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Economic Value of Irrigation Water in Dewahuwa Irrigation Scheme

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ABSTRACT. *Up to now irrigation water in Sri Lanka was unpriced. The lack of participation of water users in system management and inadequate funds for Operation and Maintenance (O & M) of irrigation schemes have led the schemes to deteriorate over time. The cost of annual O & M activities has been estimated through many studies. However the O & M fee collection collapsed due to many reasons. This study analyses a new approach to estimate the economic value of irrigation water using nonmarket valuation techniques. Productivity Change (PC), Land Value (LV) and Willingness To Pay (WTP) methods have been used to estimate the value of water and the results are indicative, except in the land value method. The Productivity Change method has given the value of water as Rs. 750/- per acre per rotation in critical periods of growth. Farmers' WTP for water is Rs. 2405/- per acre per season when they have to receive water from a private water source (Agro-well). They would like to pay Rs. 560/- per acre per year for the water received from the existing irrigation scheme. This amount is fairly high compared with the figure of Rs. 370/- per acre per year which is the current estimated cost of O & M of the irrigation schemes.*

INTRODUCTION

Farmers in Sri Lanka generally enjoy the free of charge irrigation facilities which are often provided by the government although the law provides for collecting of O & M fees. It is the attitude of most Sri Lankan farmers that, it is the responsibility of the government to provide water to the irrigable lands. The government has so far invested vast sums of money on restoration of ancient schemes and on construction of new schemes. Also the government has had the responsibility over the operation and maintenance

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(O & M) of these schemes on which a considerable amount of money is being spent annually. Under the earlier welfare oriented policy of the government in irrigation development, it offered free O & M of the schemes in addition to free land to settlers. These programs made farmers passive recipients of the government welfare and non-participants in O & M activities of the schemes. The government repeatedly claimed that it cannot provide such funding and the Department of Irrigation experienced inadequate funds for O & M activities. Due to this situation, most of the schemes have deteriorated to a level that they need major rehabilitation (World Bank, 1991).

Water use becomes inefficient due to the free nature of supply. Further, the demand for water is over and above the optimum requirement at zero price. When it is free, farmers use water until the marginal productivity of water is driven to zero (Seagraves and Easter, 1983). Even though paddy cultivation is less profitable compared to the OFC cultivation, farmers tend to grow paddy when adequate water is available at no price. Under these circumstances, the present allocation of irrigation water in Sri Lanka is far from efficient, and such failure provides a rationale for some intervention to irrigation water allocation procedures.

The past investments of the developing countries in irrigation development have not been paying reasonable dividends, often owing to sub-optimal and sometimes wasteful utilization of existing irrigation facilities, especially in the case of government owned systems. There are many reasons for sub-optimal utilization of existing irrigation facilities and lack of cost recovery. The improper pricing of irrigation water with inadequate attention paid to the level and form of water charges and the unacceptable utilization of collected revenues to the farmers are few of the important ones (Sampath, 1992). However, the budgetary constraints of the government emphasise the need to preserve and make optimum use of existing irrigation infrastructures (World Bank, 1991).

Since the 1950's the share of O & M expenditures to the total irrigation investments in Sri Lanka has remained at about 4% (People's Bank, 1991). There was no cost recovery mechanism on irrigation facilities until year 1984. The idea of charging at least the O & M cost of the schemes from farmers in major irrigation schemes came to effect with a law introduced by the government in 1984. The O & M cost at this time had been estimated as Rs. 500/- per ha per year in 1982 prices. It was decided to charge half of this amount from the farmers in the initial year and then to increase

by Rs. 50/- per ha each year so that the full amount would be charged at the end of the 5th year (IIMI, 1989).

This fee collection scheme collapsed in the late 80's due to many reasons. The legal and political issues also interfered and the fee collection was declining over the years and came to a halt after 3-4 years. The recent estimates of the O & M cost by a private firm (TEAMS) for "adequate" maintenance, defined as maintenance adequate to ensure no rehabilitation is necessary for 10-15 years, is about Rs. 927/- per ha per year in 1990 prices. For an even better maintenance, defined as being good enough so that no rehabilitation would be required, the average per ha cost would be Rs. 1727/- in 1990 prices (TEAMS, 1991). According to a study done by the Irrigation Department (ID) and Sheladia Associates, O & M cost is calculated as Rs. 790/- per ha per year in 1991 prices (ID/SAI, 1991). TEAMS figure is more acceptable than ID/SAI figure since they have used a representative sample and the ID/SAI have used more independent methodologies.

Under these circumstances, the management of irrigation schemes without participation of water users was proven a fallacy and the government resorted to try out user participation in O & M of irrigation schemes. Now the government in principle has accepted that farmers should pay for O & M but not capital cost for construction (Peoples' Bank, 1991). Although the O & M of the schemes are taken over by farmers, they will have to raise funds and there should be a basis for that. If there is a changing demand for irrigation water depending on the crop grown, season *etc.*, it is difficult to practise price discrimination. The pricing is often determined by the amount needed to recover at least the cost of O & M of irrigation projects. The value of water varies considerably across seasons, crops, regions and climate. The use of water at any point in time also depends on the rainfall, which causes the value of water to vary considerably. It may not be feasible either administratively or politically however to change the price of water frequently. Further the value of water is also difficult to be estimated because it is affected by many other factors such as the climate, fertilizer and pesticide use, cropping pattern *etc.* (Sampath, 1992).

The problem

Although there is no direct market or specified price for irrigation water, it is becoming extremely difficult to provide these services free of

charge any more. The market for irrigation water may be developed in the future depending on the demand and the availability of water. At present, however, neither is there a water charging policy nor a mechanism to recover at least the O&M cost of the schemes. A prime objective of the National Irrigation Rehabilitation Project (NIRP) is to form and strengthen Farmer Organizations (FO), and then to hand over the O & M responsibilities of the schemes to the users or farmers. Even with this system, FOs should have ways and means of raising funds to undertake annual O&M activities. Arbitrary collection of member fees will lead to disputes among farmers because individuals do not own equal extents of land within the scheme. Therefore, a need exists for an acceptable mechanism of determining the charges. The economic value of irrigation water is helpful to make this venture a success.

Objectives

Although irrigation water is not a marketed good today, certain initiatives have been taken towards handing over the canal systems to the users. On the other hand, to charging an O & M fee is considered. Regardless of the option adopted, there must be an acceptable base to determine a fee to cover at least the O & M cost of the irrigation schemes.

Since there is no developed market to assess the value of irrigation water, nonmarket valuation techniques can be adopted to estimate the economic value of irrigation water. Therefore, the specific objective of this study was to estimate the economic value of irrigation water, using nonmarket valuation techniques, in a selected irrigation scheme in the dry zone of Sri Lanka.

METHOD

Both inferential and contingent valuation techniques have been used in this study. Three methods, namely, land value, productivity changes, and willingness to pay methods were used as valuation tools and a brief explanation of each method is given below.

Land value method

In the absence of direct market, prices for natural and environmental resources can be derived from the prices of surrogate goods. The most common methods are the use of values of property and labour. The property value approach is the most common application, and it consists of observing the systematic differences in the values of property between locations, and isolating the effect of the natural and environmental resource on those values (Winpenny, 1991). In irrigation schemes, the value of land differs according to the availability of irrigation water and many other factors. If the contribution from other factors to land value can be isolated, the remainder can be used as a proxy to the value of irrigation water.

Productivity change method

When a market exists for goods and services involved, the impact of the natural and environmental resource can be represented by the value of change in output that it causes (Winpenny, 1991). The availability of irrigation water will affect the output of a crop. Therefore, different values of output will represent the different degrees of irrigation water availability. If the value of the change in output can be isolated again due to irrigation water and other factors separately, the change in productivity can be used as the value of irrigation water.

Willingness to pay (WTP)

Where actual market data are lacking, contingent valuation (CV) seeks to discover how people would value certain natural and environmental resources. This can be done questioning a sample of population concerned and making the necessary inferences. The respondents are given a hypothetical market situation to test their desire to use such commodities (Randall, 1981). Estimated net benefits can be used to assign different prices to different schemes. Net benefits per unit of water provide an upper limit on prices, since they reflect the maximum amount, a farmer would be willing to pay (Seagraves and Easter, 1983). Here it used both direct questioning and iterative bidding techniques to discover the farmers' willingness to pay for irrigation water. Applicability of this method has been tested in a study in Haiti and the validity was confirmed with the positive results (Whittington *et al.*, 1990).

The site, sample and data collection

It was the pre-conceived idea that the target group should have some experience over the value of irrigation water in order to answer this type of questions. Farmers who have faced the difficulties of getting irrigation water may have a better feeling on this, than those who do not have such experiences. Therefore, it was the intention to select a sample from such a scheme. Farmers of the Dewahuwa irrigation scheme which is situated in the boundary of the central province and the north central province in Sri Lanka, encounter many difficulties in receiving water to their fields, either due to the lack of water in the tank or some other design/management problems. Farmers who faced severe problems in receiving water had constructed open dug wells (Agro wells) as an alternative water supply with the financial assistance rendered by government agencies. Therefore, this scheme was selected as the study site. A sample of 61 farmers was selected randomly to represent head, middle and the tail sections of the scheme. A structured questionnaire was used to collect the information related to the above three techniques, in April 1993.

RESULTS AND DISCUSSION

Three methods were used to analyze the data collected for this study and they are (i) Productivity change method (ii) Land value method and (iii) Willingness to pay method. For the productivity change method, information was collected of the loss of productivity due to water shortages. It was found that the farmers faced difficulties in providing exact figures of production losses related to water shortages. Water shortages in different periods of crop growth would affect the production in varying degrees. Therefore, farmers' responses were limited only to two rotations of water losses during the crop growth giving consideration to the most critical periods of growth. It was difficult to obtain production losses of other field crops (OFC), therefore, only production losses of paddy were considered for this analysis.

If the experimental data were available on the productivity change of paddy in different water regimes, the results would have been more attractive. The loss of production given in bushels of paddy per acre per season was converted to monetary values using the conversion factors *i.e.* one bushel=22 kg and price of one kg of paddy=Rs. 7/- (existing average market price). The rotations converted into irrigation hours using the

number of hours taken to irrigate one acre within a rotation. A regression analysis was performed using the loss of paddy if they lose two rotations of water in critical periods of crop growth, in rupees per acre per season (LOSPDAC) as the dependent variable. The number of hours of water loss in two rotations (HACR2), the location of the allotment along the main canal (LOCM) (Head=1, Middle=2, Tail=3), location along the field canal, reliability of alternative sources of water, farming experiences of the farmer, pumping cost per hour and fuel cost per hour were used as independent variables. Equation (1) was selected as the best explanatory model. After removing outliers, the total number of cases used in the analysis was 58.

$$LOSPDAC = 1127.44 + 75.14\ HACR2^{*} + 569.94\ LOCM^{*} \quad \text{(1)}$$

$R^2 = 0.45$ Adj $R^2 = 0.43$ $F = 23.08$ Prob = .0001

* significant at 0.05 level

Based on the results, the production loss shows a positive relationship with both water loss and the location along the main canal. It is accepted that water loss is high towards the tail end of the scheme. According to the model, one hour's loss of water will lead to a loss of Rs. 75.14 to the farmer. This can be considered as the value of water received in one hour. If this can be converted to a volume, the value of one unit of water can be inferred. Since the average number of hours per rotation is 10, a rotation of water would cost about Rs. 750/- in critical periods of growth.

To apply the land value method to asses the value of irrigation water, information was collected on the values of seasonal land rent for both *Maha* and *Yala* separately. There was no statistical difference in the values of land rent due to season. The average land rents paid in cash for *Maha* and *Yala* are Rs. 1540/- and Rs. 1680/- respectively. Because they grow paddy in the *Maha* season, there are arrangements to pay the land rent in kind at the end of the season, after harvesting. This was around 20 bu/ac. The converted average monetary value is Rs. 3240/-. This is the general practice in the scheme and the amount is fairly high compared to the amount paid in cash. It differs rarely due to other reasons. For a particular season, farmers have pre-decided rent which is practised all over the scheme. Even though the OFC cultivation is more profitable compared to paddy cultivation, it is not reflected in the land rent. Current market values of both high lands and irrigated lands were investigated. Farmers were in a difficult position to answer this question due to the lack of experience in this field. They gave

more or less similar answers depending on some particular cases of selling the allotments.

The change in land value due to the availability of water could not be isolated. In the places where the agro-wells have been constructed, a new demand for lands has been created. Total value for land in this case has been derived only because of the availability of water. There had been a zero value for these lands before the new source of water emerged. Therefore this value can be considered as the value for water for a particular season. However, the amounts negotiated by the farmers do not vary much from the values prevailing in the scheme.

In this survey, it was found that the land rent is dependent on many factors such as crop, soil, alternative water sources *etc.* Though it is true that the value for irrigable land is mainly derived from the availability of water, farmers failed to match exact amounts of water which reflect the different land rents. The different land rents given by the sample farmers were considered as the dependent variable and several other variables were considered as independent variables to perform multiple regression analysis. The following model was selected as the best model (equation 2).

LNDRMC	=	Land rent in *Maha* season in cash (Rs)
LOCF	=	Location along the field canal (Head=1, Middle=2, Tail=3)
YIELD	=	Yield received from farmers' owned land
ALTSW	=	Reliability of alternative water sources in ascending order)

$$LNDRMC = 2308.06 - 90\ LOCF^{*} - 4.31\ YIELD^{*} - 78.43\ ALTSW^{*} \quad (2)$$

$R^2 = 0.11$ Adj $R^2 = 0.06$ $F = 2.33$ Prob $F = 0.08$

* significant at 0.1 level, number of observations 59

Although the results are not very attractive with a low value for R^2, this approach could be improved in further studies. According to the results, average land rent without the effects of other variables, is Rs. 2308/- per acre per season. The land rent declines when moving along the field canal and while the reliability of the alternative water supplies to their owned lands increases. Based on the results of this study it is clear that those farmers who get higher yields from their lands, bid lower values for renting additional lands. Although this seems somewhat contradictory, it is a possible occurence because, when farmers obtain good yields from their owned lands, they do not have sufficient resources as labour to invest on

rented lands. Therefore, they do not make higher bids for renting additional lands.

Farmers WTP for irrigation water was questioned in different ways. In open ended direct questions farmers were given three different situations *i.e.* (a) amount they are willing to pay for a rotation per acre excluding pumping cost (WTP1) (in this case they face a water shortage towards the end of the season) (b) amount they are willing to pay for a rotation per acre including the pumping cost in a similar situation (WTP2) and (c) amount they are willing to pay for a season per acre, if they happen to have an agreement with an owner of a water source (dug well) to receive water throughout the season (WTP3).

The average WTP for a rotation of water per acre excluding pumping cost in order to save the crop towards the end of the season is Rs. 226/-, and when the pumping cost is included, the average value increased upto Rs. 455/-. According to the productivity change (PC) if they lose one rotation of water, they will also lose Rs. 750/- per acre in critical periods. The third situation which gives overall understanding of the value of water for a season per acre is Rs. 2405/-. These results are summarized in Table 1.

Table 1. Farmers WTP for irrigation water in three different situations and the value of productivity change (number of observations = 60).

	WTP1*	WTP2*	WTP3**	PC*
Mean	226	455	2405	750
Minimum	25	50	500	
Maximum	500	1000	10000	
Std Dev	144	263	1869	

* Rs/ac/rotation ** Rs/ac/season

Then the iterative bidding technique was used to reveal the WTP per acre per year for water received from the scheme. The highest WTP in cash

(HWTPIC) is Rs. 560/- per acre per year, while it is Rs. 594/- when they pay in kind (HWTPIK). These figures can be compared with the cost of O & M figure calculated by TEAMS for adequate O & M activities, which is Rs. 370/ac/year in 1990 prices (Table 2).

Table 2. WTP for irrigation water received from the scheme in Rs/ac/year (number of observations=60).

	HWTPIC	HWTPIK	TEAMS Est (1990 price)
Mean	560	594	370
Minimum	100	154	-
Maximum	5000	1925	-
Std Dev	706	340	-

Even when only the payment in cash is considered, it is fairly high compared to TEAMS estimate. If this is considered by the farmer organizations in raising their funds, the monthly fee is about Rs. 50/-per acre, which may not be difficult to be collected if there is an assured water supply.

Because the farmers had the experience of paying an O & M fee in the recent past, there was a starting point bias; and a strategic bias was also observed in some cases when farmers express their fear of charging the same amount in the future as a water levy. One young farmer strongly resisted answering the questions, expressing the past experiences of this type of surveys which in turn brought bad repercussions on the farmers. He claimed that they all ended up with charging taxes or some other levy. Some other farmers felt charging for water was an insult and signified decaying of moral values of the people, since they strongly believe that this natural resource should be free for all creatures on the earth. However, after explaining the cost involved in getting water to the farm gate even if it is available underground or on the surface, they agreed to answer imagining the situation. But they still did not like to define it as a fee for water but as an extracting cost. Some other farmers who had faced more difficulties in having water for their cultivations and have had sufficient experiences on OFC cultivation have already made some arrangements with well owners to make some payments to receive irrigation water from their wells.

When they answered the question of paying the amount in kind, some farmers gave an approximate conversion of the amount they expressed to pay in cash. Some farmers became confused relating this with the payments they made to farmer representatives for their duty in operation of water issues. Therefore, care and the necessary precautions are needed when conducting a similar survey.

CONCLUSIONS AND POLICY IMPLICATIONS

The value for irrigation water per acre per rotation in a critical period of growth using the productivity change method with the availability of irrigation water is Rs. 750/-. This can be further modified with reliable data on different crop yields relevant to different water availabilities in different crop growth periods from the experimental level. It was difficult to obtain exact figures for land values under different water regimes. The land rent given by the regression analysis when there is no effect of the considered independent variables, is Rs. 2308/- per acre per season and it is accounted for Rs. 4616/-per acre per year (LV1). The simple averages of the land rents of both *Maha* and *Yala*, *i.e.* Rs. 1540/- and Rs. 1680/- respectively, give rise to a figure of land rent of Rs. 3220/- per acre per year (LV2). When farmers pay the land rent in kind it is amounted to Rs. 3240/- per acre per season. This cannot be doubled to obtain a figure for a year because this arrangement is practised only in the *Maha* season or when they grow paddy in the allotment. The total land rent has been considered as the value of water per acre per year. Farmers' willingness to pay on a contract agreement is Rs. 2405/- per acre per season. The WTP per acre per year then will be Rs. 4810/- (WTP3*2). The values Rs. 4616/- and Rs. 3220/- are very close to the value Rs. 4810/-*i.e.* farmers WTP for water per acre per year.

Farmers' WTP for the other two situations considered, cannot be taken into account here because those are exceptional and the figures are high due to the high risk involved in explained situations to save the crop. The figures which came out from the bidding technique can be compared with the recent figures of the O & M of irrigation schemes. Farmers' WTP is Rs. 560/- in cash and Rs. 594/- in kind per acre per year. The recent estimated cost of O & M is Rs. 370/- per acre per year in 1990 prices.

Non-market valuation approach could be used to determine the user charges and it will help to adopt a better charging policy for irrigation water.

Further it will be beneficial to the farmer organizations in collecting member fees for raising the O & M funds.

Further research needs

In applying the WTP method, due attention should be paid in preparing questionnaires so that the possible biases will be avoided especially starting point bias and strategic bias. It must be confirmed that farmers are convinced enough of the problem addressed in the study. There is a need to develop strategies in preparing WTP questionnaires to have better results in the direction of improving precision. Separate surveys for different schemes will help avoide site specific problems.

Experiments must be carried out to reveal the real change in productivity under different water regimes for various crops. To isolate the effect of water availability on land rent, surveys must be carried out on a broad basis to represent larger areas. A comprehensive collection of the market values of irrigable and non-irrigable lands may have a great contribution in this direction.

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