Information Management and Business Review (ISSN 2220-3796)
Vol. 14, No. 1, pp. 16-24, March 2022

Determinants of Farm Households' Willingness to Accept (WTA) Compensation for Conservation Technologies: Ethiopia, Amhara Region, Northern Showa

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Abstract: The purpose of this study was to investigate and evaluate the WTP limits of irrigation water in the Sheva region of the Northern Amhara region of Ethiopia to understand whether irrigation water is feasible. Data were collected from primary research sources. An upright bivariate model was used to determine households' willingness to address irrigation water problems in the study area. Using data from a sample of 800 farmers, the results show that WTP is positive for irrigation water in the North Sheva region. The results show that the average household can obtain irrigation water for about 3,001.47 0.25 hectares of land in Ethiopia, which is a one-time irrigation land value of US$100.05 at the current exchange rate. In addition, the study found that household size, agricultural experience, household costs, irrigated land, livestock capital education level, and measured tropical livestock live-stock units had a positive effect on willingness to pay for irrigation water. Capital is adversely affected by family age, but market access for farmers is not guaranteed. Based on the pursuit, convincing reliability constraints, increasing market access through information and irrigation schemes, and increasing farmers' awareness of irrigation water and its use, is the efficient use of irrigation and irrigation water. Valid maintenance conditions are recommended. Stick to discipline.

Keywords: *Bivariate probabilistic model, decision-making, irrigation, sustainability, willingness to pay.*

1. Introduction

Agriculture is the main source of employment and income in the most progressive countries (Driba, 2020). Ethiopia is one of the developing countries and relies heavily on agriculture as the main source of employment and income (Woldemariam, 2017). A rich agricultural sector also lays the foundation for future growth. Ethiopia has huge potential for surface water and water bases that can contribute to development. Clearly, the development of water centers is a footprint on the country's economic development (Berhanu et al., 2014). The agricultural sector offers an opportunity to move from subsistence levels to a modern and commercial sector (Woldemariam, 2017). It has the capacity to change and make a significant contribution to the country's economy, but its reliance on rainfed agriculture makes the sector's structure vulnerable. Hence, water is a major factor in the rapid development of the agricultural sector. Water treatment, access and water quality reasons are critical for development and poverty reduction. Irrigation benefits the poor by increasing yields, increasing yields, reducing the risk of crop failure, and increasing year-round on-farm and off-farm employment.

Irrigation enables smallholders to adapt to different forms of shearing & transform subsistence farming from low-value market production to high-value market production (Hussain & Hanjra, 2004). Irrigation improves livelihoods by increasing incomes, food security, employment opportunities, social needs and poverty reduction (Woldemariam, 2017). Irrigation is necessary to maximize the yield of the most fertile crops, even in areas with heavy rain, irrigation of second and third crops, or in the absence of rain in fields with multiple crops under consideration. Establishing strategies for water allocation and management is critical for assessing the economic value of agricultural water use (Medellín -Azuara et al., 2010). The Ethiopian government acknowledges that investments in irrigation, especially for smallholders and households, have the potential to transform the irrigated lives of smallholders. In addition to surface water use, groundwater use for irrigation is critical to ensuring agricultural growth for present and future generations (Hagos et al., 2012). There is very fertile land available for irrigation in the northern & northern parts of the Shewa District, but there are 3.6 million hectares of potential irrigated land.

However, only about 290,000 hectares of irrigated land may have been used so far, & its use remains low (Puertas et al., 2015). Therefore, there is a willingness to investigate whether farmers are willing to pay irrigation water fees to develop such an irrigation system. In Ethiopia, there is no knowledge or research on the pricing necessary for sustainable water infrastructure (Hagos et al., 2012). The annual water requirement is 673 M3 (Fitsume et al., 2017) and the onion is 3900 M3, and 60% of the paddy field must be used for 0.25 hectares of land. In addition to the water requirement, each meter the initial cost of one cubic meter of water is taken from each person's water needs. Based on these facts, we quoted 6 bids per Walleda to store randomness information and ordered 750-3375 Ethiopian birr as shown in Table 2. This methodological study bridges the gap in research availability on irrigation water.

2. Data Analysis Method

Data collected by STATA version 13. The composite dependent variable in this study applies to households using the small-scale irrigation dichotomy and is an estimate of a household's decision to use small-scale irrigation and nothing else. A bi-junction dichotomous model was used to coordinate farmers' irrigation readiness, and a bivariate model was used as a factor influencing household participation in small-scale irrigation use decisions.

Economy: We used two econometric models, a bivariate probability and a bivariate dichotomous model, to derive the responses to the formatted questionnaire. A closed bidichotomy model was used to drive the irrigation demand function and calculate the average readiness for each Walleda solution. A test bivariate model was used to determine household availability of irrigation water supply in the northern Shewa region. The profit evaluation process begins with the measurements required for a purpose. It is a change in net income equal to or compensated by a change in the quantity or quality of public assets. Start with that person's privilege. Let it be a vector of private property, a vector of public goods that can have the characteristics of private property. Everyone maximizes his or her income.

$$U(X_i, W_i) \quad (1)$$

Indirect utilities are $V\ (P, W, Y\ )$ provided in the following ways:

$$V\ (P,\ W,\ Y) = maximum\ X\ [\ U\ (X,\ W] = PX \leq Y] \quad (2)$$

The utility has also changed from $_{u0j}$ to $_{u1j\ to}$ show the unreasonable case of the final result of the process. The quality index q changes $u_{0j} = u(Y_j, Z_j, q^0, e_{0j})\ to\ u_{1j} = u(Y_j - WTPj, Z_j, q^1, e_{1j})$.from q0 $^{to\ q1.}$ In this case, we are willing to pay the difference between the original national income y and the environmental benefit or better water q0, and the amount of tax that everyone must pay to raise and raise the national income y-WTP water quality.

Fork-Closed Finite Double-Chain Selection Model: In the bipartite discrete dichotomy format, ask the following questions based on the first answer. The family believes the answer to the first question asked at the original price is yes. Next is more ph $^{>}$ p. If no family member answers the first question, the next question is low price p ^{L} < p (Freeman III et al., 2014). According to (Verbeek, 2004), the intent to release was undetected, revealed by the underlying WTP variable and changed to 10i according to individual characteristics.

$$WTP = X_i\beta + \varepsilon_i \quad (3)$$

Latent variables are ready to be measured in birr (Abyssinian currency) and ready to be addressed.

$$WTP = \alpha + \sigma P + \beta Z + \varepsilon \quad (4)$$

Where P is the price value, Z vector is the covariate, β is the parameter vector, $\boldsymbol{\varepsilon}$ mistakes are the limit (Addai and Danso-Abbeam, 2014; Hanemann et al., 1991; Mohd, 2013).

Bivariate Selection Model: Bivariate starting models are useful because the most common form involves the estimation of two independent models. Prisoners are free to pay their first bid p, lower bids PL, higher bids Pu. The economic model of the data generated by the correlation problem is based on two types of equations (Haab & McConnell, 2002) :

$$WTP_{1j} = \mu_1 + \varepsilon_{1j} \quad \textbf{(5)}$$

$$WTP_{2j} = \mu_1 + \varepsilon_{2j} \quad (6)$$

J was prompted for the first response by WTP $_{1j,}$ while respondents in $_J$ were prompted by $_{WTP\ 2j}$ for the second response, and µ1 and µ2 are the averages of the first and second responses. This form of discrete choice is called a bivariate model. Set the error limit for the normal distribution with mean 0 and variance σ2, then set the bivariate normal distribution for $_{WTP1j}$ and $_{WTP2j}$ with mean $_{\mu 1}$ and µ2, σ_2^2 variance σ12 is the covariate between the σ_1^2 error function WTP and the correlation coefficient $\rho = \frac{\sigma_{12}}{\sqrt{\sigma_1^2+\sigma_2^2}}$ρ.am. The value of the correlation coefficient rho between the first and second responses must be statistically significant or non-zero. According to individuals who are endogenous decision-making systems, the link between these two responses suggests that evaluating the model yielded small results. If ρ = 0, this means the best model is estimated using the Probit model.

Variable Size: Building an economic model involves specifying various interdependencies and independent specifications of the variables that share the relationships between them. Table 1 shows the expected codes of the variables, the properties of the variables, and the codes assigned to the fixed variables.

Table 1: Summary of Variable Specifications

Changing	Code	Types of	Anticipatory Signs
gender	SX	fake	+/-
Patriarch's age	joint stock company	continue	————
family size	HFS'	continue	————
stay away from the market	DFM	continue	————
Respondents' agricultural experience	AGEXP	continue	+
Total Hospitality	pay	continue	+
Potential Irrigation Site	Ilulan	continue	+
total arable land	TCLS	continue	+
livestock	TLU	continue	+
family education level	Education $_{02}$	fake	+
	Education $_{03}$	fake	+
Head of household marital status	Ms Taos	fake	+/-
access to credit services	air traffic control system	fake	+/-

3. Results and Discussion

Data Description: Data from the CVM survey was studied and analyzed in two ways, including descriptive analysis and economic analysis. Demographic and socioeconomic factors related to the availability of water supply and optimal irrigation water services were analyzed, as shown in Table 2.

Table 2: Order Recommendations and Responses

Valeda's First Name	Angola Natra	Mensgra	Mingershen Kola	Moretina Gill
say 1	1125	2700	3375	2250
Order 2	1063	2550	3188	2125
Order 3	1000	2400	3000	2000
Order 4	938	2250	2813	1875
Order 5	875	2100	2625	1750
Order 6	750	1800	2250	1500

Table 3 shows the socio-demographic characteristics of the respondents.

Table 3: Socio-Demographic Characteristics of Respondents

Categorical Variable	Category	Shares (Percentages in Parentheses)
6 families	people	717 (90.08)
	Miss	79 (9.92)
family education level	I cannot read or write	309 (38.82)
	1-8 inches	385 (48.37)
	9-12 inches	90 (11.31)
	> 12	12 (1.51)
gain academic credit	Yes	425 (53.39)
	number	371 (46.61)
non-farm employment	Yes	493 (61.93)
	number	303 (38.07)
Keep	Yes	493 (61.93)
	number	303 (38.07)
extended access	Yes	743 (93.34)
	number	53 (6.66)
cooperative farm	Yes	670 (84.17)
	number	126 (15.83)
Continuous Variable	**Average**	**Standard Deviation**
family age	43.19	10.92
family size	4.97	2.08
TLU	6.26	4.32
Land area	1.69	2.87
stay away from the market	9.55	8.36
all-weather road	7.19	8.33
irrigated land	0.16	0.42
agricultural use	24.4	12.1

About 90.08% of the sample households are headed by men and 9.92% are headed by women. According to the form of education, 38.82% of the families were illiterate, 48.37% completed grades 1-8, 11.31% completed grades 9-12, and 1.51 was in grade 12. About 53.39% of families receive credits. 46.61% unavailable. About 61.93% of households participated in instant operations and saved money. 38.07% are not shared and saved. Also, they own about 93.34% of extended family farms instead of 6.66%. 84.17% of the households are cooperatives and 15.83% are non-cooperatives. The average age of household capital is 43.19 years. The average household size is 4.97. The average land area, irrigated land and livestock based on TLU were 1.69 ha, 0.16 ha and 6.26 TLU, respectively. The average distances from markets and roads to most weather are 9.55 km and 7.19 km respectively. The average age of the head of the household is 24.4 years.

Choose a Model from a Bisecting Double Bound

Intermediate Households Want to Use Irrigation Water: The survey was conducted by farmers in the study area to determine the average amount of irrigation water available. Using the mean dichotomy to solve the double agglomeration model, it was found that farmers were willing to pay 0.25 per hectare of land for a single irrigation period of about 3001.47 birrs. Table 4 shows farmers' willingness to pay different fees for Walledum irrigation, as shown below.

Table 4: Average Voluntary Wages in Study Areas

Valeda's First Name	Means you want	Z *	P-Value
Angola	2028.226	16.66	0.000
Mensgra	2670.715	40.20	0.000
Moretina Gill	1999.935	39.73	0.000
Mingershen Kola	3839.886	25.03	0.000
Regional media	3001.474	36.80	0.000

Former Bivariate Probability Model: Which family members were identified using the estimated bivariate test model Household projections means they want higher irrigation wages. Fit fixed model, Wald chi2 (40) = 215.04, the overall model is High and shows the probability of prob > chi 2 = 0:00. This shows the variables contained in it. Statistically significant models of family-determined binding in WTP descriptions. This relationship between the two answers is "process and evaluation of a single probabilistic model will give satisfactory results.

Probability of Family Response: As a result of the marginal effects analysis, the probability of the farmer's response was determined as yes-yes, yes-no, no-yes or no-no, and the results are shown in Table 4 below.

Home Irrigation Water Decision Available: Household variables for primary and secondary education levels, household age, agricultural experience, and tropical livestock units were statistically significant (p = 0.01) levels based on bivariate models. Respondents' distance to market and availability of irrigated land was statistically significant (p = 0.05). However, household size and total household expenditure level were also significant (p = 0.1).

Table 5: Response Probabilities

Reply	May or Slightly Affect
PR (respons1 = 1, answer2 = 1)	0.644
PR (Answer 1 = 1, Answer 2 = 0)	0.093
PR (Answer 1 = 0, Answer 2 = 1)	0.112
PR (Answer 1 = 0, Answer 2 = 0)	0.171

Table 6: Marginal Effects after Bivariate Probabilities

Changing	*dy* *dy* *	Standard Error	z *	P-Value
SX	0.072056	0.103	1.16	0.056
DFM	-0.0049623**	0.00219	-2.42	0.016
HFS'	0.01693*	0.00785	1.71	0.093
joint stock company	-0.0088459***	0.00469	-3.31	0.001
AGEXP	0.0102556***	0.0024	4.27	0.000
pay	0.0000209 *	0.00001	1.88	0.093
Ilulan	0.06947**	0.04185	2.56	0.011
TCLS	0.007819	0.00319	0.84	0.398
TLU	0.01296***	0.00479	2.68	0.007
$Education_{02}$	0.2297775***	0.0433	5.31	0.000
$Education_{03}$	0.1226741***	0.04185	5.22	0.000
master*	0.093994	0.04195	1.53	0.126
*s*_ _	-0.1182569**	0.04185	-2.38	0.017

1 *** p < 0.01, ** p < 0.05, * p < 0.1
2 () dy / dx is a wonderful discrete variable from 0 to 1.

Household distance from the market has a negative sign and a significant (p = 0.05) significance level. For example, if farmers are far from the center of the market, their crops won't get attractive prices and they won't try to produce them more Furthermore, farmers closer to the market are more willing to pay for adequate irrigation water because they are cheaper and have higher wages than farmers farther from the market. Therefore, as the distance from the center of the domestic market increases by one kilometer, the water supply decreases by 0.5, and farmers are willing to pay for the development of a new irrigation system. percentage while keeping other variables constant. The age of the household variable was negative and significant, indicating that respondents' WTP had an adverse effect on irrigation water supply, and as respondents aged, they were less likely to pay higher prices for new irrigation service developments. Under other constants, as respondents aged one year, their chance of receiving the initial price tag decreased by an average of 0.88%. Very older farmers have less access to irrigation water. The reason is that older adults have less expertise in using irrigation techniques, have improved physical labor, and may be limited to irrigation practices (Abera et al., 2017). Respondents' willingness to address the development of new irrigation systems positively reflected their formal education. As a result, we receive a positive and meaningful education in both the second and second grades.

As the field of home education for low-literacy households expands and educates families in need and understands the uses and importance of irrigation water, respondents address the issue of developing new irrigation systems, suggesting that the possibilities are increasing. Improving education levels had a positive and meaningful impact on respondents' willingness to pay. With the improvement of the level of primary and secondary education, the probability of the illiterate group receiving both primary and higher education increased by an average of 23% and 22.3%, respectively, when other factors were held constant. There were no significant differences in willingness to pay between primary and secondary education levels. The results were similar to those of studies (Alemayehu, 2014). Since the development of the new irrigation system, the household WTP has had a positive and significant impact on water rates. Economic theory also states that the demand for an individual's household wealth depends on an individual's household income. People spend a lot of money on a lot of income, so we use household income as a proxy for income. Income and quantity demand is positively correlated with asset decline (Alebel Bayrau, 2002). (Arbués et al., 2003; Whittington, 2010; Whittington & Nauges, 2010). This is an increase in household spending and is more likely to pay for the development of new irrigation water systems. As household spending increased by 100 N, respondents were 0.21% more likely to accept the initial and highest bids, even at the 10% significance level.

Household size had a positive and significant effect (p = 0.1) on the level of importance of readiness to address water development in a new irrigation system. Holding other variables constant, such as the size of individual households, it was more likely to get both initials and previous variables, with an average increase of 1.42%. Larger households are labor-rich and are the source of employment and agricultural practices in most young rural areas (Alemayehu, 2014). Since irrigation is a labor-intensive activity, farmers' interest will increase with the implementation of irrigation and WTP. The size of the irrigated soil had a positive impact on the family planning for the development of new irrigation systems. A significant effect on the significance level (p = 0.05) means that all other factors are consistent. Increasing the percentage of irrigated households by one unit size increases the likelihood of payment availability by a factor of 0.001. This may be because a wide irrigated area helps increase agricultural yields through intensive production and reduces the risk of growing more than one crop in a year (Mezgebo et al., 2013). The farmer's experience had a positive effect on the importance level of household commitment (p = 0.01). Respondents increased their farming experience by one year and their odds of being admitted to more than one primary and tertiary education increased by 1.03%. According to (Chandrasekaran et al., 2009), the survey results of irrigation water observed in this area showed the highest levels of WTP. Results will be determined in other studies. Various types of livestock as measured in TLU (Tropical Herd) had a significant positive effect (p = 0.01) on household income involved in the development of a new water irrigation system.

Other constants showed that respondents' willingness to accept earlier and higher levels increased by 1.28%, increasing their tropical cattle units by one unit. There is a positive relationship between livestock wage availability and livestock ownership due to increased livestock wealth. For example, someone who owns a large cow may have enough money to participate in irrigation activities. Cattle are an important source of cash in rural areas, allowing farmers to purchase agricultural products (Luo et al., 2018). Households' willingness to pay for irrigation water prompts them to obtain credit. There was also a significant negative correlation between access to credit and the level of significance for willingness to pay at home (p = 0.05). In contrast, today's study (Birhane and Getachew, 2016) reports on increased access to credit and farmers' willingness to pay. Because it can help farmers address their economic needs and allow them to invest in production techniques to increase agricultural yields. Nonetheless, the findings of this study are inconsistent with those of other studies, with small effects of variables holding other factors constant, so that farmers who get credit irrigate more than those who don't. This shows that you are 11.83% less likely to pay for usage. It is believed that this can be explained by the fact that households are accustomed to borrowing from unproductive businesses. It will not reduce poverty; it will exacerbate it. The data collected from the center is built for households who are unable to repay their loans by paying on term loans and taking high-interest-rate loans over a period of time.

4. Conclusion and Recommendations

Finally, he believes that water is an essential economic reserve for irrigation development and plays a vital role in the agricultural transformation and economic development. Therefore, this study preliminarily analyzes the use of irrigation water and the feasibility of the canal in the Sheva region in the northern Amhara region of Ethiopia. Our estimates suggest that the feasibility of using irrigation water in the study area is as significant as household size, agricultural experience, household labor, irrigated land, and household income as measured by TLU. Negative and negative numbers are determined by age. Heads of households, market farmers and their loyalty. The results showed that the average WTP for one crop season was 3001.47 birr per 0.25 hectares. These results appear reasonable compared to other studies conducted in different parts of Ethiopia. The average WTP assessed in this regard (Wassihun et al., 2022) was 972.66 bulls per 0.25 ha. Oman et al. (2020) The average WTP is estimated at 726.55 bulls at 0.25 ha per year. Birhane and Getachew (2016) estimated an average WTP of 1004,505 bulls per year for 0.25 hectares and 128.88 bulls per hectare (6.78 hectares/year) for Alemayehu in 2014. Therefore, the estimated mean WTP was adjusted for this study. Therefore, this result supports farmers' willingness to pay for the use of irrigation water in the study area, which is a significant increase in agricultural profits. Based on the survey results, (companies, governments, NGOs and individuals) made the following recommendations: The survey requires farmers to prepare irrigation water to improve market access. show that there is Move them closer to the farmer market. This business will reduce costs and allow farmers to earn better income.

Raise awareness among illiterate farmers through information on the positive relationship between payment preparation and education, the need for stakeholders to invest in education and education in the form of training, advice and collaboration, irrigation, and the use and benefits of education. Service consultants provide irrigation systems for farmers' livelihoods. Based on the positive link between implementation readiness and agricultural experience, both parties need to share experiences through mutually beneficial cooperation in solid discussions. Earning points can negatively impact your willingness to pay. That is, households borrow from habitual consumption and unproductive enterprises, rather than spending on irrigation investments. The data collected from the center is built for people who make regular loan repayments, those who receive loan interest from the high-interest population over a period of time and are unable to repay it. This intervention should be taken into account when lending, which should be used for productive agricultural investment. Furthermore, incentivizing farmers who are able to scale up irrigation technologies, especially through government-based agricultural delivery technologies, is critical to mobilizing funds from other stakeholders to close economic disparities. In addition, groundwater supplies must be guaranteed to be designated as irrigation water, as long as farmers are willing to pay. Finally, the performance of this study is related to the knowledge of the ambassador's research through presentations to the country house, discussions and publications.

Data Availability Statement: Data supporting the findings of this study are available to respondents upon request.

Acknowledgments: Thanks to Prof. Tim, listed as the first author, this paper can have been inspired to be finished. We always thank him for supporting students doing research with financial, spiritual, tangible, or intangible devotion to building integrity and faith within the research. In his endeavor in helping people, he was reported dead on the front-line relieving suffering people in Ukraine, to which we attribute him the contribution not only to research but also the inspiration left for people.

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