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Farmers' Willingness to Pay for Irrigation Water Use: The Case of Haramaya District, East Harerghe Zone, Oromia Regional State, Ethiopia

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Abstract

The value of irrigation water is a measure of the net economic contribution of water to the value of agricultural production. The economic value of irrigation water was determined through the Contingency Valuation Method by analysing farmers' willingness to pay for irrigation water under a hypothetical market constructed in the study area. The objectives of the study were to analyse determinants of willingness to pay for irrigation water use by individual households and to evaluate their WTP for irrigation water use per hectare of irrigable land per year. Ordered Logit Model was used to identify and analyse the factors that determine farmers' WTP for irrigation water. In addition, the bivariate logit model was used to calculate the mean WTP for irrigation water use per hectare per year. The result of the ordered logit model showed that six explanatory variables were found to be significant at different probability levels. On the other hand, the result of the bivariate logit model showed that the household head mean annual WTP amount was Birr 7,402.32 per hectare per year. The results show that practical intervention measures for constructing, managing and maintaining irrigation infrastructure with community participation should consider the value they give for the resource. Policy directions for sustainable use of irrigation water and management in Ethiopia were also suggested.

Keywords: Contingent Valuation, Economic Value, Irrigation Water, Sustainability, Willingness to Pay

Introduction

In the sixteenth century, the famous Renaissance scholar Leonardo Da Vinci said that water is the driver of nature. During his lifetime, some may have considered this to be an overstatement, but some half a millennium later, Leonardos' understanding of the role, relevance and importance of water to society and nature can be considered to have been prophetic (Biswas et al., 2009). Now, in the 21st century, one of the development challenges facing the world is meeting the rising demand for food while maintaining the sustainability of the natural resource, especially water (FAO, 2004). Limited availability, declining quality and the growing demand for fresh water have now emerged as a major worldwide challenge, and climate change is expected to make matters worse (EC, 2012).

Water resources remain poorly developed, and the utilisation of the existing agricultural water management schemes is inefficient. The signs of water shortage and the need for demand management in situations where supply growth is no longer feasible, in addition to current high levels of subsidy to irrigation, in parallel with underfunding of maintenance and deterioration of infrastructure, are among the drives towards irrigation water charging. However, in some irrigation projects, water is provided as a free service. Elsewhere, even the low charges, supposed to be collected are, in fact, not collected (Cai et al., 2001). Ainsworth and John (2005) noted that adequate protection and routine maintenance enhance the sustainability of water supply systems. Thus, collaboration and integration of the government and beneficiary households are required, and such development activities should consider the value those beneficiary households give to water resources for irrigation purposes.

The value of irrigation water is a measure of the net economic contribution of water to the value of agricultural production. As a consequence, the valuation

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of water used in agricultural activities is a prerequisite in the implementation of almost every pricing method. On the other hand, it is a difficult task mainly because irrigation water is a classic non-marketed resource (Dinar et al., 1997; Ward & Michelsen, 2002). The contingent valuation method is a survey-based approach to the valuation of nonmarket goods and services and is widely applied to measure the economic value of water. It relies on people's hypothetical WTP rather than actual market information on their behaviour (Hanemann et al., 1991).

Background

About 85% of Sub-Saharan Africa's poor live in rural areas and depend largely on agriculture for their livelihoods, which depends on rainfall (Peacock et al., 2007). However, there has been less agricultural water development to date in Sub-Saharan Africa than in any other region, though the sector is the backbone of the region's economy. From 1962-2002, only 4 million hectares (Mha) of new irrigation were developed in the region, far and away the smallest expansion of any region. Yet, the region has an immense potential for irrigation. Over the same period, China added 25 Mha, and India added 32 Mha, and between 1994 and 2004, it was only 0.85 Mha (FAO, 2005).

Rain-fed agriculture dominates in Ethiopia. However, rainfall distribution and intensity vary spatially, tending to decrease from southwest to northeast (Cheung et al., 2008). Rainfall also varies temporally, resulting in incidents of drought every 4-5 years (Osman & Sauerborn, 2008). These rainfall patterns affect crop and livestock production and contribute to volatility in food prices, which ultimately affects overall economic development (FAO, 2005). However, according to Seleshi (2010), the country has about 5.3 Mha potential irrigable land. Yet, only about 640,000 ha are irrigated, of which about 241,000 ha from small scale, 315,000 ha from medium scale and 84,000 ha from large scale schemes. The per capita irrigated area was about 30 meters square (m^2), which was very small compared to 450 m^2 globally (Seleshi et al., 2007).

Nonetheless, some of the existing irrigation schemes are not operating at their full potential, while others are not functioning because of problems related to infrastructure, management and water shortages. A performance assessment conducted on six selected irrigation schemes (five small-scale and one large-scale) confirmed they are performing poorly (FAO, 2011). According to AgWater Solutions (2010), unsustainable use of irrigation, mainly due to excessive use of water and poor infrastructure maintenance, is one of the problems facing the agriculture sector of the country. In the past, the most common way of constructing and maintaining irrigation schemes in countries was through government or donor expenditures with little or no community participation. Yet improving and protecting irrigation water always requires joint action of stakeholders. Because absolute dependence on government or donor funds without community involvement is likely to be unsustainable. One example in Ethiopia from the 1980s is the large Borkena dam in South Wello (Desta et al., 2005, as cited in Habtamu, 2009). But water pricing policy aiming at cost recovery enables to cover the costs of providing the service – ranging from O&M costs to full supply cost, including capital expenses, besides regulating water demand for production purposes as it signals water is scarce.

Study Area Oromia regional state of Ethiopia, which is the largest state in terms of both population and land area, has been involved in irrigation development. Currently, there are 199 irrigation schemes in the region. These irrigation schemes covered 33,765.19 hectares of irrigated area, of which 4,627.29 ha is from small-scale, 2,800.01 ha from medium-scale, and 26,338 ha from large-scale (Seleshi, 2010). In the regional state, motorised pumps are often used to lift water from rivers, lakes, ponds or hand-dug wells when gravity irrigation is difficult. Traditional ponds (birka) and sand-water are often used for livestock in dry land areas such as Borena. In addition, rainwater harvesting has been implemented by the government, particularly in drought-prone areas, since 2002. Pond technology for small-scale irrigation is widely adopted in the region. Besides, drip irrigation, treadle pumps, rope-and-washer, and windmills are just in the adoption process in some zones of the region. There are also ample groundwater resources in the Oromia Region.

The study was conducted in Haramaya District, Eastern Hararghe Zone, Oromia National Regional State of Ethiopia. East Hararghe is one of the 180 zones in the Oromia Regional State and located in the eastern part of Ethiopia between 410 12' E - 420 53' E and 70 32' N - 90 44' N, bordering Somali and Harari Region as well as Dire Dawa Administration. Haramaya District is one of the 18 Districts in the Eastern Haraghe Zone with an area of 561.64 km^2 (HDOA, 2012). According to CSA (2008), Haramaya District has a population of 271,394, out of which 50,986 (about 16%) live in urban and the remaining 220,408 (about 84%) live in rural in 2007. The district is situated in the semi-arid tropical belt of Eastern Ethiopia and is characterised by a sub-humid climate with an average annual rainfall of about 790 mm and annual mean temperatures of 17°C with mean minimum and maximum temperatures of 9.4 and 24°C, respectively. The area experiences biannual types of rainfall classified as short and long rainy seasons. The short rainy season usually occurs from the end of February to mid-May, while the long rainy season is from July to the end of September. The altitude of the district ranges from 1400 to 2340 meters above sea level. About 36.1% of the district's land is arable, 2.3% is used for pasture, 1.5% is covered by forest, and the remaining 60.1% is considered degraded or unusable (HDOA, 2012).

The district is well known for its high production and centre for commercial exchange of Chat, which is exported to Djibouti, Yemen, Oman, and Saudi Arabia. Other crops, including sorghum, maise, coffee, and a variety of vegetables, such as potato, onion, tomato, pepper, and cabbages, are produced in the district. Livestock also plays an important role in the farming system of the area, providing income, food and fertiliser. Livestock production is largely dependent on crop residues and grazing on hillsides, field borders and roadsides.

Small-scale irrigation farms using engine-driven pumps are the most prevalent system in the area. It is widely used to lift water from rivers, lakes, or ponds for producing chat and vegetables. According to the districts' Agriculture Office (2012), motorised irrigation is widely practised in the district. Underground water, Lake Adellei, and harvested rainwater are the main sources of irrigation water in the study area in their respective order. More than 600 functional ponds were found in the district. The District Agriculture Office was providing motor pumps with 25% credit and 75% on-hand payment, while the Water, Mineral and Energy Office were providing the same with 50% credit and 50% on-hand payment.

However, the over-abstraction of the water puts the sustainable use of the resource under question. For example, Lake Haramaya of the district was dried out, mainly due to sedimentation and excessive pumping, which is endangering the biodiversity of the ecosystem (AgWater Solutions, 2010). In addition, the level of groundwater is dropping down further from year to year, and Lake Adellei, which might be suitable for irrigation purposes, is under risk.

Regarding Lake Adellei, which was the focus area of the study, there is no well-constructed irrigation scheme and regulation to use it. In addition, no attempt had been made to quantify farmers' willingness to pay (WTP) for irrigation water use in order to develop sound interventions aimed at developing irrigation schemes. This motivated the study to investigate the farmers' WTP for the non-marketed good, irrigation water use, in the hypothetical market constructed in the study area.

Methodology

Data and Sample

The study used data that were gathered from both primary and secondary sources. The primary data were collected through face-to-face interviews of the sample household heads using a structured questionnaire consisting of questions related to socio-economic, demographic and institutional characteristics of the households and contingent valuation. A draft questionnaire for these purposes was first presented to six households to generate information that was used to refine the survey instrument for the contingent valuation study. Feedback from the pre-tests was used to revise the questionnaire, especially in determining acceptable starting points and ranges of bids to minimise the effect of starting point bias. Additional primary data were generated from personal observation during focus group discussions and interviews of the District Agriculture and Water, mineral and Energy Offices workers.

Secondary data were also collected from the District Water, Mineral and Energy Office. Six enumerators who are fluent speakers of the local language were recruited and trained for a day on the objectives of the study, in data collection techniques, in the questionnaire, and how to approach the farmers during the interview for the purpose of data collection.

There are several approaches to determine the sample size. These include using a census for small populations, imitating a sample size of similar studies using published tables, and applying formulas to calculate a sample size. In this study, a simplified formula provided by Yemane (1967) was used to determine the required sample size at a 95% confidence level, 0.5 degree of variability and 9% level of precision.

$$n = \frac{N}{1+N} \qquad (1)$$

Where n is the sample size, N is the population size (total household size), and e is the level of precision. The District has 31 rural and 2 urban kebeles with a total of 33,978 households (CSA, 2008). Hence, the sample size is equals.

$$n = \frac{33978}{1+33978}$$

$$= 123.0098 \approx 123 \qquad (2)$$

Ifa Oromia and Biftu Geda were purposively selected sample Kebeles as they are the only Kebeles that have access to the resource. A total of 123 farm households were selected randomly from each sample Kebeles using the probability proportion sampling method. Accordingly, 64 samples were selected from Ifa Oromia and 59 from Biftu Geda.

Method of Data Analysis

Descriptive and inferential statistics such as means, ratios, standard deviations, variances and percentages were computed to explain the different socio-economic characteristics of the sample households. The mean WTP for open-ended questions were calculated by using descriptive statistics. In addition, inferential statistics to test statistical significance, such as the F-test and chi-square test, were employed to analyze continuous and dummy variables, respectively.

Bivariate logit and ordered logit models were used. The purpose of the bivariate logit was to calculate the mean WTP for the closed-ended format, while the ordered logit model was used to identify socioeconomic factors that affect the dichotomous choice WTP of households.

Bivariate Logit Model

The bivariate probit and logit models give generally similar results. In this study, the bivariate logit model was adopted to calculate the mean WTP for the closed-ended format, as stated by Langford and Bateman (1994). A suitable functional form for modelling WTP from the dichotomous choice format is given by:

$$\pi^{y} = G(B;\theta;\ \pi^{n} = 1-G(B;\ \theta \qquad (3)$$

where π^{y} is the probabilities of saying "yes" and is the probabilities of saying "no" at any particular bid level, B represents the bid the bid levels and θ is a parameter vector which links the probability of saying "yes" to a statistical distribution.

The probability of any household saying "yes" to a particular bid level is a binary with two possible outcomes, zero and one. The functional form restricts the possible values of π, there being several choices for:

$$G(i) = a - b(Bi) \qquad (4)$$

where (4) is commonly taken to be logit function, it becomes

$$G(\pi i) = ln \qquad (5)$$

For the logit model (4), the estimate of the mean WTP is given by

$$E(WTP) = \frac{a}{b} \qquad (6)$$

where a is constant and b is the coefficient of the bid.

Ordered Logit Model

Amani (2009) and Muluken (2011) employed an ordered logit model in studying water allocation and WTP for reused water and factors affecting farmers' WTP for municipal solid waste chat residual compost, respectively. In another study, Zelalem (2010) employed an ordered probit model in studying determinants of WTP for improved rural water supply. Although the two methods are actually interrelated as one is the mirror image of the other and may give the same result, this study used an ordered logit model to analyse the effect of socio-economic characteristics of the farmers on their choice of

WTP for irrigation water use. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. The ordered logit model was used to analyse the factors that are responsible for farmers being willing or unwilling to pay for irrigation water because it is simpler to work with, and the interpretation of parameter estimates is straightforward.

In this study, the outcomes of the bidding procedure are categorised into the following indices for WTP bids:

$$Y = \qquad (7)$$

Consequently, probabilities for the above choice indices can be specified as:

$$P(Y=j)\begin{cases} P(Y=1) = F(\alpha - \beta B_D + \lambda X) \\ P(Y=2) = F(\alpha - \beta B_I + \lambda X) - F(\alpha - \beta B_D + \lambda X) \\ P(Y=3) = F(\alpha - \beta B_P + \lambda X) - F(\alpha - \beta B_I + \lambda X) \\ P(Y=4) = 1 - F(\alpha - \beta B_P + \lambda X) \end{cases} \qquad (8)$$

The probabilities of WTP indices can be expressed as:

$$P(Y=j) = \begin{cases} P(Y=1) = \frac{e^{\alpha-\beta B_D+\lambda X}}{1+e^{\alpha-\beta B_D+\lambda X}} \\ P(Y=2) = \frac{e^{\alpha-\beta B_I+\lambda X}}{1+e^{\alpha-\beta B_I+\lambda X}} - \frac{e^{\alpha-\beta B_D+\lambda X}}{1+e^{\alpha-\beta B_D+\lambda X}} \\ P(Y=3) = \frac{e^{\alpha-\beta B_P+\lambda X}}{1+e^{\alpha-\beta B_P+\lambda X}} - \frac{e^{\alpha-\beta B_I+\lambda X}}{1+e^{\alpha-\beta B_I+\lambda X}} \\ P(Y=4) = 1 - \frac{e^{\alpha-\beta B_P+\lambda X}}{1+e^{\alpha-\beta B_P+\lambda X}} \end{cases} \qquad (9)$$

In a case where there are N respondents, the log-likelihood form for the above sets of responses, following Hanemann et al. (1991) can be written as:

$$\text{LnL}=\sum\left\{I_{Y_{i-1}} lnP(Y=1) + I_{Y_{i-2}} lnP(Y2) + lnP(Y=3) + I_{Y_{i-4}} lnP(Y=4)\right\} \qquad (10)$$

Where $I_{Y_{i=j}}$ is an indicator function for the occurrence of Yi = j (j =1, 2, 3, 4), and the subscript i denotes the ith individual observation.

Maximum likelihood parameters were used to obtain the parameter values that maximize the probability of observing the WTP. In reality, the significant explanatory variables do not have the same level of impact on the dependent variable. Maximizing and then taking the first derivative of the log- likelihood function produces the parameters for each explanatory variable. This produces the marginal effects or marginal probabilities, which measure the change in the probabilities resulting from a unit change in one of the regressors while holding other regressors constant.

Predicted marginal probabilities were used to assess the influence of the independent variables on the dependent variable. Mathematically this can be expressed as:

$$\frac{\partial(E(WT))}{\partial x_i} \qquad (11)$$

Result and Discussion

The Evaluation Scenario

Assumption: There is a project to develop and maintain an irrigation scheme on Lake Adellei, which is found in the Haramaya district around Adellei. The project resolves the dependency on rain-fed agriculture. To optimize long- and short-run benefits from irrigation water, irrigation beneficiary households often contribute money to sustain the project's dam and channels.

During the pretest of the questionnaire, three respondents of different income groups from each Kebeles were provided with open-ended questions on how much they would be willing to pay for the irrigation water they use. The mean bid was calculated for individually two Kebeles and the aggregate of the two Kebeles. The aggregate mean bid amount was taken as an initial bid for the double-bounded dichotomous question after it was checked for initial bid bias. The individual mean bid of the two Kebeles was used in checking the initial bid bias associated with the aggregate mean, which was taken as the initial bid. The result showed that there were no spastically significant differences in the final WTP bid amount for three different means of the two Kebeles and their aggregate taken as initial bids. Therefore, the aggregate mean of the two sampled Kebeles was taken as the initial bid.

The households' willingness to pay for irrigation water: This represents a household's WTP decision for irrigation water. Thus, the households' WTP for irrigation water use is the dependent variable. It has four bid categories, the first bid depending on the bid levels. (No-No), second bid (No-Yes), third bid (Yes-No) and fourth bid (Yes-Yes) for those who were willing to pay Birr 0-2,792[1], Birr 2,800-5,592, Birr 5,600-11,192 and above Birr 11,200 per hectare per year, respectively.

In this study, different prices, higher or lower than the initial bid, were offered to the respondents depending on their response to the initial bid. Answers to the sequential questions in the double-bounded dichotomous choice were sorted into four intervals: (0, BD) when the first and second answers were both “No”, (BD, BI) when a discount offer was accepted at the second bid, (BI, BP) when a premium was rejected, and (BP, +∞) when both answers were “Yes”. BI, BD, and BP denote the initial bid, bid with discount, and bid with premium, respectively. Since households’ WTP is a latent variable and not subject to direct observation, the sequential questions served to place upper and lower bounds on the true WTP. As a result, the WTP bids were categorized into four: 1 (No-No) for those who said No for both the initial bid and for the discount, 2 (No-Yes) for those who were not willing to pay for the initial bid but were willing to pay for the discount, 3 (Yes-No) for those who were willing to pay for the initial bid but not willing to pay for the premium bid and 4 (Yes-Yes) in this category included those who were willing to pay for the premium and above it.

Farmers in the study area used *kindi* (1/8 ha) to measure their farm size. Hence, willingness to pay a bid was provided for them per *kindi* of irrigable land per year. During the pretest of the questionnaire, three farmers from each Kebeles with different income group was provided an open-ended on how much they would be willing to pay for irrigation water use per *kindi* of irrigable land. Accordingly, the mean willingness to pay of them was Birr 700 per *kindi* of irrigable land per year. In addition, the discounted and the premium WTP bid were Birr 350 and 1,400 per *kindi* of irrigable land per year.

[1] Exchange rate at the time data collection 1USD= 0.05405 ETB (Ethiopian Birr)

As a result, the WTP bid was ordered into four: 1 (No-No) for those who said No to both the initial bid and the discount (i.e. Birr 0-349 per *kindi* per year), 2 (No-Yes) for those who were not willing to the initial bid, but willing to the discount (i.e. Birr 350-699 per *kindi* per year), 3 (Yes-No) for those who were willing to pay the initial bid but not willing to pay the premium (i.e. Birr 700-1,399 per *kindi* per year) and 4 (Yes- Yes) for those who were willing to pay the premium and above it (i.e. ≥ Birr 1,400 per *kindi* per year) were included.

However, for convenience, the result was presented per hectare of irrigable land per year. Consequently, the initial bid of WTP was Birr 5,600 per hectare of irrigable land per year, while the discount and the premium were Birr 2,800 and 11,200 per hectare per year, respectively. Accordingly, the WTP bid was ordered into four: 1 (No-No) for those who say No to both the initial bid and the discount (i.e. Birr 0-2,792 per hectare per year), 2 (No-Yes) for those who were not willing to the initial bid, but willing to the discount (i.e. Birr 2,800-5,592 per hectare per year), 3 (Yes-No) for those who were willing to pay the initial bid but not willing to pay the premium (i.e. Birr 5,600-11,192 per hectare per year) and 4 (Yes-Yes) for those who were willing to pay the premium and above it (i.e. ≥ Birr 11,200 per hectare per year) were included.

WTP: Bivariate Logit Model Result

The mean annual bid that households were willing to pay was estimated at Birr 7,402.32 per hectare of irrigable land per year. This was higher than the result reported by Dagne (2008) that farmers in Jibrat District were willing to pay Birr 453.82 per hectare per year. On the other side, Habtamu (2009), in the Nile Basin, reported Birr 192 per hectare of irrigable land per year. This shows that users in this study area value irrigation water at a higher level. In addition to macroeconomic phenomena such as currency devaluation, this might be because of the type of crops farmers are producing. The study area is well-known for its export crop chat.

Determinants of WTP: Ordered Logit Model Result

The result of the model revealed that six variables were significantly affecting farmers’ WTP for irrigation water use bid categories at different probability levels. Irrigation experience of the household head (irrig_exp) and income of the household (income) positively and significantly affected WTP at a probability level of less than 1%, and the sex of the household head (sex) and access to extension services (ext_acc) positively and significantly affected at 5% probability level whereas age of household head (age) and family size of the household (f_size) negatively and significantly affected at probability less than 1%.

Table 1: Estimates of Ordered Logit Model and Marginal Effect of Explanatory Variable on WTP Orders Probabilities

			Marginal Effects			
Variables	Coefficient	p value	1	2	3	4
Age	-0.0886***	0.0030	0.01	0.01	-0.01	-0.01
Sex	1.9497**	0.0100	-0.25	-0.24	0.22	0.26
Educ	0.1820	0.3250	-0.02	-0.02	0.02	0.02
f_size	-0.4074***	0.0000	0.05	0.05	-0.05	-0.05
dom_crop	0.1968	0.6460	-0.03	-0.02	0.02	0.03
irrig_exp	0.2083***	0.0000	-0.03	-0.02	0.02	0.03
TLU	0.1541	0.2880	-0.02	-0.02	0.02	0.02
Income	0.0001***	0.0000	0.00	0.00	0.00	0.00
cred_acc	0.6261	0.1750	-0.08	-0.07	0.07	0.08
ext_acc	1.0034**	0.0210	-0.13	-0.12	0.11	0.14
mkt_dist	-03797	0.3400	0.05	0.05	-0.04	-0.05
lab_avail	0.2977	0.4870	-0.04	-0.04	0.03	0.04
Trend	0.5797	0.1830	-0.07	-0.07	0.06	0.08

*** and ** show significance at 1% and 5% probability level, respectively

Log likelihood = -108.21093 Number of observation = 123,

LR chi2 (13) = 117.47, Prob> chi2 = 0.0000,

Pseudo R2 = 0.3518

Source: Own survey result (2012).

The marginal values provide the probability that a unit change in the individual continuous independent variables and being the household head male and having access to extension service individually has on different WTP bid categories when all other variables are held at their means. The result in Table 1 was interpreted as below:

Age of the Household Head (Age): This variable was significant at a 1% probability level and negatively related with the WTP bid levels. A unit-year increase in the household head's age increases the probability of paying the lower bid categories. i.e. (No-No) and (No-Yes), by 1%. In contrast, it decreases his/her willingness to pay the higher bids .i.e. (Yes-No) and (Yes-Yes), by the same 1%. The possible reason is that older household heads are more likely to reject new ideas and approaches. They may not be willing to pay or to pay more since they are traditionally used for free services and may have a low preference for a new source that will require fees. The result agrees with the hypothesis and the findings of Simret (2009) and Zelalem (2010).

Sex of the Household Head (Sex): This variable was significant at a 5% probability level and positively related with the WTP bid levels. Being male decreases the WTP probability to the first and second bid categories by 25% and 24%, respectively. Yet it increases the probability of paying the higher bids, i.e. the probability to pay for the third and the fourth categories increases by 22% and 26%, respectively. A possible reason is that, as Seleshi (2010) stated, irrigation can have potentially negative consequences for women, such as increasing the burden of labour on women, as irrigation is a labor-intensive form of agriculture, and allowing men to capture an unfair share of farm profits. The result was consistent with expectation and the findings of Habtamu (2009) and Eden (2010).

Household Family Size (f_size): This variable was significant at a 1% probability level and negatively related with the WTP bid levels. A unit increases in household member increases the WTP probability to the first and second bid levels by 5%. However, the WTP probability to the third and fourth bid levels decreases by the same per cent. This can be justified by the fact that an increase in family size decreases the per capita income of the member and, hence, it will decrease the payment for irrigation water. The result was consistent with the hypothesis and the findings of Dagne (2008) and Simret (2009).

Irrigation Experience of Household Head (irrig_exp): This variable was significant at a 1% probability level and positively related with WTP bid levels. A unit-year increase in the household head irrigation experience decreases the probability of a WTP decision to the first and the second bid levels by 3% and 2%, respectively, while it increases the probability of paying the third and fourth bid levels by 2% and 3%, respectively. The possible reason is that farmers who have longer experience in irrigated farming know the benefits of irrigation. The result was consistent with the hypothesis, and the studies of Chandrasekaran et al. (2009) and Habtamu (2009) supported it.

Household Income (Income): This variable was significant at a 1% probability level and positively related with WTP bid levels. An increase in the total annual income of the household increases his/her financial position and affects the willingness of the farmer to pay for irrigation positively. However, it is difficult to see the effect of one Birr on the probability level. The result was supported by the studies of Chandrasekaran et al. (2009), Habtamu (2009), and Eden (2010).

Access to Extension Service (ext_acc): This variable was significant at a 5% probability level and positively related with WTP bid levels. Access to extension service decreases the probability of WTP of farmers to the first and second bid levels by 13% and 12%, respectively. However, it increases the probability of paying the third and fourth bid levels by 11% and 14%, respectively. This might be because extension services enhance farmers' awareness in improved and modern agricultural technologies. The findings of Dagne (2008) and Eden (2010) supported the result.

Conclusion and Recommendations

This study explored the household valuation of irrigation water as an initial step towards the development of a payment for the resource they use that might estimate the economic contribution of the resource and reduce the negative impact of free use of the resource on its sustainability and analyzed factors determining their WTP decision. Based on the findings of the study, the following recommendations were listed for further consideration, particularly in the study area and in general in similar situations in the country.

The result of the bivariate logit model estimated the mean WTP amount to be about Birr 7,402.32 per hectare of irrigable land per year, showing that users in the study area value irrigation water at a higher level. Since the government alone cannot address every development demands, NGOs, local communities, and other concerned bodies need to participate in the provision, operation and maintenance of irrigation schemes. Hence, on the side of the local community, development planners should consider the value the households give to the resource.

On the other hand, the result of the ordered logit model indicated that the sex of the household head and WTP bid levels were positively related. That is, being a headed household increases the probability of WTP. The reason might be the labour-demanding nature of irrigation activity. Thus, the policy implication of this result is the introduction of labour-saving technologies, such as less labour-demanding crop types, could improve female-headed households' WTP bid levels.

The age of a household head negatively and significantly influenced the WTP of the households for irrigation water. The reason for this might be older household heads are more likely to reject new ideas and approaches. In addition, since they had been traditionally used for free, they may have a low preference for a new source that will require fees. Thus, awareness creation about the financial limitation of the government for investment, operation and maintenance to use the resource sustainably would increase farmers' WTP bid levels.

Family size and WTP were negatively related. Controlling the increase in the family size should be of priority to enhance farmers' WTP bid levels. Policy related to family planning, such as strengthening the existing education by health extension agents and awareness creation through mass media, etc., helps to control the family size and, in effect, enhances WTP bid levels through an increase in the per capita income.

Farmers' experience in irrigated farming showed a positive influence on farmers' WTP bid levels. Therefore, the policy implication of the result might be that building farmers' awareness about the benefits of irrigation and its profitable use by strengthening the existing farmers' training centres, arranging field visits, and etc., improves their experience and bid levels in effect.

The total income of farmers determines their WTP decisions. Activities that could improve farmers' return, such as improving the provision of improved and cost-minimising technologies, diversifying sources of income, etc., increase their WTP bid levels through its effect on income.

Access to extension service is important to increase the WTP bid levels of the farmers. A well-organised extension service focused on what, how and when to produce by irrigation and, etc., uplifts farmers' knowledge and skill and hence increases their WTP bid levels. Therefore, the quality and coverage of the service should be improved and updated.

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