Estimating Economic Value of Irrigation Water through Contingent Valuation Method: Results from Bhavani River Basin, Tamil Nadu

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INTRODUCTION

Water used for irrigation purpose is mainly ‘non-market’ in nature (Freeman III, 2003). Even if the irrigation water is priced, the price does not reflect its ‘true opportunity cost’ which is equivalent to the Hicksian ‘consumer surplus’ measure (Hicks, 1946). Over and above the market price, the irrigation water may generate ‘extra-market benefits’ enjoyed by the users. Since the ‘revealed preference methods’ are not capable of capturing these extra-market values adequately, it is argued that the ‘stated preference method’ could be effectively utilised for estimating the total economic value of irrigation water. The contingent valuation method as a widely used stated preference method can measure the true opportunity cost of irrigation water use – within the framework of Hicksian ‘compensating variation’ and ‘equivalent variation’ measures (Venkatachalam, 2004). The present study makes an attempt to estimate the compensating and equivalent variations for irrigation water. More precisely, the study elicits farmers’ preferences measured in terms willingness to pay (WTP) and willingness to accept (WTA) compensation for ‘voluntary’ exchange of irrigation water within the agriculture sector in the Bhavani river basin, Tamil Nadu.

Since the paper exclusively focuses on Bhavani river basin, let us briefly understand the issue of water scarcity associated with this basin. River Bhavani, though perennial, experiences water scarcity problem due to both intra-sectoral and inter-sectoral demand for limited amount of water. The total command area irrigated is about 1,00,098 hectares covered by four different canal systems. The Arakkankottai, Thadappalli, and Kalingarayan canals come under the ‘Old Canal System’ (hereafter, Old System) and the Lower Bhavani Project (LBP) canal comes under the ‘New Canal System’ (hereafter, New System). While the Old System was

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established in 1855, the New System was operationalised in 1955. In the case of Old System, Arakkankottai canal irrigates about 2834 hectares, Thadapalli canal has a command area of 7085 hectares and Kalingarayan canal was designed to irrigate a total area of about 6373 hectares. Altogether, the old canal system consists of an irrigated area of about 13157 hectares and irrigation water is released for over 11 months a year. Total command area of the LBP irrigation system is about 83805 hectares. In the LBP, a ‘turn system’ is being followed to efficiently make use of the scarce water available for cultivation. During the ‘first turn’ (from 15th August to 15th December), irrigation water will be released through odd-numbered sluices to irrigate half of the total command area (i.e., 4,19,028 hectares) of the canal. A total quantity of 5,50,964 acre feet of water will be released for the ‘wet crops’ such as, paddy and sugarcane. During the ‘second turn’ (from 16th December to 15th March), 2,75,482 acre feet of water will be released through even-numbered sluices for cultivation of ‘dry crops’ such as, turmeric, cereals, oilseeds, etc. in the remaining half of the command area of the canal. In the next year, the turn system will be changed –i.e., even numbered-sluices will get water for wet crops and the odd-numbered sluices will get water for dry crops.

The Old System farmers inherit ‘senior appropriation rights’ and they are supplied irrigation water on a ‘first-come first-served’ basis. The LBP was operationalised in 1955 in order to utilise any ‘surplus water’ available in the basin. However, over a period of time the LBP farmers claimed permanent entitlement for a constant portion of water. This led to intense conflict between the old and the new canal farmers. It is argued that there is a potential for improving water use efficacy in the old canal system which could save around 10 per cent of irrigation water being used in this system at present. However, the old canal farmers resist transferring water to the LBP system even temporarily. This is because they fear that the LBP farmers experiencing water scarcity would tend to make permanent claim over the excess water transferred, as they did in the past. Since there is no incentive for the old canal farmers to save water at present, they will not be expected to take up water conservation measures. Compared to the old canal system, the water use efficiency in the LBP is found to be high and therefore, there is a greater potential for increasing the efficiency of water allocation if more water is allocated to LBP canal. This is possible only if the existing senior appropriation right is replaced with alternative institutional arrangements to generate adequate incentives for the old canal farmers to ‘voluntarily’ transfer water to the LBP farmers; such arrangements should also ensure that the old canal farmers’ current water entitlements are in no way altered under the new institutional regime. Though the changes in land use and cropping pattern have been favourable for saving significant amount of water in the Old System, the existing institutions do not provide any incentive for them to transfer water to the New System where water-productivity is relatively higher than other systems in the basin (Palanisami and Ramesh (n.a)).
II

METHODOLOGY

In order to elicit the preferences of the farmers and estimate the potential gains from water trade, a ‘contingent valuation’ (CV) survey (Venkatachalam, 2004) was conducted among the sample farmers in the Bhavani basin. Voluntary exchange in water will take place only when: (a) there are potential buyers and sellers in the basin, who would prefer to trade some portion of irrigation water through ‘voluntary’ exchange; (b) the average WTP value of potential buyers is greater than the average WTA value of the potential sellers; and (c) the transaction cost of voluntary transfer of water is negligible. Through extensive field visits, we identified potential sellers and buyers of ‘tradable’ water across different canal systems in the river basin. The potential sellers are those who are: (i) not using their entitled water for cultivation, at least temporarily; (ii) willing to conserve water to generate some amount of excess water; and (iii) willing to switch over from a high water intensive crop to a less water-intensive one. The buyers are those farmers, who are willing to pay for additional water for irrigation. The selling and buying decisions of the farmers are \textit{ex-ante} in nature and are taken at present for the next season of cultivation (i.e., January 2008 to April, 2008 season). For the present study, we have selected a sample of 310 farmers across all the canal systems in the Bhavani basin. The details of sample selection are presented in Table 1.

<table>
<thead>
<tr>
<th>Canal system (1)</th>
<th>Number of sample farmers (2)</th>
<th>Per cent (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arakkankottai</td>
<td>74</td>
<td>23.90</td>
</tr>
<tr>
<td>Kalingarayan</td>
<td>21</td>
<td>06.80</td>
</tr>
<tr>
<td>Thadappalli</td>
<td>67</td>
<td>21.60</td>
</tr>
<tr>
<td>New System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LBP</td>
<td>148</td>
<td>47.70</td>
</tr>
<tr>
<td>Total</td>
<td>310</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In order to estimate the WTP and WTA values, we have used CV experiment within a ‘repeated game theoretic framework’ (Plott and Zeiler, 2005; Shogren et al., 1994; Taylor, 2006). From the buyers and sellers identified, we elicited, in the first round, their initial WTP and WTA values for specific amount of additional water to be purchased and sold, respectively. This initial round was conducted as a ‘one-shot game’ where the respondents were asked to state their maximum WTP value/minimum WTA value, based on the CV scenario communicated to them; in this round, the respondents had no idea about the bid values stated by other respondents and whatever the value that they stated was based on their own individual preference. We recorded all these values.
In the next round, we conveyed to ‘all’ the buyers the minimum WTA value of that respondent whose WTA value was the highest among all the sellers. All the buyers then were asked whether they would be willing to revise (both upwards and downwards) their WTP bid based on the WTA bid made known to them. The answer was recorded properly. Similarly, the WTP value of that respondent whose bid was the lowest among the buyers was communicated to the sellers and the sellers were asked to revise their WTA values accordingly. In the third round, we repeated the same procedure with the ‘new’ highest WTA and lowest WTP values. We stopped with three rounds since none of the farmers were willing to revise their bids any more. The values in all the rounds have been derived by using a ‘scientifically’ conducted CV survey. The CV scenario consisted of the good under valuation (i.e., five rounds of irrigation on per acre basis), payment vehicle (i.e., in terms of tradable permits equivalent to five irrigation per acre), institutional mechanism through which water trade will take place (i.e., a centralised authority who co-ordinates buying and selling of permits), frequency of trade (i.e., once prior to start of cultivation season) and debriefing questions and ‘cheap talk’ information to ensure that the respondents are giving valid answers. In this way, we ensured the overall validity of the CV results. The results of our study are discussed in the following section.

III

ANALYSIS OF WTP/WTA VALUES FOR WATER

The results from the main survey reveal that almost all the potential buyers of ‘excess’ water are located in the LBP canal and the entire potential sellers are located in the other Old System (except only one buyer from Arakkankottai canal). Altogether, we have identified 125 farmers as potential buyers and 129 as potential sellers. The remaining 54 farmers (i.e., 17.5 per cent) in our sample were not willing to participate in water exchange. In order to elicit the WTP/WTA values, we have used ‘repeated experimental method of value elicitation’ in the field. This method involves asking the WTP/WTA question to the same farmer in every subsequent round, wherein the WTP/WTA values elicited during the previous round is communicated to the farmer in each subsequent rounds. For example, the maximum WTP value of the potential buyers and minimum WTA values of the potential sellers are elicited separately during the first round. Subsequently, the maximum WTP value of a water buyer (who stated a lowest WTP value among all buyers) elicited during the first round was communicated to a seller (who stated the ‘highest’ WTA value among all sellers in the first round) who was asked if he was willing to ‘revise’ his WTA value accordingly. Similarly, a buyer (who stated the lowest WTP value among all buyers) was provided with the WTA value of the seller (who stated the highest WTA value among all sellers) and asked if he was willing to revise his WTP value accordingly. This kind of repeated experiment is expected to eliminate any information asymmetry among the buyers and sellers that may potentially affect the
water trade in the absence of such information flow. The major objective of this experiment is to create a ‘real market’ situation for the water buyers and sellers so that the trade in water could reach an ‘equilibrium’ point.

In our experiment, we found that out of the total 148 sample farmers in LBP canal, 124 farmers (i.e. 83.78 percent) were willing to pay for additional water equivalent to ‘ten irrigations’. We had one farmer from Arakkankottai canal in the Old System as a potential buyer. Similarly, out of the 162 sample farmers in the Old System we have identified 129 ‘willing sellers’ (around 79.6 per cent) spread across all the three canals in this System. The mean WTP value stated by the potential buyers for obtaining ‘10 additional irrigations’ during the first round of our experiment stands at Rs. 272.44. However, the mean WTA compensation, elicited in the first round for selling excess water equivalent to same number of irrigations is estimated to be Rs. 318.44. The results on WTP and WTA values derived from the first round indicate that even though there are water buyers and sellers who are willing to exchange excess water, the exchange will not take place smoothly because of the fact that the mean value of ‘selling price’ (i.e., WTA) is greater than that of ‘buying price’ (i.e. WTP). The reason for this WTP/WTA disparity affecting the market exchange is that since the buyers (sellers) had no idea about the selling (buying) price of the water sellers (buyers) during the initial round they had to value the water based only their ‘own’ preference. However, one’s value of water in a market environment not only depends on one’s own individual preference but also on how much value that others place on the same amount of water. This means that a buyer’s WTP for water is not dependent entirely on his own valuation but also on the WTA value of the seller. Recognising this ‘interdependent’ nature of the valuation process, we conducted the second round of value elicitation with a view to see how

<table>
<thead>
<tr>
<th>Elicitation round</th>
<th>Number of farmers</th>
<th>Mean value (Rs.)</th>
<th>Median value (Rs.)</th>
<th>Minimum value (Rs.)</th>
<th>Maximum value (Rs.)</th>
<th>Std. Deviation (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP1</td>
<td>125</td>
<td>272.44</td>
<td>250.00</td>
<td>75.00</td>
<td>560.00</td>
<td>156.80</td>
</tr>
<tr>
<td>WTAC1</td>
<td>129</td>
<td>318.44</td>
<td>260.00</td>
<td>100.00</td>
<td>960.00</td>
<td>195.31</td>
</tr>
<tr>
<td>WTP2</td>
<td>125 (110 farmers revised)</td>
<td>308.12</td>
<td>250.00</td>
<td>100.00</td>
<td>600.00</td>
<td>169.53</td>
</tr>
<tr>
<td>WTAC2</td>
<td>129 (42 farmers revised)</td>
<td>301.97</td>
<td>250.00</td>
<td>75.00</td>
<td>960.00</td>
<td>190.51</td>
</tr>
<tr>
<td>WTP3</td>
<td>125 (24 farmers revised)</td>
<td>312.64</td>
<td>250.00</td>
<td>100.00</td>
<td>600.00</td>
<td>170.14</td>
</tr>
<tr>
<td>WTAC3</td>
<td>129 (10 farmers revised)</td>
<td>300.03</td>
<td>250.00</td>
<td>75.00</td>
<td>960.00</td>
<td>190.25</td>
</tr>
</tbody>
</table>

Source: Computed from the primary data.
disclosing the value of water elicited in the first round affects the value of the respondent in the second round. In the second round, we have communicated the maximum WTP value of that farmer whose stated WTP value was lowest among all buyers (i.e., Rs. 75.00) to all the sellers. Similarly, we have informed the buyers about the minimum WTA value of that farmer whose stated WTA value was highest among all sellers (i.e., Rs. 960.00). All these farmers were asked if they were willing to revise their initial value given by them in the first round, and were subsequently asked to revise the values in case they were willing to do so. In the case of buyers, 110 farmers out of 125 (88.00 per cent) farmers were willing to revise their WTP values and did so accordingly. In the case of sellers, 42 farmers out of 129 (32.60 per cent) were willing to revise their stated WTA values and revised subsequently. After the second round, we found that the mean WTP value increased to Rs. 318.44 and that of the WTA value declined to Rs. 302.00 approximately.

In the third and final round, we repeated the same procedure followed in the second round. In this round, only 24 buyers (i.e., 19.20 per cent) did revise their WTP value again; in the case of sellers, only 10 sellers (i.e., 7.80 per cent) revised their WTA values. In all the rounds, the buyers revised their values ‘upwards’ while the sellers revising their values ‘downwards’. Another round of elicitation was not possible because almost all the farmers in both the categories refused to revise their values any further. So, we stopped the elicitation process with three rounds. In the final round, the mean WTP value slightly increased to Rs. 312.64 and the mean WTA value declined to Rs. 300.03. The repeated rounds of value elicitation suggest that in a ‘market set-up’ where full information about the buying and selling prices made available to the farmers, the WTP and WTA accept values converge to an equilibrium point, making the trade in the water to be optimal. Out of all the buyers, 64 per cent of them are willing to pay the equilibrium price of Rs. 300 and 63 per cent of sellers are willing to accept this amount as compensation. This means that water trade will take place at least among 63 per cent of the farmers whose are willing to participate in water trade.

The analysis of WTP and WTA values for a possible water trade suggests that an alternative institutional arrangement with more ‘incentive-based’ mechanism inbuilt in it would generate more benefits to the farmers in the Bhavani basin, through more efficient allocation of water. Since the tradable water rights provide such kind of incentives, making effort to introduce it in the Bhavani basin would generate substantial benefits to the farmers.

IV

CONCLUSIONS

In the present study, we estimated the economic value of irrigation water for allocating water efficiently among the farmers both within as well as across the canal systems in the Bhavani river basin, Tamil Nadu. We employed a contingent valuation
survey within a repeated experiment for estimating the economic value of irrigation water among the potential buyers and sellers. Having identified water buyers and sellers across different canal systems in the Bhavani basin, it was found that around 82 per cent of the sample farmers were willing to participate in the water trade. To estimate the ‘benefits’ that could be obtained from the water allocation under the tradable regime, WTP values have been elicited from the potential buyers and WTA values from the potential sellers for exchanging tradable water. Through the repeated experiments, we arrived at equilibrium level of WTP and WTA values under which trade in excess water could take place. The elicited WTP and WTA values suggest that there is a greater potential for increasing the net benefits to the farmers by way of reallocating irrigation water on the basis of the WTP and WTA values. Under the existing institutional arrangement, the water allocation pattern is found to result in inefficient use of water. Therefore, diverting water from the willing sellers to willing buyers under an alternative institutional arrangement namely, the tradable water rights system, would generate larger net benefits in the Bhavani basin.

NOTES

1. This is explained in the analysis part in the subsequent section.
2. In the CV scenario, the potential buyers of water were asked to state their maximum WTP for water equivalent to 10 irrigations for the next cropping season in case the irrigation water will be supplied to them under the condition of payment. Similarly, the potential sellers were asked to state their minimum WTA compensation for selling water equivalent to 10 irrigations, in case they could save such amount of water without affecting crop growth. Prior to asking the WTP and WTA questions, the farmers were told that a new ‘tradable water rights system’ will be introduced in the Bhavani river basin and a River Basin Board, consisting of representatives from all the stakeholders, will be created for coordinating the water trade between buyers and sellers. The farmers were told very clearly that their current entitlement for water will never get affected under the tradable rights system; their decision on whether to make use of the entitled water for their own purpose or sell it to others (or buy the water from others) is purely their own private decision.
3. Scientifically used CV survey is the one which takes all possible measures - as much as possible - to reduce biases and errors that could potentially infect the true values.
4. It should be noted that at present there are ongoing conflicts over water between the LBP farmers and the farmers in the Old Canal System and therefore, one may wonder how the farmers in the Old Canal System will be even willing to accept that there is an ‘excess’ water in their fields, let alone agree for transferring water to the LBP farmers. The point to be noted here is that the ongoing conflict is mainly to retain the ‘riparian rights’ possessed by the farmers in the Old System and therefore, the potential sellers are willing to ‘sell’ the excess water to any potential buyer located anywhere in the Basin provided that they are adequately compensated for transferring the water.

REFERENCES


Palanisami, K. and T. Ramesh (n.a), “Water Productivity at Farm Level in Bhavani Basin, Tamil Nadu: Estimation, Challenges and Approaches”, in http://nrlp.iwmi.org/PDocs/DRdocs/Phase_01/09%

