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Smallholder Farmer's Willingness to Pay for Improved Irrigation Water: A Contingent Valuation Study in Koga Irrigation Project, Ethiopia

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Abstract
This paper estimates the mean willingness to pay (WTP) of smallholder farmers for improved irrigation water using a contingent valuation method with a double bounded dichotomous choice question format in the case of the Koga irrigation project, Ethiopia. The mean and the total WTP of households and the major determinants of the WTP were estimated by applying seemingly unrelated bivariate Probit regression model. Data sources originated from primary and secondary sources. Primary data were collected from 140 randomly selected smallholder farm households through a structured questionnaire and focus group discussions using face-to-face interviews. Moreover, secondary data were collected from published and unpublished documents. The study findings have shown that the majority of the sample households has been affected by irrigation water scarcity problems, mainly because of soil erosion and deforestation. Furthermore, results underline that there is a positive WTP for improving irrigation water facilities. The response obtained from hypothetical market scenario indicates that households convey their WTP with a mean value of 128.88 Birr/hectare/year (US$6.78hectare/year) and the total WTP in the Koga irrigation command area is estimated to be 1,753,799.04 Birr/year (US$ 92,951.34). Moreover, the study identifies education level, household size, gender; first bid, total family income and cultivated land size are the main factors having a substantial effect on households' WTP of improved irrigation water. The study underlines that more attention should be given by government and other stakeholders for the implementation of irrigation water management practices in order to supply reliable irrigation water to the farmers. Furthermore, policy makers should develop and provide proper irrigation water pricing system, strengthen the existing soil and water conservation efforts and ensuring better soil and water conservation practices to manage the erosion problems in the catchment. Lastly, government and policy makers should consider the significant variables which have an impact in determining households' WTP.
Keywords: Willingness to pay; Contingent valuation method; Dichotomous choice; Koga irrigation; Ethiopia

1. Introduction

Ethiopia is an agricultural country where 85% of the population are living in rural parts of the country, and directly involved in the production of agricultural crops and livestock husbandry. There is no reservation for the importance of this sector in poverty reduction and sustainable development in the country. The agricultural sector accounts for 45% of the GDP, provides employment for 85% of the population and accounts for 90% of the export revenue (MoFED, 2010). The agriculture sector in Ethiopia is dominated by smallholder farmers and characterized by rain-fed agricultural practices (Chamberlin and Schmidt 2011). However, heavy reliance in rain-fed agriculture affects Ethiopian agriculture and the economy of the country (Hagos, Makombe et al. 2009). According to Chamberlin and Schmidt (2011) and Hagos, Makombe et al. (2009) during variable and insufficient distribution of rainfall over crop growing time, smallholder farmers' crop production may fail to be a viable livelihood option. In addition, recurrent droughts have resulted in poor crop yields and leading to serious hunger, malnutrition and food shortages (Haile 2005). The most vulnerable groups are low-income and poor rural people, children, women, female-headed households and the elderly (Deressa, Hassan et al. 2008). Likewise, increased weather variability and climatic change have an adverse effect on the economy, and food deficit is prevalent in the country. Hence, government is prudent and embarked on rehabilitation and development of small to large-scale irrigation agriculture to realize the nation, food demands and to satisfy the raw material demands of the growing local agro industries. One example is the Koga dam irrigation project (KIP) which has the goal of contributing the sustainable livelihoods of farmers through increasing agricultural productivity, reducing poverty and improving the employment opportunities of the rural community with active involvement of the local communities (Gebre, Getachew et al. 2007).

According to Gebre, Getachew et al. (2007)at the start of KIP the project aimed for applying the full cost recovery principle with the participation of farmers that should have benefited from the scheme. There was a belief that farmers will be in a position through time to cover the operation and maintenance and the entire investment cost. However, so far KIP has an operation and maintenance problem that has no self-financing system so far. It has operated using donor funding and government financing contrary to the government of Ethiopia cost recovery policy. Moreover, the past experience shows the limited capacity of the government for maintenance support. This will jeopardize the sustainable delivery of water services, inefficient water use practices and lack of incentives to irrigation water. If the problems persist, it is difficult or incapable of sustaining water needs of the farmers. Consequently, it leads to discouraging the beneficiary farmers and may result in low agricultural productivity.

Knowing of all concern and facts, the government is now planning different activities and measures to improve the irrigation system of KIP. Implementing these measures require, however, that farmers are willing to assist in recovering the cost of the management, maintenance and operation of the irrigation system that will result from the improvement. This show, the need of examining farmers' WTP of improved irrigation water services assuming the irrigation system is improved. So far, however, little has become known about whether farmers in Ethiopia indeed have a positive WTP, and of what size the WTP would be in different environmental goods and services. Given the background discussed above, the major objective of this study is to estimate smallholder farm households' WTP for improved irrigation water services using double bounded Contingent Valuation Methods (CVM) and to find the major factors influencing farmer's WTP in the case of KIP, Ethiopia. Besides, the study collects information about the demand side for irrigation water that assists the Ethiopian government in the development and implementation of policy strategies for sustainable use of irrigation water.

2. Theoretical and Conceptual Model

In general WTP is the amount of income or money that makes the respondent indifferent between the status quo (the existing situations) and proposed contingent valuation scenario (Haab and McConnell 2002, Siyaranamual 2014). Alternatively, WTP is defined as the amount of maximum income (money) a person willing to spend in exchange for an improvement of circumstances or avoiding decline in the quality of circumstances.The ultimate goal of most practical dichotomous choice contingent valuation studies is to provide an empirical estimate of the WTP and the effects of covariates on the WTP (Haab and McConnell 2002).

Different scholars employed the random utility model approach for dichotomous contingent valuation responses to estimate the WTP (Hanemann 1984, McFadden 1999, Haab and McConnell 2002). Moreover, Hanemann (1984), rationalized dichotomous CV questions putting them in a framework that allows how parameters to be estimated and interpreted. Hanemann (1984) has recommended deriving WTP from the indirect utility function. The indirect utility function of respondent j can formulate as follows:

$$V_{ij} = v\ (y_{j,}\ q^{j}, M, p\ ) \tag{1}$$

Where, V (.) is the indirect utility function, $y_{j,}$is the respondent farm household income, q^{j} is the situation of the irrigation project, M *is* the covariates or characteristics of households that might affect farmers' WTP and p is an exogenous price. For the status quo, where there is no any improvement in the irrigation water services (i=0), the indirect utility function of the smallholder farm household is given by:

$$V_{0j} = v\ (y_{j,}q^{0}, M, p\ ) \tag{2}$$

Letting 0 superscripts denote the initial (status quo) conditions and 1superscripts denote the new conditions, then q^{0} is the irrigation project current situation and q^{1} is newer or improvement situations. If the household is willing to pay some money $c(c_j > 0)$ for the improved irrigation program, because of quality and quantity changes (q^{1}> q^{0}), the indirect utility function of the individual farm household is given by:

$$V_{1j} = v\ (y_j - c_{j\,,}q^{1}, M, p\ ) \tag{3}$$

In a general market equilibrium, we need to consider the amount of income that an individual will give up to make the farmer indifferent between an initial situation (the current situation of the irrigation project where income is at y_j and good at q^{0}), and revised or final situation (in this case the improved irrigation water situations, where income is at $y_j - c_j$ and good is at q^{1}) – Economist call this amount of income the compensation variation or the WTP (Haab and McConnell 2002). Therefore, the compensation variation in the Koga irrigation dam project case is given by a mathematical equation below:

$$v\ (y_{j,}q^{0}, M, p\ ) = v\ (y_j - c_{j\,,}q^{1}, M, p\ ) \tag{4}$$

Where v (.) is the indirect utility function, y is the income of a farmer, q^{0} is the level of goods in the current situations of the irrigation project, q^{1} is the level of goods in the improved irrigation project (q^{1}>q^{0} and increase in q is desirable), M is the covariates or characteristics of households that might affect farmers WTP and p is a vector of exogenous prices and, c is the compensation variation that is the WTP bid of the smallholder farmer.

3. Empirical Review

A study by Mesa-Jurado, Martin-Ortega et al. (2012) assessed the value farmers place on the guarantee of water supply for irrigation in Guadalbullon river sub-basin (South of Spain) using CVM. The findings underline that farmers are willing to increase their current irrigator's community annual payment. Moreover, they are willing to cut average water supply their administrative water allowance, to increase the guarantee of their water supply.

The study results also confirmed that, farmers have been given values when water become scarce associated with an increased guarantee, in addition to direct use supplied water. The result also suggests that providing evidence of a predisposition to measure or strategies that allow such improvement to farmers make them perceive the benefits obtained from the improvement increase their welfare.

Alhassan, Loomis et al. (2013) estimated farmer's WTP for irrigation water in Northern Ghana using the CVM from randomly selected farm households based on their location of farms. The study used payment card elicitation format to collect WTP information. The study results confirmed that farmers are willing to pay for the improved irrigation water services. The study identified land ownership, location of the farm and land lease price are the determinants that affect farmers' WTP for the irrigation water.

Using CVM Chandrasekaran, Devarajulu et al. (2009) estimated farmers' WTP for the tank irrigation system in India during dry and wet seasons of paddy cultivation. The study confirmed that farmers are WTP for the irrigation water. The study used a logit regression model and identified education level of the household head, family size, age of the respondent and family labor force were identified as factors determining farmers' WTP.

In Turhal and Sulvova regions of Turkey Basarir, Sayili et al. (2009)analyzed producer's WTP for improved irrigation water using a contingent valuation survey technique. The survey technique was implemented through face-to-face interview with 130 randomly selected producers to elicit the WTP, as well as, to collect data for the factors responsible for WTP. The researchers used Tobit and Heckman sample selection model for data analysis since their data were censored at zero. The result has shown that, male producer from Turhal region, who have more vegetable land, and polluted water were WTP more for increasing the quality of irrigation water.

Using CVM as an analytical tool Kanayo, Ezebuilo et al. (2013) calculates WTP for improved domestic water services in South Western Nigeria and identified the determinants of people's WTP. The study used Tobit (censored) regression model. The study findings informed that WTP for water services is sensitive to the level of education and occupation of the household head, the price charged by water vendor and the average income of the household.

Summing up, the above empirical review offers evidence that CVM is a powerful and viable tool to elicit and quantify farm households' WTP for non-market goods both in developed and developing countries. Even though there are different CVM studies in developing countries, the result of WTP using CVM is very context dependent based on farmers social, economic and biophysical environment. Moreover, this study also contributes to the scientific literature regarding the application of CVM to irrigation water.

4. Methodological Approach

4.1 Sampling and Data Collection Method

The sampling technique used in this study to draw representative sample household heads was two-stage sampling technique. First, from the ten-peasant associations (PA's) in the irrigation command area, two PA's, namely "Kudmi" and "Inguti" were selected in simple random sampling procedure. In the second stage, 140-sample respondents were selected from the two sampled PA's using simple random sampling technique and probability proportional to size sampling technique. Sampling list of beneficiary households was obtained from the district and respective peasant association administrations. The required data were obtained from Primary and secondary data sources. The primary data was collected from a pre-tested questionnaire using face-to-face interview survey method. Face-to-face interviews usually provide a higher response rate comparison to telephone and mail surveys. Moreover, telephone and mail surveys are not common in this area and the respondents are not familiar for such techniques in Ethiopia. To arrive at WTP estimates, a CVM study in the Double Bounded Dichotomous Choice elicitation format was used. This method is advantageous in many ways. Firstly, a given function is fitted with more data points because of the increased number of responses. Second, the yes-no and the noise responses sequential bid offer yields clear bounds on WTP. Finally, from the yes-yes and no-no combinations there is the efficiency gained in that they truncate the distributions where the respondent's WTP are expected to exist in.

4.2 Bid Design and Preliminary Survey

A total of three-focus group discussion with a group of 5-6 individuals and pilot survey was conducted with 30 selected household heads to set up the starting point bids which were used to elicit WTP. To consider the range of bid values, the pilot survey was undertaken in open-ended questionnaire format. After the focus group discussion and pilot survey, three most frequent bid values (12, 26 and 36 Birr/0.25ha/year) were identified as an initial bid value for the double bounded dichotomous choice format and distributed proportionally to the formal survey questionnaire. Then, sets of bid values (6, 13, 18, 24, 52 and 72 Birr/0.25ha/year) was determined for the follow-up question based on the respondents "yes" or "no" response of the initial bid value. The questionnaire has the following main components: the different economic, demographic and social characteristics of the household; a valuation scenario in question and the different WTP questions based on the bids obtained from the focus group discussion and pilot survey. The valuation section of the questionnaire includes the detailed description of a hypothetical scenario, specifically about description of what is going to be valued and the constructed market. After the scenario was presented to the respondent, the payment mechanism was explained to the farmers. The payment vehicle mechanism was per 0.25 hectares of land per year to be paid after the end of crop harvest that could assist the cost of government for the improvement.

4.3 Empirical Model Specification

4.3.1 Estimation of Mean Willingness to Pay

In this study paper to estimate the mean WTP from the dichotomous double bounded elicitation format, a seemingly unrelated bivariate Probit model was used. This is because, the normal density function of a bivariate Probit model is allowing non-zero correlation, but the logistic does not take into consideration non-zero correlation (Cameron and Quiggin 1994). Because of the advantage in minimizing and avoiding the different biases that are known and common in the other elicitation format of CVM, this format is more efficient and consistent with the utility maximization economic theory and it provides more information on WTP of the respondent (Cameron and Quiggin 1994, Hanemann 1994, Haab and McConnell 2002). Haab and McConnell (2002) also mentioned that respondents have shown a diminished ability to influence the total outcome, if respondent failed to value their WTP estimate directly. Therefore, to get a better estimate WTP, the researchers have recommended a follow-up question (Alberini and Cooper 2000, Haab and McConnell 2002). In double bounded dichotomous choice method, the respondent farm households will be asked additional questions if he/she documents that he/she would pay a higher amount if the first answer is "yes" or a lower amount if the first answer is "no" (Ahmed and Gotoh 2005). Following Ahmed and Gotoh (2005) theoretical explanation, the mathematical formulation and estimation of the bivariate Probit model is:

Let's assume that "t" is the pre-specified initial bid offered, "t^L" be a bid value less than the pre-specified initial bid ($t^L < t$) and "t^H" be a bid value higher than a pre-specified initial bid (tH > t). The double bounded dichotomous format question starts with the pre-specified initial bid, "t". The lower level "tL" and the higher level "tH" depends on the response obtained from the pre-specified initial bid. That means, if the respondent household answers ''yes'' for the pre-specified initial bid, she/he receives a higher bid "t^H"; if she/he answers ''no'' for the pre-specified initial bid, she/he receives a lower bid value "t^L". Finally, we have "yes-yes", "no-yes" "no-no", and "yes-no" categories of outcomes.

According to Haab and McConnell (2002), the bounds on WTP are:

$WTP \geq t^H$ For yes- yes response;
$t \leq WTP < t^H$ For yes-no response; (5)
$t > WTP \geq t^L$ For no-yes response;
$WTP < t^L$ For no-no responses;

The formulation in equation (6) is the most common general econometric model for the double – bounded data (Cameron and Quiggin 1994, Haab and McConnell 2002).

$$WTP_{ij} = \mu_{ij} + \epsilon_{ij} \quad (6)$$

Where WTP_{ij} represents the i[th] respondent's WTP, and j=1, 2 represents the first and second answers; μ_1 and μ_2 are the mean for the first and second responses; ϵ_{ij} unobservable random component.

Based on Haab and McConnell (2002) the probability of observing each of the possible two-bid response sequences (yes-no, yes-yes, no-yes, no-no) that respondent i answers the first and second bid can be represented as follows.

$$\Pr(yes, yes) = \Pr(WTP_{1i} \geq t, WTP_{2i} \geq t^H) = \Pr(\mu_1 + \varepsilon_{1i} \geq t, \mu_2 + \varepsilon_{2i} \geq t^H)$$
$$\Pr(yes, no) = \Pr(WTP_{1i} \geq t, WTP_{2i} < t^H) = \Pr(\mu_1 + \varepsilon_{1i} \geq t, \mu_2 + \varepsilon_{2i} < t^H) \quad 7)$$
$$\Pr(no, yes) = \Pr(WTP_{1i} < t, WTP_{2i} \geq t^L) = \Pr(\mu_1 + \varepsilon_{1i} < t, \mu_2 + \varepsilon_{2i} \geq t^L)$$
$$\Pr(no, yes) = \Pr(WTP_{1i} < t, WTP_{2i} < t^L) = \Pr(\mu_1 + \varepsilon_{1i} < t, \mu_2 + \varepsilon_{2i} < t^L)$$

Where t = is the initial bid, t^L= the lower second bid and t^H= the second higher bid

Assuming normally distributed error terms with mean 0 and respective variances of σ_1^2 and σ_2^2, then WTP_{1i} and WTP_{2i} have a bivariate normal distribution with mean u_1 and u_2, variances σ_1^2 and σ_2^2 and correlation coefficient ρ, the above type of model is called the bivariate model. Given the binary choice responses to each WTP question, the normally distributed model is called bivariate Probit model (Haab and McConnell 2002). However, in theory according to (Cameron and Quiggin 1994, Alberini 1995, Shyamsundar and Kramer 1996) there are cases where the interdependence of variables is precluded by pooling the response of the respondent from the initial and followup equations, and estimating as the independent Probit.

Therefore, according to Cameron and Quiggin (1994) the bivariate discrete Probit model estimated correlation coefficient of the error term are assumed to follow the normal distribution with a normal distinguishable from zero, the system of equation could be estimated as Seemingly Unrelated Bivariate Probit Regression model (SUBPRM) that takes into account independent Probit. Therefore, for this study SUBPR model was used to estimate the mean WTP of the respondent from the double bounded format.

According to Greene (2003) the bivariate Probit model general specification can be formulated as:

$$Y_1{}^* = X_1\beta_1 + \varepsilon_1$$
$$Y_2{}^* = X_2\beta_2 + \varepsilon_2$$
$$E\left[\varepsilon_1 \mid X_1X_2\right] = E\left[\epsilon_2 \mid X_1X_2\right] = 0 \qquad (8)$$
$$var\left[\varepsilon_1 \mid X_1X_2\right] = var\left[\epsilon_2 \mid X_1X_2\right] = 1$$
$$var\left[\varepsilon_1\varepsilon_2 \mid X_1X_2\right] = \rho$$

Where, $Y_1{}^*$ = i[th] respondent unobservable true WTP at the time of the first bid offered. WTP = 1 if $Y_1{}^* \geq X_1$, 0 otherwise; $Y_2{}^*$= i[th] respondent's point estimate at the time of the second bids offered; X_1 and X_2 are the first and second bid offered to the sample respondents; ε_1 and ε_2 are error terms for the first and second equation; $\beta_1 and\ \beta_2$ are coefficients of the initial (first) and second bid.

Finally, after running the regression of the dependent variable WTP on the constant and the bid values, the mean WTP from the bivariate Probit model was calculated using the formula specified by (Haab and McConnell 2002) as follows:

$$MWTP\ = \frac{-\alpha}{\beta} \qquad (9)$$

Where α = a coefficient for the constant term or the intercept of the model and β = slope coefficient of bid values that will be offered to the respondents.

4.3.2 Model Estimation of Factors Affecting WTP

The main objectives and focus of this model is to identify the major determinants of the probability of the farmers accepting the initial bid. The respondent farmer either to accept or reject the initial bid depends on his or her utility derived from the different scenarios. Thus, Following (Hanemann 1984) the decision of the respondent farmer can be described using a utility framework. The respondent utility or satisfaction function is given by:

$$U_i = U_i(Y, M, q^j) \qquad (10)$$

Where, $U_i$is the utility of respondent i, Y is respondent income, M is characteristics of the respondent and other exogenous factors that affect WTP and q^j is the situation of the project as perceived by the respondent. Thus, the utility function of the respondent in the two different states is different based on the quality and quantity of the project situationsq^j. Therefore, the utility functions for the two states of conditions are given by equation (11) and (12), respectively.

$$U^0{}_i = U_i(Y, M, q^0) \qquad (11)$$
$$U^1{}_i = U_i(Y - BID, M, q^1) \qquad (12)$$

Where$U^1{}_i$ and $U^0{}_i$ are the farmer utility derived from the improved situation and the original situations of the project, respectively, and BID is the initial amount of value offered to the respondent, and the other variables are as defined above. The i[th] respondent will be willing to pay the first bid value when the respondent thinks that she/he is better off in the proposed scenario ($U^1{}_i$ = improved irrigation project scenario) than the utility obtained from the status quo ($U^0{}_i$ = the original situations of the irrigation project). Mathematically, it means

$$U^1(Y - BID, M, q^1) + \varepsilon_1 \geq U^0(Y, M, q^0) + \varepsilon_0 \qquad (13)$$

Where ε_0 and ε_1 are the error terms with zero mean and independently distributed.

WTP is a dummy variable that takes a value of 1, if the farm household accepts for the initial bid and 0 otherwise. Therefore, such type of binary choice problem can be best analyzed or modelled by considering my (WTP) as a binary response variable, where,

$$Y_i = \begin{cases} 1, if U^1 \geq U^0\ = U^1(Y - BID, M, q^1) +\ \varepsilon 1\ \ \geq U^0(Y, M, q^0) +\ \varepsilon 0 \\ \qquad 0,\ \ otherwise \end{cases} \qquad (14)$$

The probability that a given farm household is willing to pay for the irrigation water is given by;

$$\Pr(Y_{i\,=}1) = \Pr(U_i^1 > U_i^0) \qquad (15)$$

This provides a fundamental structural model for estimating the probability of WTP and can be estimated either using a logit or Probit model, depending on the assumption on the distribution of the error term (ε) and computational convenience (Greene 2003, Gujarati 2003).

When the dependent variable in a regression model is binary (0, 1) the analysis could be conducted using either linear probability model or logit or Probit models. But, the linear probability model may generate predicted values less than 0 or greater than 1, which violate the basic principles of probability and the coefficient of determination (R^2) is likely to be much lower than one. For this reason, it is questionable to use R^2 as a measure of model fitness (Gujarati 2003, Gujarati 2004). The other problem with the linear probability model is that the partial effect of any explanatory variable is constant (Maddala 1983). Hence, in this study Probit model was used to identify the factors that affect WTP.

Following Cameron and Quiggin (1994), the Probit model takes the following form;

$$Y_i^* =\ \beta' X_i + \varepsilon_{i,} Y_i = 1\ if\ Y_i^* \geq t_i and\ \ Y_i = 0\ if\ Y_i^* < t_i \qquad (16)$$

Where: β' = is a vector of unknown parameters of the model, X_i = is a vector of explanatory variables (Land cultivated, total household income, age of the household head, education level of household, household family size, gender of the household, access to extension services, farm experience, access to credit, initial bid), Y_i^* = Unobservable households' actual WTP for irrigation water. Y_i = Discrete response of the respondents for the WTP, t_i= the offered initial bids assigned arbitrarily to the ith respondent random component and ε_i = error term N (0, σ).

5. Results and Discussion

5.1 Descriptive Analysis of the Survey

From the total sample respondents (n=140) majority of the sample households 98 (70%) were male households, while the remaining 42 respondents (30%) were female households. The result of the survey regarding the education level of the sample respondent showed that 82 (58.57%) of the sample households were illiterate while 58 (41.43) were attending primary school. There are also 852-family members in total in the sample households, and the average family size of the sample farmers was 6.085.Moreover, the result obtained from the survey revealed that the average cultivated land of the sample respondent households was 0.604 hectares. Nevertheless, the sizes of cultivated land owned by households' are ranging from a maximum two to the lowest 0.25 hectares. Regarding the income of the households, most of the incomes are obtained both from farm and non-farm sources or activities, and the average income of sample respondents was 8427.921Birr per annum. Currently, 53.57% of the sample respondents are involved in non-farm activities to diversify their income to maintain their livelihood. In addition, ownership of different types of livestock is sources of livelihoods for farmers in the study area. The mean total livestock unit (TLU)[1] is 4.34.

In the study area there are formal and informal sources of financial institutions that provide credit to farmers to fulfil the economic or financial requirements. The survey revealed that 116 respondents (82.86%) have access and received credit. Furthermore, access to agricultural extension services play a central role in a nation like Ethiopia where the largest proportions of the farmers are ignorant. The study results demonstrated that nearly 95.71% of the responding farmers were visited and assisted by the developing agents, whereas only a small proportion 4.29% has not been imposed by developing agents.

With respect to the current irrigation water problem, of the total households in the sample 83 respondents (59.29%) reported the problem of irrigation water scarcity problems, whereas 57 respondents (40.71%) indicated that there isn't any irrigation water scarcity problem. According to the response from the farmers, various intermingled factors or forces caused irrigation water scarcity problem in the study area. Most of the respondents indicated that soil erosion 50 (60.24%), deforestation 25 (30.12%) and population pressures 8 (9.64%) are the primary causes for the scarcity of irrigation water problems.

The size of irrigated agricultural land owned by farmers varies with maximum landholdings of 0.5 hectares and minimum landholdings of 0.1 hectares. Moreover, the survey result revealed that farmers have different years of irrigation experience ranging from one to four years. The mean irrigation farming experiences of the sample household was three years. Irrigation water management training as one of the useful services to understand and develop a practice of modern irrigation technologies, farmers were asked in the survey about access to practical training in irrigation water management. The survey results reveal that 59.29% of the respondents did not have access to irrigation water management training while 40.71% could participate in such training.

5.2 Estimation of Households WTP for Improved Irrigation Water

The mean WTP for the double bounded dichotomous contingent valuation was analyzed using the seemingly unrelated bivariate probit regression model (SUBPRM). The regression output in table 2 revealed that the coefficient of the initial and follow-up (second-bid values) have negative and significant at less than 1and5 percent significant probability level, respectively. The implication of this negative relationship indicated that, the value of the initial and second price increases, households' WTP for the improved irrigation decreases.

In the bivariate Probit model the correlation coefficient rho (ρ) is significant and positive, and significantly different from zero, which proves the existence of a positive relationship between the two reactions. Moreover, the coefficient of the correlation value ρ is less than one which confirms the random component of WTP for the first and the second question is not perfectly correlated. The mean WTP for the improved irrigation water from the double bounded Probit was estimated to be 128.88 Birr/hectare/year (US$6. 78 /hectare/year) and

[1] A common unit to describe livestock numbers of various species as a single figure that expresses the total amount of livestock present – irrespective of the specific composition, or tropical livestock unit is a commonly taken to be an animal of 250 kg live weight. The values are 1 for Camel, 0.7 for Cattle, 0.8 for Mule/Horses, 0.5 for Donkeys, and 0.1 for Goats/sheep. Jahnke, H. E. and H. E. Jahnke (1982). Livestock production systems and livestock development in tropical Africa, Kieler Wissenschaftsverlag Vauk Kiel.

162.72 Birr[2]/hectare/year (US$8. 56/hectare/year). This implies that at 95 percent confidence interval the mean WTP varies 128.88 to 162.72 Birr/hectare/yr. However, the reason being the fact that the second-equation parameters are likely to contain more noise in terms of anchoring bias where the respondents are assumed to take while forming his/her WTP for the second question, estimated parameter of the first-response equation was used to obtain mean WTP.

5.3 Analysis of Determinants that Affect Households' WTP for Improved Irrigation Water

In the econometric model, the existence of multicollinearity was tested using contingency coefficient for dummy variables and variance inflation factor (VIF) for continuous explanatory variables before running the Probit model. In addition, Breusch-pagan/cook-Wisberg test was used to test the problem of heteroskedasticity. The result of the contingency coefficient and variance inflation factor confirmed the non-existence of multicollinearity between the variables. The Breusch-pagan test also indicates no problem of heteroskedasticity in the Probit model.

The estimation output of the econometric models showed that from the total 10 explanatory variables included in the model, four independent variables such as education level (EDUL), family size (FASIZE), gender (GENDER) and household income (HINCOME) of the respondent have a significant and positive effect on the households' willingness to pay for the offered initial bid for the improved irrigation services, and two of the independent variables, namely the initial bid offered (BID1) and total cultivated land (CULTLAND) had a negative and significant effect on the willingness to pay for the offered initial bid for improved irrigation water. However, the rest of the explanatory variable included in the model was not significant at ($\rho < 0.05$) probability level. In table 4, there are two basic outputs. The first output includes the coefficient and standard errors of the Probit model and the second output is the marginal effects of the Probit model. The coefficient of the Probit model does not show the marginal effects of the independent variable on the variation of the dependent variable willingness to pay; rather it tells us only the sign of each independent variable. On the other hand, in order to infer the effects of each explanatory variable on the likelihood that smallholder farmers' reject or willing to pay the initial bid, the marginal effect of each independent variable was taken.

The education level of the respondent (EDUL) was significant and positive at ($\rho < 0.01$) probability level. The implication of this is that education provides knowledge and makes the household get information, and the information creates awareness about the benefits obtained from improved irrigation water. This showed that higher level of education leads to higher willingness to pay for improved irrigation water. The marginal effects indicated that, being literate will increase the probability of willingness to pay for the initial bid by 23%, keeping the other variable constant.(Tiwari 1998,Chandrasekaran, Devarajulu et al. 2009, Mezgebo, Tessema et al. 2013) have obtained similar effects.

The coefficient of the gender of the respondent (GENDER) is significant at ($\rho < 0.05$) significant level and positive effect. This indicated that male households are more willing to pay for the improved irrigation water services than female households. The marginal effects of gender indicated that being a male will increase the probability of willingness to pay for the proposed initial bid by 28.74%, keeping other variables in the model constant.

Family size of the respondent (FASIZE) is positive and significant at ($\rho < 0.05$) probability level. This implies that households of large numbers of family members are more willing to pay for the initial bid than households with small numbers of family members. This is probably households perceived that the output (production) obtained using irrigation water can support the large family members via increasing the supply of enough food to the household. Comparable effects have been obtained in other studies by Chandrasekaran, Devarajulu et al. (2009), Mesa-Jurado, Martin-Ortega et al. (2012).

The total income of the respondents (HINCOME) has positive and significant effects at ($\rho < 0.05$) probability level. This relationship indicates that higher income households are more likely willing to pay a pre-specified initial bid than lower income households. This result also shows the general demand theory which states the positive relationship between income and demand for goods. The marginal effect underlined that keeping other variable constant at their mean value, a one Birr increase in income of the household increases the willingness to pay by 0.0318%. Similar results have been obtained by Balana, Catacutan et al. (2013); Arouna and Dabbert (2012); Mezgebo, Tessema et al. (2013) and Chandrasekaran, Devarajulu et al. (2009) who have conducted a CVM study on irrigation water.

The total cultivated farm size of the respondent (CULTLAND) was significant and positive at ($\rho < 0.05$) probability level. The significant results indicated that farm households who have large size of cultivated land were less likely to say yes for the offered bid value than respondent with small cultivated land size. This is probably being the fact that larger cultivated farm size provides enough output (yield of different crops) and that may make the farm household become strong and gives less value to irrigation water. Similar effects have been obtained by Chandrasekaran, Devarajulu et al. (2009).

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[2] Birr is the monetary unit of Ethiopian currency. 1 Ethiopian Birr (ETB) = 0.053 USD (2014)

The initial bid offered (BID 1) has found to be negative and significant at ($\rho < 0.01$) significance level with willingness to pay for improved irrigation water. The implication of this indicated that as the value of the initial bid increases the probability of the yes answer for the bid value decreases and vice versa that is also consistent with the economic theory.

5.4 Analysis of Aggregate WTP for the Improved Irrigation Water

As indicated in table 5, one of the ultimate objectives of WTP contingent valuation study is to calculate or estimate the aggregate WTP of the goods valued or the analysis of welfare measures using the value of total WTP obtained from the sample households to the total population in the irrigation command area. For valid analysis of aggregation of benefits, the different bias of the sample design during contingent valuation study has to be minimized, and protest zero responses should be excluded from the data (Mitchell & Carson, 1989). Hence, attention has been paid to minimize all the biases in this study. We used an appropriate sampling technique to select sample households where lists were obtained from corresponding peasant association administrations. Moreover, the questionnaire was administered through a face-to-face interview that helps us get a high-response rate. Lastly, as indicated in table 3, based on the NOAA[3] panel guide following Arrow & Solow (1993), protests zero households are excluded from the aggregation, and hence we expected none of the different biases in the analysis. Consequently, the total WTP for the project area was calculated by multiplying the mean WTP value obtained from seemingly bivariate Probit regression model for the double bounded by the valid number of households in the project area. The valid number of households was obtained after deducting the expected protest zero responses (392)[4]from the total population. Therefore, the entire aggregate values of the improved irrigation water in the Koga irrigation project from the double bounded formats are 1,753,799.04 Birr/year (US$ 89,646.21) and 2,214,293.76 Birr/year (US$113, 184.60).

6. Conclusion and Recommendation

Access to irrigation water for smallholder farmers where the challenges of climate variability and climate change has an adverse effect can have many positive effects: It may help to satisfy the household demand for food, reduce poverty and improve employment opportunities. Understanding the relevance of irrigation farming in the area, the government of Ethiopia launched the Koga irrigation project in the Mecha district, Amhara region. However, lack of regular maintenance and rehabilitation, hampered a proper implementation of the project and as a consequence, discouraged smallholder farmers in the area. Thus, there is a need to improve the irrigation water in the area. In order to improve the irrigation water the government considered applying a mechanism that farmer's contribute recovering the cost burden for management, maintenance and operation of the irrigation system. Implementing such a mechanism requires information about (i) whether smallholder farmers are indeed willing to contribute to the project, and (ii) how large their average and total WTP for the improved irrigation water will be.

Therefore, methodologically this study used the contingent valuation study with dichotomous double bounded choice format to estimate the mean WTP and then the total WTP for the improved irrigation water. The contingent valuation study used survey data collected from 140 randomly selected sample households from two PA's of the irrigation command area and administered through face-to- face interviews by enumerators. PA's were selected using a simple random sampling technique and numbers of sample households was determined from each PA's using probability proportional to size sampling technique and simple random sampling techniques.

The result of the survey shows that, 59.29% of the sample farmer described the existing irrigation water is unsatisfactory for agricultural crop productions, which are caused by erosion and deforestation. Moreover, the descriptive output confirmed that 60.71 % of the sample farm households are willing to pay for the improved irrigation water services and 39.29% is not willing to pay initially offered bid. This shows that most of the sample farm households understand the existing irrigation water problems in the area and willing to pay and assist the government for the improvement scenario. Moreover, this result tells us that, if farmers once realize the benefits obtained from irrigation in terms of better productivity and increased income, they are willing to pay more than the above stated WTP value.

The mean WTP for the improved irrigation water (the hypothetical market scenario) from the double bounded dichotomous elicitation response using the empirical result obtained from the seemingly bivariate Probit econometric model was estimated to be 128.88 Birr/hectare/year (US$6.78 /hectare/year) and 162.72 Birr/ha/year (US$8.56/hectare/year). The overall value of the improved irrigation water in the Koga irrigation

[3]The National Oceanic and Atmospheric Administration (NOAA) convened a panel of prominent social scientists established in in 1992, to assess the reliability of contingent valuation (CV) studies. The product of the panel's deliberations was a report that laid out a set of recommended guidelines for CV survey design, administration, and data analysis.

[4] The invalid responses are calculated by multiplying the sum total percentage of the protest responses in the sample by the total population in the command area. Expected invalid response = 0.028 * 14,000 = 392 households. Thus, the valid number of responses = 14,000 - 392 = 13,608 households.

project from the double bounded formats per year are 1,703,278.08 Birr (US$ 89,646.21) and 2, 150, 507. 52 Birr (US$113, 184.60). Moreover, the empirical findings identified education level, family size, gender, household income, the size of the initial bid and cultivated land have a significant effect on the households' WTP. Therefore, the possible policy recommendations that originate from the results of the research study are presented as follows:

φ The government should implement irrigation water management practices to supply reliable irrigation water to the farmers and government should set up proper irrigation water pricing an amount close to the mean WTP that households were willing to pay. Moreover, the government should establish and strengthen administrative and institutional set up of the project.

φ The result of this study indicated that factors related to demographic, socioeconomic and institutional services were found to have a significant effect and contribution on households' WTP for the improved irrigation water services. Thus, the policy implication of this relationship between the variables and WTP is that, government and policy makers should consider the significant variables which have an impact in determining households' WTP. To this end, the primary step should be identifying and promoting income generating programs, upgrade the education level of the farmers. Moreover, create awareness and teach people about the benefits that farmers get with improved irrigation water.

φ The results of the analysis underlined that soil erosion and deforestation are the main reasons for the scarcity of the irrigation water in the area. Therefore, government should innovate and adapt soil and water conservation technologies that fit a particular situation to protect the Koga catchment from degradation, and to minimize the accumulation of sediment in the dam. Furthermore, sustainable land management practices should consider the biophysical and socioeconomic contexts of the community at village level.

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Table 1: summary of descriptive statistics for independent variables (n=140)

Variable	Variable description	Mean	Std.dev	Max.	Min.
BID	Initial bid in Birr	24.65	9.91	36	12
AGE	Age of the household head in years	51.54	13.04	90	25
EDUC	Education level of the household (1= Illiterate, 0 otherwise)	0.41	0.49	1	0
FSIZE	Family size	6.08	2.24	11	2
GEDNDER	Gender of the household head (1=male)	0.7	0.45	1	0
LANDCULT	Cultivated land in hectares	0.6	0.29	2	0.25
HINCOME	Total household income in Birr	8427.92	4768.42	36500	1160
FEVIST	Frequency of extension agent in days	17.92	11.03	60	0
ACREDIT	Access to credit (1= if credit is accessible)	0.83	0.37	1	0
TLU	Number of livestock in tropical Livestock Unit	4.34	2.08	10.9	0.8

Source: Own survey (2014)

Table 2: Parameter estimates of the double bounded using the bivariate probit model

Variable	Coefficients	St. Er	Z-value
BID1(initial bid)	-0.03875***	0.01075	-3.60
Constant	1.24887***	0.2948	4.24
BID2 (Second bid)	-0.01733**	0.0079	-2.19
Constant	0.69174**	0.2793	2.48
Rho***	0.621214	0.2142	

Log- likelihood= -181.22
Number of Observations = 140
Wald chi2 (2) = 14.4
Probe> chi2=0. 000
Likelihood-ratio test of rho = 0: chi2 (1) =16. 372 Prob > chi2 = 0.001

Source: Own survey performed in 2014, ***, ** Significant at less than 1% and 5% significant level.

Table 3: Reasons for protest zero and not willing to pay households

Reasons	Frequency	Percent
I cannot afford to pay	26	86.67
I do not trust the improvement	2	6.67
The government is responsible to finance	2	6.67
Protest zeroes[5]	4	13.34

Table 4: Probit model output estimation

VARIABLES	WTP			
	Coefficients	St. Er	Marginal effects	St.Er
BID1	-0.00583***	0.00162	-0.00208***	0.00557
AGE	-0.0165	0.0115	-0.0059	0.00414
GENDER	0.7741**	0.3384	0.2874**	0.1257
EDUL	0.6726**	0.3146	0.230**	0.1011
FASIZE	0.2750***	0.0862	0.0982**	0.0295
ACREDIT	-0.1805	0.4334	-0.062	0.1445
FREVISIT	0.0150	0.0150	0.0053	0.0053
CULTLAND	-1.2559**	0.5962	-0.4487**	0.2092
HINCOME	0.0008**	0.0004	0.000318**	0.0001
TLU	-0.0281	0.0681	-0.01005	0.0244
CONSTANT	0.2779	0.9490		
Observations	140			
Log likelihood	-55.714			
LR chi2 (10)	76.18			
Pseudo R2	0.4060			
Prob>Chi2	0.0000			

Source: own survey 2014, ***, **and * Significant at 1%, 5% and 10% significant level

Table 5: Estimated Aggregate WTP of the improved irrigation water

Total number of population (A)	Expected Protest zeroes (B)[6]	Expected Valid responses (C) =A- B	Mean WTP (Birr) (D)	Aggregate value (Birr) (I) =C*D
14000	392	13608	128.88	1753799.04

[5]Out of the total 140 sampled respondents 4 (0.028%) were considered as protest zeroes. Whereas, 26 (0.185%) were considered as true zeroes. Therefore, based on NOAA panel guide, protest zeroes are excluded from the aggregation analysis.
[6] The expected number of protest zeroes in the total population.

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