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Farmers' Willingness to Pay for Tank Maintenance and Conservation – An Economic Valuation Approach

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ABSTRACT

Contingent Valuation Method involves a resource by imputing a monetary value on the response of the people affected by the change in the state of the resource. In this study, contingent valuation method is used to study the factors influencing farmers decision on willingness to pay and payment levels for tank maintenance and conservation and to rank the reasons for farmers willingness to pay and non-willingness to pay. Two tanks surrounding the Noyyal river in Tirupur district of Tamil Nadu namely, Manickapuram tank and Anaipalayam tank were selected purposively. A quota of 30 farmers surrounding each tank were randomly selected and interviewed for willingness to pay after clearly explaining the benefits of tank rehabilitation, maintenance and conservation. The collected data were analyzed using Logistic, Multiple regression and Garette ranking technique. The study revealed that past benefit had a greater influence on farmers decision on Willingness to pay. Age, Education, Farm income, Farming experience and Land holding influences the payment levels. The study also identified and ranked the reasons for farmers willingness to pay and non-willingness to pay. Finally, the study recommends the farmers to construct small percolation ponds for improving the quality of groundwater.

***Key words**: Contingent valuation method, Groundwater quality, Tank rehabilitation, Willingness to pay*

Introduction

One of the precious gifts of nature available on the earth is water. Life is not possible on earth without water, since it is useful for several purposes in day-to-day activities like drinking, irrigation, cooking, construction, domestic purposes, etc. However, all kind of water available on earth is not fresh and usable. Out of the total fresh water available on earth, only 30.36 per cent of fresh water is available for use, which is less than 1 per cent of the total water available on the earth and that too present in rivers, lakes and in underground as groundwater.

Now-a-days quality of water is reducing due to several industrial activities like textile dyeing, leather tanning, paper and pulp processing, sugar manufacturing, pesticides, etc., (Chaudhry and Malik, 2017). The discharge of untreated effluent by the dyeing units into the land pollutes the ground water and makes it unfit for drinking and irrigation (Noel and Rajan 2015 and Gopal *et al*., 2019).

The same kind of water pollution is caused by dyeing industries in the Noyyal river, which further pollutes the groundwater. Groundwater pollution is due to infiltration of polluted water entering the soil and rock, which is difficult to remediate (Geetha *et al.,* 2008). High salt concentrations beyond permissible limits were found in the groundwater sur-

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rounding the Noyyal region (Gowsar *et al.,* 2019). The time taken for remediation of groundwater quality will be very high. A study reported that Water storage in the checkdams improved the quality of groundwater in the surrounding area of 3km^2. Similarly, water storage in dams also leads to improvement in the quality of groundwater in the surrounding region (Parimalarenganayagi and Elango 2015). Hence storage of clean water in tanks, ponds, lakes, dams and other surface water storage structures in the groundwater polluted areas will improve the quality of groundwater.

Studies in the Noyyal region also showed that quality of water is the major problem in the Noyyal river, not the availability of water. Public Works Department in due course rehabilitated few tanks and ponds surrounding the Noyyal river favouring for rain water harvesting and permitted only for percolation purpose and not for irrigation, which helped in reducing ground water pollution. Farmers in these areas enjoyed the benefits of improved ground water quality after rehabilitation of tanks thereby noticed improvement in agriculture. The farmers who had enjoyed the benefit are now ready to pay for the tank maintenance and conservation. From this it is evident that by Contingent Valuation Method, environmental asset possessing value in terms of money (tank in this case) can be measured though willingness to pay.

Contingent Valuation Method involves a resource by imputing a monetary value on the response of the people affected by the change in the state of the resource. In this study, this method is well suited to the valuation of a change in the status of the tanks. Contingent valuation method is applied essentially asking people how much they are willing to pay for the benefit. Willingness to pay does not necessarily mean the actual price, it is the maximum sum the people are willing to pay to have the benefit or the minimum sum they are willing to accept to forego the benefit, thus giving a value to the resource (Karpagam, 1999).

Contingent Valuation Method was used in several studies which includes the factors determining willingness to pay (Sivasakthi devi *et al.,* 2010 and Karthikeyan Chandrasekaran *et al.,* 2009), Heckman's the factors affecting decision of willingness to pay and factors influencing payment levels (Fanbin Kong *et al.,* 2014). In this study contingent valuation method is used with the following objectives

- To study the factors influencing farmers decision on willingness to pay and factors influencing payment levels for tank maintenance and conservation.
- To rank the reasons for farmers willingness to pay and non-willingness to pay.

Materials and Methods

Area selection

Two tanks surrounding the Noyyal river in Tirupur district of Tamil Nadu namely, Manickapuram tank and Anaipalayam tank were selected purposively. Both the tanks were rehabilitated by Public Works Department about two years ago. But farmers surrounding the Manickapuram tank maintained the tank properly, allowing the water in the tank only for recharge purpose and enjoyed the benefit of increased quality of groundwater due to percolation of water from the tank whereas it is not so in the case of Anaipalayam tank. Inorder to compare quality of water and willingness to pay, the tanks were purposively selected.

A quota of 30 farmers surrounding each tank was randomly selected and interviewed for willingness to pay after clearly explaining the benefits of tank rehabilitation, maintenance and conservation. The primary data was collected during May to December, 2021. One groundwater sample from each tank was collected, tested for quality parameters and results were tabulated.

Tools

The collected data were analyzed using Logistic regression, Multiple regression and Garette ranking technique and the results were interpreted.

Logistic regression model was used to determine the factors that determine the farmers' decision on willingness to pay for the resource. The logit model in this study postulates that Pi, the probability of the ith respondent's decision is a function of an index variable Zi, summarizing a set of the individual attributes (Gujarathi *et al*., 2003). To examine the determinants of decision on willingness to pay, the logit model with most likely variables was fitted, estimated using maximum likelihood method. The logit equation is expressed as:

$$Li = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu$$

Where, α = Constant

X_1-Age of the respondents (years)

X_2-Education (years)
X_3-Farming experience (years)
X_4-Land holding (acres)
X_5-Farm Income (Rs./year)
X_6-Past benefit (dummy as 1 for farmers benefitted and 0 for not benefitted in the past)
β_i's-Parameters to be estimated and
μ-error term

Multiple Regression model was used to empirically determine the factors that influence the payment level, the following regression model was fitted

$WTP = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \mu$

where, WTP-Willingness to pay (Rs./annum)
α-Constant
X_1-Age (years)
X_2-Education (years)
X_3-Farming experience (years)
X_4-Land holding (acres)
X_5-Farm income (Rs./year)
βi 's -Parameters to be estimated
μ-Error term

Garrett ranking technique was used to rank the reasons for farmers willingness to pay. Similarly, the reasons of farmers for non-willingness to pay was also ranked. The per cent position of each rank was found out by the equation.

$$\text{Per cent position} = \frac{100\left(R_{ij} - 0.5\right)}{N_j}$$

where, Rij-Rank given for the ith items by the jth individual, and Nj -Number of items ranked by the jth individual (Devi and Ponnarasi, 2009)

Results and Discussion

Table 1. Test results of groundwater samples

Particulars	Manickapuram tank	Anaipalayam tank
pH	7.4	6.98
EC(dSm^{-1})	1.9	11.9
Chloride (meq/l)	12.5	57.2
Calcium (ppm)	65.2	337.5
Magnesium (ppm)	117.9	315
Sodium (ppm)	120.1	351.8
Potassium (ppm)	11.34	49.71

Note - Higher ionic values implies high salt concentration and hence poor quality of water

The results of the ground water samples showed that values of water quality parameters like EC and ionic concentrations are high (three to five times) in Anaipalayam tank region compared to Manickapuram tank region. In addition, ionic concentrations in the Manickapuram tank region were slightly problematic whereas in Anaipalayam tank they were highly problematic. It revealed that rain water harvesting and percolation of water from tanks to underground was the reason for low water quality parameter values in Manickapuram tank regions. It is also evident that water storage reduces the salt concentrations in Manickapuram tank region which makes the groundwater quality to shift from highly problematic to slightly problematic which in future may become fit for irrigation, if the same trend continues in that region.

Table 2. Estimates of factors determining farmers decision on willingness to pay

Variables	Co-efficient	Odds ratio	P value
Constant	-7.3410	-	0.195
Age	-0.0189	1.019	0.138
Education	0.8761	2.407	0.092*
Farming experience	0.5649	1.759	0.180
Land holding	0.3892	1.475	0.198
Income	0.1381	1.148	0.010***
Past benefit	1.2915	3.638	0.003***
R^2	0.73		
-2 loglikelihood	35.789		
Nagelkerke R^2	0.80		

*, *** shows significant at 10 and 1 per cent respectively

It could be inferred from the Table 2 that the variables education, farming experience, land holding, income and past benefit have positive influence on WTP and the variable age has negative influence on famers decision on WTP. However, variables like age, farming experience and land holding are non-significant and variables like education, income and past benefit are significant. The variable education revealed that one year increase in education increases the odds of farmers decision on willingness to pay by 2.407 times. The variable income revealed that a rupee increase in income will increase the odds of farmers decision on willingness to pay by 1.148 times. Similarly, the variable past benefit showed that a farmer with past benefit increases the odds of farmers decision on WTP by 3.638 times. Nagelkerke R^2 is 0.80 which shows that 80 per cent of the sample fall in line with the results obtained. Negative loglikelihood is 35.789 indicating the goodness of fit of the model.

Table 3. Estimates of factors determining farmers payment levels

Variables	Co-efficient	Standard error	T statistic
Constant	7314.64	4876.953	1.499
Age	-99.28	97.21489	-1.021
Education	150.83	196.6621	0.766**
Farming experience	27.12	86.69762	0.312**
Farm holding (in acres)	157.07	135.426	1.159**
Income	0.02	0.001406	15.652***
R^2	0.796		

** and *** refers to significance to 5 and 1 per cent levels respectively.

Table 4. Reasons for willingness and non-willingness to pay

Particulars	Mean Score	Rank
Reasons for willingness (Manickapuram tank)		
Experiences benefit in the past	76.20	1
Ecological concern	58.00	4
Dependence on Agriculture	73.25	2
Increase in income due to tank maintenance	67.55	3
Health benefit	53.00	5
Reasons for non-willingness to pay (Anaipalayam tank)		
Reduced agricultural activity	61.45	4
Lack of past benefit	72.00	2
Increased income from other sources	76.55	1
Lack of awareness on tank maintenance	55.65	5
Availability of panchayat water for drinking	62.35	3

The results of multiple regression analysis (Table 3) indicated that 79.6 per cent variation in farmers willingness to pay was explained by explanatory variables viz., Age(X_1), Education(X_2), farming experience(X_3), land holding(X_4) and Farm income(X_5). Further the coefficients of X_2, X_3, X_4 and X_5 were positive indicating they were positively related with the amount that the farmers are willing to pay. It could be inferred that a year increase in education will increase the farmers WTP amount by Rs. 150.83 keeping other variables constant and a year increase in farming experience will increase the farmers WTP amount by Rs. 27.12, *ceteris paribus*. Similarly, an acre increase in land holding by a farmer increases the WTP amount by Rs. 157.07, *ceteris paribus*.

The results of Table 4, revealed that out of the selected reasons for willingness to pay, Experiences benefit in the past occupied first place with a mean score of 76.20, dependence on agriculture was ranked second place with mean score of 73.25. Further, Increased income, ecological concern and health benefit occupied third, fourth and fifth places respectively. On the other hand, among the reasons identified for non-willingness to pay, Increased income from other sources and lack of past benefit ranked first and second place with a mean score of 76.55 and 72.00 respectively. Availability of panchayat water for drinking, reduced agricultural activity and lack of awareness on tank maintenance occupied third, fourth and fifth ranks respectively.

Conclusion

The results of the ground water samples showed that EC and ionic concentrations were three to five times higher in Anaipalayam tank region compared to Manickapuram tank region.

The study revealed that the variables like education, farming experience, land holding, income and past benefit had influenced the farmers decision on Willingness to Pay. The results of multiple regression analysis indicated that 79.6 per cent variation in farmers payment level was explained by explanatory variables. Further the coefficients of X_2, X_3, X_4 and X_5 were positive indicating they were positively related with the amount that the farmers are willing to pay.

The important reason for farmers willingness to pay was found to be past benefit from water storage

in tank. Similarly, the important reason for non-willingness to pay was found to be increased income from other sources.

Policy recommendations

- The study revealed that farmers who were non-willing to pay are those who were not aware of tank maintenance, hence it is necessary to create awareness among the farmers about the tank maintenance and its benefit.
- The study also showed that past benefit plays major role on farmers decision on willingness to pay and hence recommends previously benefitted farmers to interact with non-beneficiaries and to share about the increase in the income due to tank maintenance.
- Ground water sample test revealed that salt concentrations decreased in Manickapuram tank area due to storage of water in the tank and allowing only for percolation and hence the study suggests the farmers to construct small percolation ponds for improving the quality of groundwater.
- The study suggests timely maintenance of tanks by Public Works Department so as to conserve the diversity of ecology.

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