.346 (1.603)	0.428 (1.078)
Adj. R^2	0.534	0.4439	0.487	0.390
F. stat	43.42*	52.18*	102.47*	37.265*

* significant at or less than 10 % level

Figures in parenthesis are t values

Table 2. Annual irrigation costs to farmers after IMT (1994-95)

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

Table 3. Estimated regression coefficients explaining trends in paddy yield in the selected schemes, 1985-95

Variable Description	Regression Coefficients			
	IMT and Rehabilitated	No-IMT and Rehabilitated	IMT and Un-rehabilitated	No-IMT Un-rehabilitated
Constant	12941	5163	- 1761.38	-3558.15
Trend in paddy yield in the pre-IMT period (β_1)	-98.79 (-2.875)*	-6.32 (-2.219)	61.14 (2.338)*	89.83 (3.088)*
The change in trend paddy yield in the post-IMT period (β_2)	245.54 (3.799)*	-0.70 (-0.219)	-52.09 (-1.06)	-93.66 (- 1.728)*
Adj. R^2	0.113	- 0.008	0.038	0.076
F. stat	7.81*	0.124	5.18*	7.72*

* significant at or less than 10% confidence level

Figures in parenthesis are t values

Table 4. Estimated regression coefficients explaining trends in cropping intensities in the selected schemes, 1985-95

Variable Description	Regression Coefficients			
	IMT and Rehabilitated	No-IMT and Rehabilitated	IMT and Un-rehabilitated	No-IMT Un-rehabilitated
Constant	-34.16	242.63	372.87	-27.21
Trend in cropping intensities in the pre-IMT period (β_1)	1.797 (0.578)	-1.356 (0.551)	-2.49 (-1.158)	1.57 (0.496)
The change in trend in cropping intensities in the post-IMT period (β_2)	5.878 (0.937)	5.545 (1.133)	7.026 (1.645)	-0.375 (0.058)
Adj. R^2	0.11	0.0001	0.01	0.008
F. stat	4.31	1.041	1.511	0.424

Figures in parenthesis are t values

Table 5. Estimated regression coefficients explaining trends in the productivity of water in the selected schemes, 1985-95

Variable Description	Regression Coefficients			
	IMT and Rehabilitated	No-IMT and Rehabilitated	IMT and Un-rehabilitated	No-IMT Un-rehabilitated
Constant	0.181	0.135	-	-
Trend in GVO/m3 in the pre-IMT period (β_1)	-0.001 (-1.323)	-7.6512 -(0.400)	-	-
The change in trend GVO/m3 in the post-IMT period (β_2)	0.0033 (1.710)**	0.0053 (1.693)**	-	-
Adj. R^2	0.014	0.11	-	-
F. stat	1.54	0.011*	-	-

Figures in parenthesis are t values

* Statistically significant at the 10 % level.

** Statistically significant at 5 % level.

Figure 1 Relative Irrigation Supply and Relative Water Supply 1985-1995 - Nachchaduwa and Hakwatuna Oya Schemes

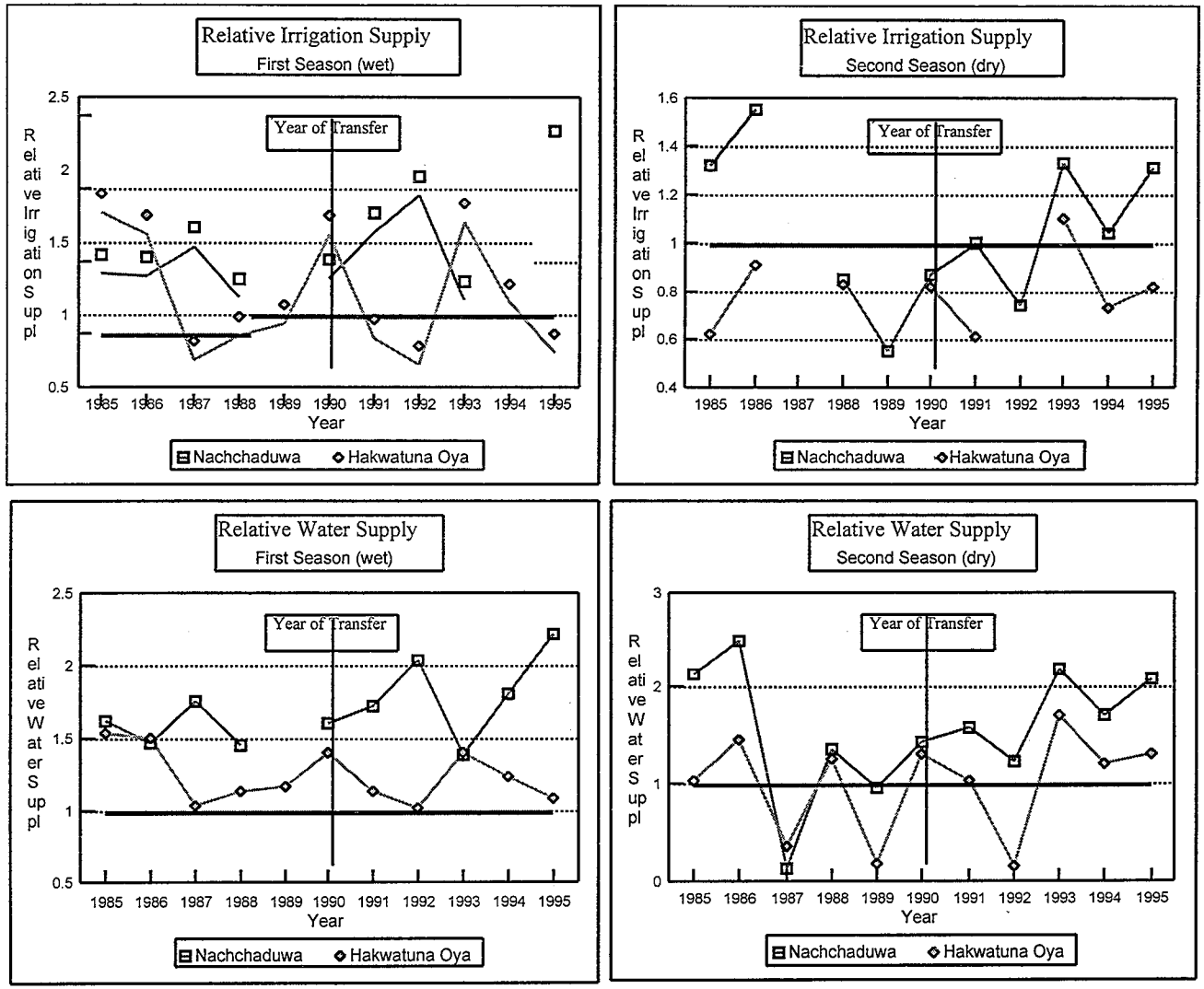
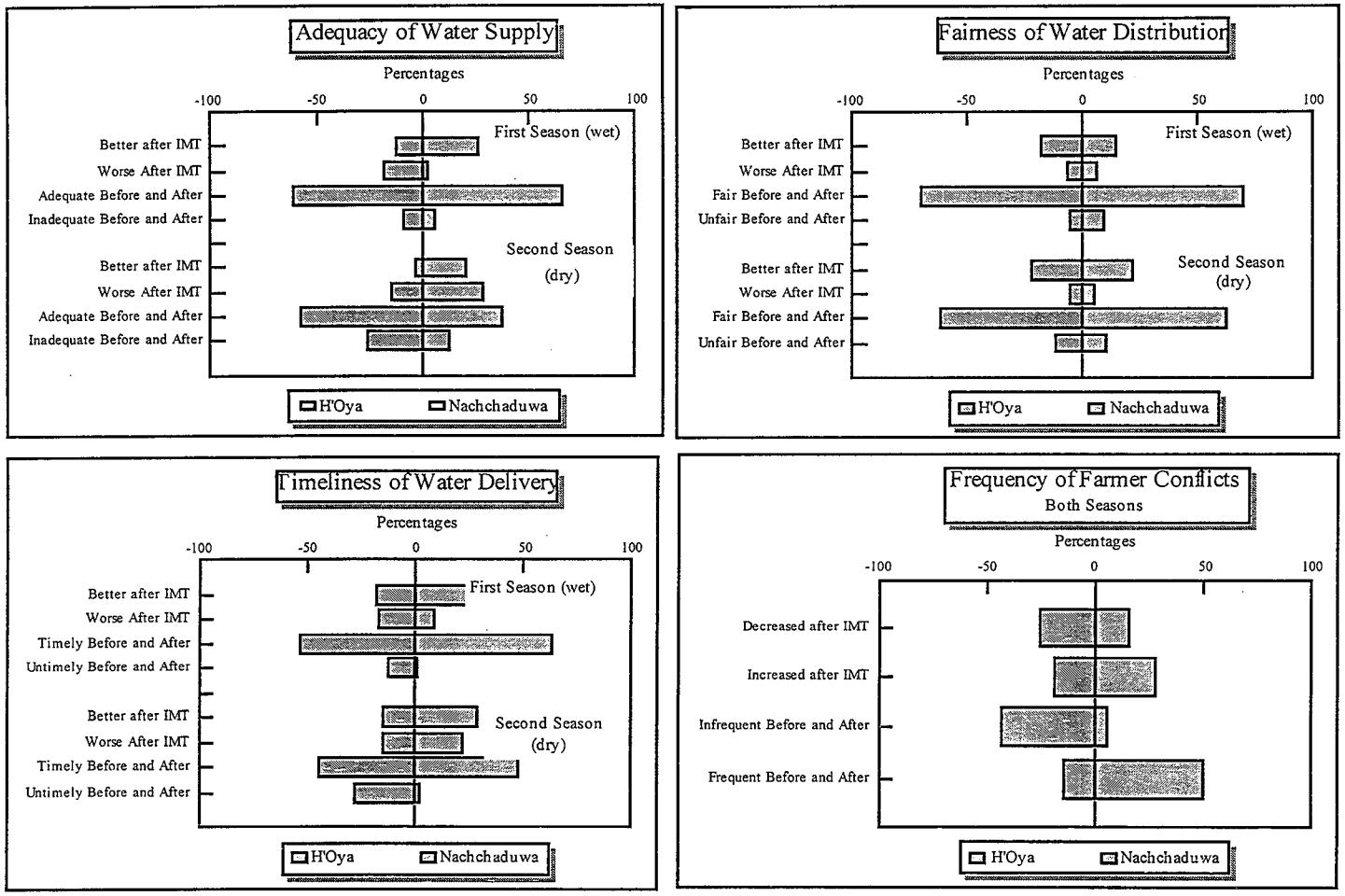


Figure 2 . Farmer perceptions about the quality of irrigation service before and after IM



Literature cited

Abeywickrema, Nanda. 1986, Government policy in participatory irrigation management, in *Participatory Management in Sri Lanka's irrigation schemes,* Colombo, Sri Lanka, IIMI.

Amerasinghe, Upali A., Sakthivadivel, R and Hammond Murray -Rust (1998), Impact Assessment of Rehabilitation Intervention in the Gal Oya Left Bank, Research Report 18, Colombo, Sri Lanka, IIMI

Brewer, Jeffrey D. 1994. The participatory irrigation system management policy, *Economic Review*, Vol. 20, No. 6,

IIMI/HKARTI. 1997, Monitoring and Evaluation of the Participatory Irrigation Management Policy, mimeo.

Johnson III, Sam H., Vermillion, Douglas L. Sargadoy, J.A. 1995 (eds), *Irrigation management transfer: Selected papers from the International Conference on Irrigation Management Transfer*, Wuhan, China, 20-24 September, Rome, IIMI/ FAO.

Kloezen, Wim. 1995, Results of participatory management in two irrigation systems in Sri Lanka, in Vermillion, Douglas L (ed), *The Privatization and self-management of irrigation* , Final Report, Colombo, Sri Lanka, IIMI.

Meinzen-Dick, Ruth., Mendoza, Meyra., Sadoutlet, Loic., Abiad-Shields., Subramaniam, Ashok., 1997, Sustainable water users association; Lessons from a literature review. In Subramaniam, Jaganathan, Meinzen-Dick (Ed), *User organizations for sustainable water services*, World Bank Technical Paper 354. Washington D.C. World Bank.

Molden, David., Sakthivadivel, R.,Perry, Christopher J., de Fraiture, Charlotte., and Kloezen Wim, H. 1998, Indicators for comparing the performance of irrigated agricultural systems, Research Report 20, Colombo, Sri Lanka, IIMI.

National Development Council (1996), Report of the National Development Council Working Group on Agricultural Policy, Colombo, Sri Lanka, duplicated.

Ratnayake, Ranjith. 1995, Irrigation management transfer in Sri Lanka, in J.C.M.A. Geijer (ed) *Irrigation management transfer in Asia,* Papers from the expert consultation on irrigation management transfer in Asia, Bangkok and Chiang Mai, 25-29 September, FAO/IIMI, Bangkok.

Samad, M. and Vermillion, Douglas (forthcoming), Participatory Irrigation Managment in Sri Lanka: Partial Reforms, Partial Benefits, Colombo, Sri Lanka, IIMI.