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AN EVALUATION OF THE FACTORS INFLUENCING FARMERS' WILLINGNESS TO PAY (WTP) FOR IRRIGATION WATER: THE CASE OF AHERO IRRIGATION SCHEME IN KENYA

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Abstract

Background: Agriculture is the mainstay of the economy in Kenya. However, the country's capacity to increase agricultural production through the expansion of cultivated land under rain-fed conditions is severely constrained for two main reasons. First, only about 20% of the Kenya's land area is medium to high potential with respect to rain-fed agricultural production. Second, there is an increasing population density on that 20% of Kenya's land area because it hosts over 60% of the country's total human population that has been growing relatively fast (at an average of around 3% per annum) over the last five decades. These factors underscore the importance of irrigation development in enhancing agricultural production toward achieving food security, employment creation and poverty reduction in Kenya. Therefore, the knowledge of the farmers' demand for irrigation water and the factors that influence their Willingness-to-Pay (WTP) for irrigation water are important inputs in the design of effective and sustainable irrigation schemes as well as in the benefit-cost analyses of investments for irrigation development in any country, Kenya included. Therefore, this study aimed at analyzing the factors that affect farmers' WTP for irrigation water and thus provide some information that can be used in the formulation of policies to enhance the development of irrigated agriculture in general and in Kenya in particular. **Methodology:** Stratified and random sampling techniques were used to select 221 rice farmers in Ahero Irrigation Scheme in Kenya whose WTP for irrigation water was evaluated through this study. A contingent valuation method (CVM) was applied to elicit the farmers' WTP bids, while the ordinary least squares (OLS) regression method was used to evaluate the marginal effects of the factors that significantly influence the farmers' WTP for irrigation water. **Results and Implications:** The results indicated that the farmers were willing to pay Ksh. 2,773 per acre per year as opposed to the current charges by the National Irrigation Board (NIB) for the use of irrigation water at Ksh. 3,100 per acre per year that are intended to meet the Board's costs of scheme operation and maintenance. The results thus suggest that the farmers are being overcharged by about 11.8% by the NIB. Off-farm income, access to credit and satisfaction with the management of water supply system were found to be the factors that significantly influence the farmers' WTP for irrigation water. Therefore, policies to address these factors to enhance irrigation development in Kenya are called for.

Keywords: Evaluation, Factors, Farmers' WTP, Irrigation Water, Kenya.

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1.0 Introduction

Water is an important resource to humans (Mallios, 2010), being a necessary input in most economic sectors and especially in the development of irrigation schemes. Therefore, its supply and availability should be assured for economic development. However, water is becoming increasingly scarce as population grows and water demand in agriculture, industry and households rises (World Health Organization, 2009). Despite the agricultural sector being the biggest consumer of fresh water and thus being characterized by a high water use intensity, it is also a sector that is characterized by low water use efficiency (Mallios, 2010). There is need to treat water as an economic good and devise ways of increasing its use efficiency. This, in turn, requires that efficient water prices be introduced to optimize water consumption, especially in those countries where irrigation development is an important vehicle for the attainment of food security and economic development, as is the case for Kenya.

Agriculture is the mainstay of the economy in Kenya and contributes about 25% to the country's Gross Domestic Product (GDP) with food crops contributing about 26% of the country's agricultural GDP (Republic of Kenya, 2010). Kenya's capacity to increase agricultural production through the opening up of new land area for cultivation under rain-fed conditions is highly constrained for two main reasons. First, only about 20% of the Kenya's land area is medium-to-high potential with respect to rain-fed agricultural production (Muthigani, 2011) and this also happens to be the land area in Kenya that hosts over 60% of the country's human population (Republic of Kenya, 2010). Second, increasing population density in the medium-to-high potential land area in Kenya has been leading to excessive subdivision of land into uneconomic units from a farming perspective in many parts of Kenya (Republic of Kenya, 2008). This excessive subdivision of land into uneconomic units is commonly referred to as land fragmentation (Sundqvist, 2006). These factors make irrigation development a valuable means of enhancing agricultural production in Kenya.

To enhance food security, employment creation and poverty reduction, Kenya is embarking on the construction of new irrigation schemes as well as the rehabilitation of the existing ones. Information and/or knowledge on the farmers' demand for irrigation water and their WTP for it is important when planning for effective water management and sustainable irrigation schemes. Such information is also needed to facilitate benefit-cost analyses of investments in irrigation and when determining optimal distribution of water resources between different users. In other words, such information is critical in the formulation of water pricing policies intended to promote water use efficiency. The knowledge of the farmers' WTP for irrigation water is important for decision makers in developing countries where demand for water is increasing faster than the existing infrastructure can supply. Optimal pricing of water is thus necessary to ensure that the revenues from the purchases of water can be used to cover the costs of developing a country's public water utility. Therefore, this study aimed to contribute to knowledge by characterizing and analyzing the factors that determine the farmers' WTP for irrigation water with a view to pinpointing their marginal contributions.

2.0 Research Plan and Methods

2.1 Area of study, sampling and data collection

The study was conducted at the Ahero irrigation scheme in the Kisumu County of Kenya during the month of April 2012. The scheme is managed by the National Irrigation Board (NIB), a statutory body in Kenya, through a partnership with the farmers, the main crop being rice. The basic sampling unit was a farm household. The sampling frame, this being the list of all the farmers in the various irrigation blocks, was obtained from the Ahero regional office of the NIB. Stratified and random sampling techniques were applied to generate a sample of 221 farmers who were interviewed during the study. Primary data was collected using a structured household questionnaire. Secondary data was obtained through the reviews of existing relevant literature, especially the NIB and government (Ministry of Agriculture) publications and reports.

2.2 Theoretical framework

The contingent valuation method (CVM) has been employed to estimate the economic value of irrigation water as well as to assess the factors influencing farmers' WTP for irrigation water in a number of previous studies. Some of these studies include: Mezgebo et al. (2013), Alhassan et al. (2013), Tang et al. (2013), Assefa (2012), Jaghdani and Brümmer (2012), Mesa-Jurado et al. (2011), Karthikeyan (2010), Storm et al. (2010), Basarir et al. (2009), Jaghdani et al. (2009), Chandrasekaran et al. (2009), Weldesilassie et al. (2009), Leyva and Sayadi (2005), Birol et al. (2007), Akter (2006) and Tiwari (1998). However, no such studies have been undertaken in Kenya to estimate the farmers' WTP for irrigation water. The current study was thus undertaken to address this gap in knowledge.

The current study employed the CVM as the basic framework of the analysis. The CVM is a stated preference method of estimating the value of a non-market or non-priced good or service (Birol et al. 2006) and usually employs the WTP approach. An evaluation of the WTP is an economic concept that aims at determining the amount of money a consumer would be willing to pay for the supply of a good or service, such as irrigation water, that is currently not being supplied in the market. The individual is asked how much he/she would be willing to pay for a particular good or service or how much he/she would be willing to accept for the loss of a good or service in a hypothetical market. In other words, the CVM basically tries to elicit for an individual's WTP for a given good or service in a hypothetical market. The aim is to obtain valuations or bids that are close to what would be revealed if an actual market existed.

In the current study, each respondent was asked how much he/she was willing to pay for the irrigation water rather than have it taken away. The irrigation water was assumed to generate and sustain the user's utility and this was reflected in the user's WTP for that water. The WTP thus gives the amount of money the consumer is willing to have deducted from his/her income to sustain his/her utility with respect to a particular good or service.

For the current study, and in the case of the farm households in the Ahero irrigation scheme, Equation 1 represents a farm household's utility function in the status quo scenario, i.e. under the current water supply system that has inadequate and irregular water supply. Equation 2 represents a farm household's utility function under the hypothetical market, i.e. under a situation with sufficient water throughout the year. Farmers have to pay for the change from the status quo scenario by an amount equal to M, and the farm household will agree to pay for irrigation water if the condition in Equation 3 is satisfied, i.e. if the utility derived after paying M for the change is greater than the utility derived without the change.

$$U^0 = V^o(q^0, I, F, S, e_0) \qquad (1)$$

$$U^1 = V^1(q^1, I - M, F, S, e_1) \qquad (2)$$

$$V^1(q^1, I - M, F, S, e_1) \succ V^o(q^0, I, F, S, e_0) \qquad (3)$$

In the above equations:

(i) e_0 and e_1 are the error terms which are assumed to be distributed normally with mean zero and variance of one;
(ii) 'I' denotes average household income;
(iii) F stands for farm characteristics;
(iv) S stands for socio-economic characteristics of the household;
(v) M is the WTP (money amount the household is willing to trade off) in the hypothetical market with improvement in the irrigation water supply system.

A bidding game was used in the current study to elicit for the WTP values. The bidding game is identical to an ordinary auction, which is familiar to the respondents. It provides a "market like" situation on the basis of which to "price" their valuation. The initial bid is iteratively changed until the respondent states his/her maximum WTP (Chowdhury, 1999). In the current study, the hypothetical market was "improved water supply", which was expected to be achieved by ensuring that water is available throughout the year for rice production. The payment vehicle was through the water user fees, payable to the NIB. The payment vehicle basically provides for the form of payment and where to pay the stated WTP if the hypothetical market was real.

In this study, the initial bid amount was Kshs.3,100, which was informed by the discussions held with the farmers and also by the information generated through questionnaire pretesting. During the questionnaire pretesting, the farmers were asked to state their maximum WTP for irrigation water. To reduce the starting point bias, a mean of the stated WTP values was computed and found to be close to the current NIB Operation and Maintenance cost of Kshs.3,100 per acre per year under unsatisfactory irrigation water provision conditions. During the actual survey, the respondents were asked if they would be willing to pay Kshs.3,100. If the response was "yes", the value was iteratively increased by 10% after each "yes" response until the point where the respondent would not be willing to pay was reached. The last "yes" bid amount was then recorded as the respondent's maximum WTP. If the response was "no" to the first (Kshs3,100) bid, the bid amount was iteratively reduced by 10% after each "no" response until the point where the respondent would be willing to pay was reached. This bid value was then recorded as the maximum WTP for the respondent. A follow-up question was asked to find out why the respondent had stated that particular amount which was recorded as the maximum WTP amount.

2.3 Empirical Model

The Ordinary Least Squares (OLS) estimation method was used to characterize and evaluate the marginal effects of the factors that influence the farmers' WTP for irrigation water. The dependent variable was specified as the natural logarithm of the stated WTP for irrigation water. The WTP values were expressed in the logarithmic form to reduce the variability in the dependent variable. The model was specified as follows:

$$\ln WTP = \alpha + \beta_1 AGE + \beta_2 GEN + \beta_3 HHSIZE + \beta_4 EDUC + \beta_5 INC + \beta_6 CREDIT + \beta_7 LAND + \beta_8 SATISFACTION + \varepsilon \quad \text{... ... ...} \quad (4)$$

where: $\ln WTP$ is the natural logarithm of stated WTP for irrigation water per acre per year;

α is the constant; β_s are the coefficients to be estimated; AGE is the categorical age group of the household head in years (1=15-30, 2=31-45, 3=46-55, 4=56-70, 5=above 70); GEN is a dummy variable for gender of the household head (1=male, 0=female); HHSIZE is the number of individuals in a household; EDUC is the education level completed by household head (1=None, 2=Primary, 3=Secondary, 4=College, 5=University); INC is a dummy variable for earnings from off-farm income (1= household head earns some off-farm income, 0=household head does not earn any off-farm income); CREDIT is a dummy variable for access to credit (1=has access to credit, 0=has no access to credit); LAND is the size of land cultivated during the 2011/2012 season in acres; SATISFACTION is a dummy for whether satisfied with the management of water supply system (1=Satisfied, 0=Not satisfied).

4.0 Results and Discussion

4.1 Descriptive statistics

Table 1 presents the results on household socio-economic and demographic parameters that had been hypothesized to influence the farmers' WTP for irrigation water. These parameters were generated using SPSS version 17.0.

Table 1: Summary of descriptive statistics

Variable	Mean	Std. Dev
Farmer specific variables		
Gender (1=male,0=female)	0.70	0.46
Household size	5.66	2.10
Off farm income (1=Yes,0=No)	0.39	0.49
Credit access (1=Yes,0=No)	0.30	0.46
Number of farm extension contacts	1.87	1.63
Farm specific variables		
Land size cultivated (acres)	3.24	1.23
Distance to input market (km)	3.07	2.18
Distance to output market (km)	2.88	1.72
Satisfaction with water supply (1=Yes,0=No)	0.44	0.03
Stated WTP for irrigation water per acre per year (Ksh.)	2,772.96	787.14

Source: Author's Survey (2012)

The parameters given in Table 1 reveal that 70% of the interviewed farmers were male while 30% were female. The average household size was found to be 6 individuals. About 39% of the interviewed farmers earned some off-farm income, while 30% of the farmers had access to credit in the year 2011. On average, farmers had 1.9 contacts with extension workers. The average land size cultivated in the year 2011/2012 season was 3.2 acres. The average distance to input and output markets was 2.9 km and 3.1 km respectively. About 44% of the interviewed farmers were satisfied with the current supply of irrigation water. The mean stated WTP for irrigation water for rice production was Ksh. 2,773 per acre per year, which is lower than the current NIB charges of Ksh. 3,100 per acre per year for irrigation scheme water operation and maintenance (O&M). The results suggest that the farmers are being over-charged by about Ksh. 327 per acre per year because the WTP effectively reflects the shadow price with respect to the item under analysis (irrigation water in this case).

The education level of the interviewed household heads is presented in Table 2.

Table 2: Education level of the household head

Education level	Frequency	Percent
None	17	7.7
Primary	135	61.0
Secondary	62	28.1
College	5	2.3
University (Degree)	2	0.9
Total	221	100.0

Majority of the farmers interviewed (61%) were in the primary school category. About 28% were in the secondary school category, with about 8% having no formal education. Only about 3% of the respondents had attained college/degree education level. On average, the rice farmers in Ahero irrigation scheme have 7 years of education, corresponding to primary school level (Table 2).

Table 3 presents the age categories of the household heads.

Table 3: Farmers' age categories (years)

Age group (years)	**Frequency**	**Percent**
15-30	7	3.2
31-46	67	30.3
47-62	84	38.0
63-78	60	27.1
Above 78	3	1.4
Total	221	100.0

Table 3 shows that 38.0% of the farmers were in the 47-62 years age group, followed by 30.3% in the 31-46 years category and by about 27.1% in the 63-78 years age group. Only 3.2% of the farmers were in the 15-30 years age group, while 1.4% were above 78 years old. The average age across all age groups was found to be 54 years.

4.2 Factors that influence the WTP for irrigation water

As stated elsewhere, the factors that influence the farmers' WTP for irrigation water were characterized and their marginal effects determined through the OLS technique, using the STATA version 10.0, with the dependent variable being the natural logarithm of the stated WTP.

Table 4 presents the OLS results. These results indicate that about 76.4% of the observed variation in the dependent variable (lnWTP) is explained by the explanatory variables included in the OLS model. For a regression model, the F-value gives the overall significance and fitness of the model. In the case of this study, the F-value is 92.1 (Table 4) and is significant at the 1% level. This result indicates that the OLS model adequately explains the effects of the factors included in the model on the farmers' WTP for irrigation water.

Table 4: Results of OLS regression

Dependent variable: lnWTP			
Independent variables:	Coefficient	Robust Standard Errors	P value
Age	0.0035	0.0094	0.714
Gender	0.0167	0.0204	0.414
Household size	-0.0060	0.0043	0.166
Education	0.0257	0.0169	0.129
Off farm income	0.0545	0.0173	0.002***

Credit	0.0339	0.0199	0.091*
Land size	-0.0031	0.0074	0.672
Satisfaction	0.4420	0.0184	0.000***
Constant	7.6738	0.0532	0.000***
Number of observations	217		
F (8, 208)	92.10		
Prob>F	0.0000		
R^2	0.7644		
Root MSE	0.1234		

Legend: *, **, and *** imply statistical significance at 10%, 5% and 1% level respectively.

Out of the eight explanatory variables included in the OLS model, three were found to be significant at 10% or lower levels in determining the farmers' WTP for irrigation water in the Ahero Irrigation Scheme. These variables are the off-farm income, access to credit and satisfaction with the management of the water supply system.

Off-farm income affected farmers' WTP for irrigation water positively. This finding is consistent with that from Akter (2006) who found that the households that earned some off-farm income were more willing to pay for irrigation water when compared to those who did not earn any off-farm income. This study estimated the marginal effect for "off-farm income" at 5.5%.

As expected, access to credit also positively influenced the farmers' WTP for irrigation water, probably due to the possibility that part of the credit offered is used to pay for irrigation water among the other inputs in rice production. This study estimated the marginal effect for "access to credit" at 3.4%.

Satisfaction with the management of the irrigation water supply system also positively influenced the farmers' WTP for irrigation water. The study found that the farmers who were satisfied with the management of irrigation water supply system were willing to pay more when compared to those who were not satisfied with the management of irrigation water supply. This result is consistent with that of Tang et al. (2013). This study estimated the marginal effect for "satisfaction with the management of irrigation water supply system" at 3.4%.

5.0 Conclusion

Based on the findings from this study, off-farm income, access to credit and satisfaction with the management of irrigation water supply system positively influenced the farmers' WTP for irrigation water. These results have far-reaching implications on irrigation development. First, the income earned off the farm is used to enhance agricultural production. Second, access to credit enhances irrigation development, and third, satisfaction with the management of the water supply system will enhance farmers' participation in irrigated agricultural production. Therefore, promotion of Small and Medium Enterprises (SMEs) in rural areas to improve off-farm income in the neighbourhood of irrigation schemes can be expected to increase the farmers' WTP for irrigation water. Provision of accessible credit to farmers in irrigation schemes should be encouraged as it enhances their WTP for irrigation water and thus serves as a channel to improve agricultural production.

The study found that the farmer's WTP for irrigation water was Ksh. 2,773 per acre per year while the current O&M charges for irrigation water by the NIB were Ksh. 3,100 per acre per year. Hence the farmers at Ahero irrigation scheme were paying much more than the expected shadow price for irrigation water, a result that reflects an 11.8% surcharge by the NIB. This could be attributable to the perceived poor supply and management of irrigation water because about 56% of the respondents were found to be dissatisfied with the water supply management system at the Ahero irrigation scheme. Therefore, there is need to improve the supply and management system of irrigation water at the Ahero irrigation scheme and thus be able to enhance the farmers' WTP for irrigation water at the scheme. The NIB should ensure adequate volumes of water are supplied at the scheme throughout the rice production season to enhance the farmers' WTP to pay for irrigation water. This action will, in turn, improve cost recovery and sustainability of the irrigation scheme. To achieve this requires that the water pumps are well serviced and maintained so that they do not break down during the rice production periods.

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