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Labor as a Payment Vehicle for Valuing Soil Conservation Practices in a Subsistence Economy: Case of Adwa Woreda in Ethiopia

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Abstract Soil erosion has been one of the major problems undermining agricultural production in Ethiopia. In response, efforts have been made by the government and people to tackle the adverse effect of soil erosion via Food-for-Work and Cash-for-Work programs. However, the existing literature shows that the achievements of such programs are far from the expectations. This paper explores the value that the rural households have attached to soil conservation measures using the Contingent Valuation Method. The value elicitation method used is a double bounded dichotomous choice with an open ended follow-up question, which is closer to the market scenario respondents are familiar with in Ethiopia. The paper is based on a field survey carried out among 218 smallholder farm households. The study uses Tobit model. Results from the study indicate that, age, education, farm income, perception of soil erosion, tenure security, extension contacts, total livestock units, labor shortage for farm practices, distance to the nearest market are significant factors that explain Households' WTP. The study estimates the mean WTP to be 48.94 labor days per year with an aggregate benefit of 1,186,648 labor days per year which is equivalent to 14,239,778 Birr. Policy trust should focus on enhancing land tenure security through land certification among others.

Keywords Willingness to Pay, Contingent Valuation Method, Soil Erosion

1. Introduction

Soil is the second most important for life after water. Abundant growth of life is found in areas with good soils. From the record of past achievements, history has unveiled that civilization and fertility of soils are closely interlinked. However, the loss of soil through land degradation and soil erosion has been a great threat for this valuable resource in most developing countries[1]. An empirical work by Bai *et al*[2] indicated that more than 20% of all cultivating areas are degrading worldwide, affecting the livelihood of about 1.5 billion people. Furthermore, Eswaran *et al*[3] on their interesting research indicated that, soil erosion is resulting in total loss of 75 billion tons of fertile soil which is equivalent to 400 billion US$ annually. The declination of the fertility of soil has occurred due to accelerated erosion caused by human interference. Today soil erosion is almost universally recognized as a serious threat to human wellbeing especially in developing countries.

Ethiopia, being among developing countries, has heavily relied on its agriculturally based economy. However, agriculture in Ethiopia is characterized by limited use of external inputs and continuous deterioration of the resources. According to Daniel[4], Ethiopia for the last couple of decades has faced serious ecological imbalances because of large scale deforestation and soil erosion caused by improper farming practices, destructive forest exploitation, wild fire and uncontrolled grazing practices. This has resulted in a declining agricultural production, water depletion, disturbed hydrological conditions, and poverty and food insecurity.

Bojo and Cassells[5] assessed land degradation and indicated that the immediate gross financial losses due to land degradation in the Ethiopian highlands were about US$102 million per annum which was about 3% of the country's GDP. The study also showed that virtually all of the losses were due to nutrient losses resulting from the removal of dung and crop residues from cropland, while the remaining was mainly due to soil erosion. Other modelling work suggests a loss of agricultural value of about US$7

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billion between 2000 and 2010[6].

Natural and environmental resources conservation in Ethiopia, specifically soil, is therefore not only closely related to the improvement and conservation of ecological environment, but also to the sustainable development of its agricultural sector and its economy at large. However, according to Alemneh[7] there was no Government policy on soil conservation or natural resources management in Ethiopia prior to 1974. The 1974-1975 famine was the turning point in Ethiopian history in terms of establishing a linkage between degradation of natural resources and famine. Since then, different soil conserving technologies with a varied approach has been underway via the Food for Work (FFW) and Cash for Work (CFW) programs. However, the existing literature shows that, the achievements of such programs have fallen far below expectations. The country still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly[8].

Does such an experience mean that there is no hope for soil conservation in Ethiopia? Absolutely it is doubtful, the problem could have been rather, the campaigns that have been undertaken in Ethiopia for soil conservation practices have failed to consider local peoples' willingness to pay for such activities from the very initiation of conservation measures. This motivates that, adequate understanding of the socio economic circumstances is required to determine the household's soil conservation demand behaviour and the factors that determine their willingness to pay for it[1]. In the absence of market to determine the price or value of such environmental service non market valuation techniques, such as asking people directly what they would be willing to pay for such services in a hypothetical market scenario, could be used[9].

Thus, in this study we have applied the Contingent Valuation Method which normally is used to elicit Willingness to Pay (WTP) for non-marketed environmental and public goods. Double Bounded Dichotomous Choice format with an open- ended follow up, which is closer to the market scenario respondents are familiar with, were used to elicit the willingness to pay of the rural household's. The objective of this paper was to estimate the mean willingness to pay for soil conservation practices and to assess the determinants of willingness to pay among the rural household's in the study area.

The rest of the paper is organized as follows: section two builds conceptual framework, section three presents, theoretical and empirical model, section four presents' findings and discussion of model results, and the last section concludes the paper and provides policy implications.

2. Conceptual Framework Work

The goal of this paper is to value soil erosion problem using stated preference techniques. In this section, we have tried to discuss the economic theory that allows us to obtain measures of consumer benefits from stated preference methodology, specifically Contingent Valuation Method (CVM). The economic valuation of changes in environmental quality caused by a given intervention typically aims at the question whether or not a given household is better off after that intervention has to be performed. Two steps are necessary to answer this question: first, individual welfare changes of all people potentially affected by the intervention in question have to be assessed and, second, these individual welfare changes have to be aggregated in order to compute the resulting change in social welfare.

The individual welfare change can be measured from simple random utility theory. Following Yu and Abler[10], if the indirect utility function for a respondent is given by $V(p,q^*,l)$, given labor endowment of the household l, soil conservation quality q^* and an exogenous price vectors p. If the respondent decides not to protest and participate in bidding, and she/he is willing to contribute some labor $t(t \geq 0)$ for improving soil conservation quality (e), the indirect utility function can be represented by $V(p,q^*+e,l-t)$. Under the market equilibrium, the indirect utility function becomes;

$$V(p,q^*,l) = V(p,q^*+e,l-t) \quad (1)$$

Suppose soil conservation improvement and labour changes are very small, and we can take the first order approximation of $V(p,q^*+e,l-t)$.,

$$V(p,q^*+e,l-t) \approx V(p,q^*,l) + \frac{\partial V(p,q^*,l)}{\partial q^*}e - \frac{\partial V(p,q^*,l)}{\partial l}t \quad (2)$$

Combining equation (1) and (2), we have

$$WTP = t = \frac{\partial V(p,q^*,l)\big/\partial q^*}{\partial V(p,q^*,l)\big/\partial l}e \quad (3)$$

Equation (3) indicates that WTP may be zero for a given household when his/her marginal utility of soil conservation quality $\partial V(p,q^*,l)/\partial q^*$ is zero, or when the marginal utility of labor endowment $\partial V(p,q^*,l)/\partial l$ tends to infinity; otherwise, it is a positive number.

3. Material and Methods

3.1. Description of the Study Area

The study was done in Adwa Woreda[i] of the central Zone of Tigray regional state of Ethiopia. The study area is found, towards north, about 1006 km away from the capital of Ethiopia, Addis Ababa. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), the Woreda has a total population of 99,711 of whom

49,546 are men and 50,165 women. With a total area of 1,888.60 square kilometres, Adwa Woreda has a population density of 52.80, which is less than the Zone average of 56.29 persons per square kilometre. A total of 24,692 rural households were counted in this Woreda, resulting in an average of 4.95 persons to a household. Adwa Woreda was selected because it is one of the soil erosion prone areas in the region, as well as, in the country.

3.2. Sample and Sampling Techniques

This study randomly selected 5 rural Kebeles (peasant associations) from the existing 18 Kebeles of the Woreda. Further, farm households were selected using the probability proportional to size using simple random sampling technique. The sampling list was obtained from the Woreda and respective peasant association administrations. A total of 225 households were randomly selected and 218 households were used for the analysis. Three of the seven respondents were excluded because they had insufficient information in their questionnaire. Four of the seven respondents were excluded because they had protest zeros[ii]. But, before we decided to exclude them from further analysis, a sample selection bias test was undertaken whether excluding the protest zeros would create a sample selection bias. The two sample (Valid responses and protest zeros) mean were not statistically different in almost all the covariates. This revealed that excluding the protest zeros would not insert sample selection bias. Thus, the final analysis was undertaken based on the respondents (218) who had valid responses. The primary data were collected from sample respondents through a structured questionnaire, via face to face interview.

3.3. Field work Procedure and Questionnaire Design

The survey questionnaire of this study had three parts. The first section of the survey questionnaire included perceptions of respondents on soil erosion and soil conservation practices. The second section presented the valuation scenario and willingness to pay. The valuation scenario section tried to give as much information as possible about detailed description of the hypothetical market of soil conservation practices to be undertaken. Specifically, the valuation scenario includes descriptions of the good (what is going to be valued), the constructed market (how the good will be provided) and the method of payment (how could be paid for the good). In the Double-bounded dichotomous choice elicitation format a respondent was asked about his/her WTP of a pre-specified amount of initial bid which was determined during the pilot survey for the proposed soil conservation practices. The questionnaire contains questions on the number of labor days that households could be willing to pay for soil conservation practices per year. Only labor payment vehicle was taken based on the results of the pilot survey i.e. the respondents were not willing to pay any amount of cash for the proposed soil conservation practices. This can be justified by the fact that rural households in Ethiopia are experienced cash constraints and have cheap labor (see[11]) Finally, the questionnaire was designed to collect the socio economic characteristics of the sampled respondents.

An important issue in the implementation of the CV survey and especially the Dichotomous choice is the choice of initial and follow up bid values. Bid design is important from the point of view of the efficiency of the estimators because they determine the variance-covariance matrix when they are the only regressors. That is why before the final survey was implemented, we had to do a pilot survey and focus group discussions to come up with starting bids with a randomly selected 30 households. The main objective of the pilot survey was to elicit the payment vehicles and to set up the starting point prices which finally were distributed randomly to the questionnaires. The pilot survey was undertaken via the open ended questionnaire format. The results of the pilot survey revealed that households willingness to pay ranges from 0 to 110 labor days per annum. In view of this, three starting bids 22, 40 and 65 labor days per year were randomly allocated to the 225 randomly selected respondents in the final survey. If the respondents were willing to take the offered initial bid, the follow up bid is doubled and in case of a “no” response to the initial bid, the follow up bid is half of the initial bid. For example, when offered a bid of 22 a follow up bid of 44 is offered if the answer was “yes” and in case of a “no” response a bid of 11 is given to the household. Thus, the range of bid vectors in the follow up were 11, 20, 32, 44, 80 and 130 labor days per year. Finally, the open ended format was presented to the respondent and the value of this question was used in this paper as the maximum WTP for a given household.

3.4. Empirical Models

3.4.1. Determinants and Intensity of WTP to Pay for Soil Conservation Practices

Households’ willingness to pay for soil conservation practices especially in low-income countries could be influenced by a complex set of socio-economic, demographic, technical and institutional factors. Hence, modelling farmers’ willingness to pay has become important and relevant both theoretically and empirically. As it is discussed in the conceptual framework section, households’ are assumed to maximize their expected utility function given the constraint that they face. The theory of the maximization of utility is generally used to explain the response of the farmer to the elicitation method, in our case open ended format of our Contingent Valuation Method (CVM) survey. To address this objective, it is assumed that every Household has the objective to maximize utility, but each Household has their own perception of utility and constraint and makes willingness to pay decisions based on the unique attributes of their own situation. In other words, the willingness to participate in soil conservation practices is assumed to depend upon the set of attribute values that apply to the particular household. Because some households are non-willing to pay for soil conservation practices, the maximum willingness to pay for such households is equal to zero. As noted in Greene[13] a dependent variable that has a zero value for a significant fraction of the observations requires a censored regression model (also referred to as a Tobit model) because standard Ordinary Least Square technique results in biased and inconsistent parameter estimates i.e. they are biased even asymptotically. The bias arises from the fact that if one consider only the observable observation and omit the others, there is no guarantee that the expected value of the error term, $E(u_i)$ will be necessarily zero. Moreover, without $E(u_i)=0$ we cannot guarantee that the OLS estimates will be unbiased. It is intuitively clear that if one estimates a regression line based on the observable observations only, the resulting intercept and slope coefficients are bound to be different than if all the observations were taken into account. Hence, in this study Tobit model was used. Following Madala[14], the Tobit model can be defined as

$$MWTP_i^* = \beta' X_i + u_i$$

$$MWTP_i = \begin{cases} MWTP_i^* \, if \; MWTP_i^* > 0 \\ 0 \; if \; MWTP_i^* \leq 0 \end{cases} \tag{4}$$

Where, $MWTP_i^*$ is latent or unobserved willingness to pay for soil conservation practices; $MWTP_i$ is household's maximum willingness to pay for soil conservation practices in a year; X_i is vector of independent variables that are hypothesized to influence maximum willingness to pay; β is unknown parameter vector to be estimated; ε_i is error term which are assumed to be normally distributed with mean zero and constant variance.

The model parameters are estimated by maximizing the Tobit likelihood function of the following form.

$$L = \prod_{MWTP^*>0} \frac{1}{\sigma} f \ln\left(\frac{MWTP_i - \beta X}{\sigma}\right) \prod_{MWTP^*\leq 0} \frac{1}{\sigma} F\left(\frac{-\beta X}{\sigma}\right) \tag{5}$$

Where, f and F are the density probability function and cumulative distribution function of $MWTP_i^*$ respectively. $\prod_{MWTP^*>0}$ means the product over i for which MWTP*>0, and $\prod_{MWTP^*\leq 0}$ means the product over i for which $MWTP^* \leq 0$.

The Tobit coefficients do not directly give the marginal effects of the associated independent variables on the dependent variable. But their signs show the direction of change in probability of WTP and the intensity of maximum WTP as the respective explanatory variable changes[15].

[16] proposed the following techniques to decompose the effects of explanatory variables into the probability of *WTP* and intensity of *WTP* effects. Thus, a change in X_i (explanatory variables) has two effects: it affects the conditional mean of $MWTP_i^*$ in the positive part of the distribution, and it affects the probability that the observation will fall in that part of the distribution. This decomposition approach is used in this study.

1. The effects of a given explanatory variable on the probability of WTP is:

$$\frac{\partial F(Z)}{\partial X_i} = f\,(z)\;\frac{\beta_i}{\sigma} \tag{6}$$

2. The marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$\frac{\partial E(MWTP_i)}{\partial X_i} = F(z)\beta i \tag{7}$$

Where, $\frac{\beta_i X_i}{\sigma}$ is denoted by z, following Maddala,[14].

3. The change in the amount of respondents is willing to pay with respect to a change in explanatory variable among individuals who are willing to pay is:

$$\frac{\partial E(MWTP_i / MWTP_i^* > 0)}{\partial X_i} = \beta_i\left[1 - Z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \tag{8}$$

Whereas: F (z) is the cumulative normal distribution of Z, f(z) is the value of the derivative of the normal curve at a given point (i.e., unit normal density), Z is the z-score for the area under normal curve, β is a vector of Tobit maximum likelihood estimates and σ is the standard error of the error term.

4. Results and Discussion

4.1. Descriptive Statistics

The descriptive statistics results of our respondents are presented in Table 1 below. As can be seen from Table 1 below, the mean age of the respondents were 52.22 years with a minimum of 24 and a maximum of 95. The average number of years that the households spent on school is 1.64 years. On average, the households walk for 68.47 minutes to shop in their nearest market. The mean household size of the respondents was also estimated to be 6 persons with 0.61 hectares of land holding. The average household income was 6592.49 Birr per year and the households have on average of 4.42 total livestock holdings measured in Total Livestock Units.

4.2. Determinants and Intensity of Willingness to Pay for Soil Conservation Practices

Results of the estimated parameters and their marginal effects of the explanatory variables that were hypothesized to affect willingness to pay for soil conservation practices are presented in Table 2. The dependent variable is a continuous variable which is the respondents' maximum willing to pay for soil conservation practices in the study area. A total of 14 regressors were considered in our Tobit model, out of which 10 variables were found to significantly influence maximum willingness to pay for soil conservation practices ($p<0.1$).

Table 1. Descriptive statistics of the Sampled Respondents

Variable	Mean	Min	Max
Age of the household head	52.22	24	95
Sex of the household head (1=Male, 0=Female)	-	0	1
Education level of the household head	1.64	0	15
Distance from home to the nearest market (in minutes)	68.47	5	180
Family size of the household	6.06	1	11
Farm size of the household in hectares	0.61	0.125	2.5
Perception of soil erosion hazard (1=yes, 0=otherwise	-	0	1
Initial bid offered to the household in person days	42.34	22	65
labor shortage for farm activities (1= yes, 0= otherwise)	-	0	1
Number of extension visits per annum	16.80	0	60
Land Tenure Security (1= Yes, 0, otherwise)	-	0	1
Total Income of the household per year in Birr	6592.49	600	28000
Total livestock holdings of the household	4.42	0	14.91
Access to credit (1=if there is access to credit, 0=otherwise)	-	0	1

1USD=17.44 Birr (Ethiopian Currency) at the time of data collection

Table 2. Tobit Model Estimates of WTP for Soil Conservation Practices

VBID1	Coefficients	t-value	Marginal effects		
			a Pr(Y>0)	b $\partial E(Y/Y>0)/\partial X$	c $\partial E(Y^*/Y>0)/\partial X$
Age	-0.4647***	-2.80	-0.0016	-0.3846	-0.4448
Sex of a Household	7.1290	1.57	0.0277	5.7997	6.7820
Education level	1.3940*	1.85	0.0049	1.1538	1.3346
Distance	-0.0786**	-2.00	-0.0002	-0.0650	-0.0752
Household size	5.8460***	5.37	0.0205	4.8382	5.5963
Farm size	-6.9821	-1.01	-0.0245	-5.7780	-6.6834
Perception	13.3415	1.11	0.0701	10.2042	12.3786
BID1	0.2896***	2.74	0.0010	0.2396	0.2772
Labour shortage	-19.68***	-3.80	-0.0984	-15.2534	-18.3279
Extension contacts	0.4072*	1.91	0.0014	0.3369	0.3897
Land tenure	24.26***	3.09	0.0853	20.0760	23.222
Farm income	0.0018***	2.87	0.0000	0.0015	0.0018
Total Livestock Unit	2.8843***	2.99	0.0101	2.3869	2.7609
Credit access	3.4170	0.72	0.0127	2.7981	3.2590
Intercept	-41.4680***	-2.14			
Log likelihood	-875.27				
LR $\chi^2(14)$	208.95***				
Pseudo R^2	0.1066				

***, ** and * Significance level at 1%, 5% and 10% respectively
[a] Marginal effects on the probability of being censored
[b] Marginal effects on the truncated expected value (Willing only)
[c] Marginal effects on the censored expected value (All observation)

Table 3. Economic Value of Soil Conservation Practices

Total Households (Y)	Expected Households to have a protest zero (X)[1]	Expected Households' with Valid Responses (Z)[2]	Mean WTP[3]	Aggregate Benefit (Labor)[4]	Aggregate Benefit (in Money)[5]
24,692	445	24,247	48.94	1,186,648	14,239,778

1. 4(1.8%) of our 222 sampled households were protest zeros. We excluded those protest zeros from further analysis after we have tested for sample selection bias. So X is the expected number of households which are expected to protest for the proposed project. It is calculated by multiplying the percentage of sampled protest zeros (1.8%) with the total population 24,692 (Y).
2. Is Y-X which is the total households in the study area which are expected to have a valid response
3. The mean willingness to pay calculated from the maximum amount of labor that a household could pay for soil conservation
4. Is mean multiplied by the number of total households which are expected to have valid response (Z*Mean WTP) measured in labor
5. Is the total aggregate benefit in monetary equivalent in Ethiopian local Currency (Birr), which is calculated by multiplying the total labor of the households with the minimum wage rate in the study area (12 birr) at the time of data collection.

The parameter estimate of the age of the household head variable was negatively and significantly related with maximum willingness to pay ($p<0.01$), as expected, indicating that young household heads are more willing to pay than old household heads. This is possibly because young households have long term planning horizon than old household heads.

The marginal effects results presented in Table 2 shows that when age of the household head increases by one year; it decreases the probability of a household's willingness to pay by 0.16%. Similarly, as the age of the household head increases by one unit, the amount of labor days that he/she could pay for soil conservation practices decreases by 0.445 among the total population, and 0.38 among the willing, ceteris paribus. The number of years that the household head spent in school (Education) was found to have a positive effect on willingness to pay for soil conservation practices ($p<0.1$). This might be due to the fact that educated household heads perceive and are willing to pay more than less educated households. This clearly calls the importance of human capital development for implementation of soil conservation practices. The marginal effect results of our Tobit regression model (Table 2), indicate that, when education level of the household head increases by one unit, it increases the probability of willingness to pay for soil conservation practices by 0.49% ($p<0.1$). Furthermore, an additional increase in education level of a household head may increase willingness to pay for soil conservation practices by 1.33 person days for soil conservation practices among the whole population and 1.15 among the willing only.

The other variable that had a negative and significant effect for willingness to pay was distance of farm household to the nearest market ($p<0.05$). No wonder the sign is found to be negative because distance of home from market takes some labor endowment of the household that might undermine willingness to pay for soil conservation practices. The marginal effect of our Tobit model estimates reveals that a one minute walk increase in distance of home from the nearest market decreases the probability of willingness to pay by 0.027%. On the other hand, a one minute walk increase in distance of home to the nearest market results in a decrease of 0.065 and 0.075 labor days among the willing and the total population, respectively. The estimated coefficient of the total family size, which is one of the most crucial explanatory variables of probability of WTP, was found to be statistically significant with the expected positive sign ($p<0.01$). This indicates that the probability of WTP to support the proposed soil conservation practices increases as the total household size increases under the hypothetical market scenario. Keeping the influence of other factors constant, an increase in household size by one member increases the probability of willingness to pay by 2.05%. This could be explained by the fact that, soil conservation practices are labor intensive; hence, households with large labor supply are willing to invest more in soil conservation practices. Furthermore, as the family size of the household increases by one person, the amount of labor days that a household is willing to pay increases by 5.59 and 4.84 among the entire population and the willing only, respectively.

Consistent with the earlier expectation and economic priori, the initial bid offered (BID1) has a negative and significant effect on the WTP for soil conservation practices ($p<0.01$). The marginal effect indicates that a one person day increase for the contribution of the proposed project reduces the probability of willingness to pay by nearly 0.1%. The security of land at least until lifetime (land tenure) was positively and significantly related to the households' willingness to pay for the proposed conservation practices. This variable was expected and significant at less than 1% probability level. Holding other variables at their respective means, a perception of land security at least until life time increases the probability of household's WTP to support conservation practices by approximately 8.5%. This result implies that it is not only the capability of farmers but also their perception of land security that influences the decision to participate in soil conservation practices. Similarly, security of land at least until lifetime would increase, willingness to pay of households by 23.22 and 20.07 labor days per year among the whole population and those who are willing, respectively, ceteris paribus. Frequency of extension contacts was another variable that comes out to be significant ($p<0.1$). Since the parameter estimate is positive, it implies that more frequency of extension contacts increases willingness to pay.

Total farm income have a positive and significant effect for *WTP* ($p<0.01$). Specifically, when farm income of a household increases by one birr, households' willingness to pay for soil conservation increases on average by 0.0018 labor days for the whole sample and 0.0015 for willing respondents, ceteris paribus. Total Livestock Unit (TLU) has been found to relate to the probability of willingness to pay for soil conservation practices positively and significantly ($p<0.01$). TLU could be a proxy for wealth under Ethiopian farming system. As the wealth of a household increases, the willingness to pay will also increase. The marginal effect shows that for each additional increment of TLU, the probability of the willingness of the household to pay for the conservation practices will increase by 1.01%, keeping the other explanatory variables at their mean. This is consistent with the fact that TLU is one of the wealth indicators and should have a positive contribution to willingness to pay. Furthermore, a one unit increase in total livestock holdings, increases willingness to pay by 2.76 and 2.38 labor days for the entire population and for those who are willing, respectively, ceteris paribus.

4.3. Mean WTP and Estimation of Consumer Surplus of Soil Conservation Practices

An important issue related to the measurement of welfare using WTP is aggregation of benefit[11]. According to Mitchell and Carson[17], there are four important issues to be considered regarding sample design and execution in order to have a valid aggregation of benefits: population choice biases, sampling frame bias, sample none response bias and sample selection bias. Random sampling method was used in this study using a list of households. A face to face interview method is used and Protest zero responses were excluded from the analysis and possibility of protest zeros was accounted in the estimation of the aggregate benefit. Hence, none of the above biases were expected in our analysis.

Mean was used as a measure of aggregate value of soil conservation in this study. The mean is perhaps better than the median since the good dealt with is not a pure public good[11] as there are purely private benefits from soil conservation measures. The mean willingness to pay for soil conservation practices was 48.94 labor days per household per year. As it is indicated in Table 3, the aggregate WTP was calculated by multiplying the mean WTP by the total number of households who are expected to have a valid response in the study area. Following this, in this study the aggregate WTP for soil conservation practices was computed at 1, 373,592 person days per year which is equivalent to 16,483,104 Birr.

5. Conclusions

The paper has estimated the mean willingness to pay for soil conservation practices and assessed the determinants of willingness to pay among the rural household's in the Adwa Woreda in Ethiopia. The value elicitation method used is a double bounded dichotomous choice with an open ended follow-up question, which is closer to the market scenario respondents are familiar with in Ethiopia. Evidence from the study support that, age, education, farm income, perception of soil erosion, tenure security, extension contacts, total livestock units, labor shortage for farm practices, distance to the nearest market are significant factors that explain Households' WTP. The mean WTP is found to be 48.94 labor days per year with an aggregate benefit of 1,186,648 labor days per year which is equivalent to 14,239,778 Birr. Policy thrust should focus on enhancing land tenure security through land certification among others.

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[i] Is an Administrative Unit in Ethiopia which is similar to District

[ii] The criteria for selecting protest zero was based on the discussion on NOAA panel guide on Arrow et al. [12].