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HOUSEHOLDS' WILLINGNESS TO PAY FOR THE CONSERVATION OF NOUG: A CASE STUDY

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ABSTRACT

Research background: Crop genetic resource conservation and management requires farmers' financial and labour contribution. Guizotia abyssinica (locally named as 'Noug') is among the oil crops originated from Ethiopia, but currently neglected and poorly managed resource.
Purpose of the article: The purpose of this research to understand farmers' behaviour for conservation program and identify better policy, by examining factors affecting households' willingness to pay (WTP) for conservation Guizotia abyssinica, and by estimating the aggregate welfare contribution of household for the proposed conservation program in West Shewa, Ethiopia.
Methods: A contingent valuation survey, double bound with an open-ended follow-up question was directed on 160 selected rural households using multi-stage sampling method. Probit model is employed to achieve the purpose of this study.
Findings & Value added: The probit model result showed that factors, such as the amount of credit received, perception of conservation problem, education, frequency of extension contact, proportion of land allocated to Guizotia abyssinica, income from Guizotia abyssinica and income from farm activity have a positive and statistically significant effect on households' WTP. On the other hand, total livestock holding, age of households, and initial bid have a negative and significant effect WTP. The aggregate welfare contribution household was estimated to be 1,718,059 man-days and 23,260,839 Ethiopian Birr per year. Improving farmer's extension contact, training farmers, education and solving financial constraints can increase the farmers Guizotia abyssinica conservation in the study area.

Key words: willingness to pay; contingent valuation method; Probit; Ethiopia
JEL Codes: Q6; Q8; Q19

INTRODUCTION

Ethiopia has been recognised as one of the worldwide diversity hotspots for several crops and medicinal plants (**Engels *et al.*, 1991**). Among these noug (*Guizotia abyssinica*), coffee (*Coffea arabica*), safflower (*Carthamus tinctorius*), tef (*Eragrostis tef*), anchote (*Coccinia abyssinica*), enset (*Ensete ventricosum*) are originated from Ethiopia (**Husen, 2012**). *Guizotia abyssinica* is an oil crop cultivated in Ethiopia as a source of income and livelihood for 800,000 farmers (**CSA, 2019**). It is also an important edible oil crop constituting more than half of the total oilseed production of the country. *Guizotia abyssinica* shares 20% of Ethiopian export earnings next to coffee (**Bickford, 2020**). In addition, it is source of proteins, carbohydrates; vitamins and fibre that significantly contribute to the human diet and food security (**Geleta, 2013**). Conservation of crop genetics has considerable social and economic benefits for humans and animals. A crop genetic resource is very important to realize sustainable agriculture being source of food, income and medicine (**Lipper and Zilberman, 2005; Jiang *et al.*, 2014**). However, sustainable benefit from crop is directly related to conservation and management at community level. Unfortunately, farmers who can get income from Noug seed conserve it in unsustainable manner. Noug seed has been recognized as one of the crop that is not properly conserved in Ethiopia (**Tsehay *et al.*, 2020**). There is a growing recognition that sustainable crop conservation and improvement on farm and gene bank brings long-lasting benefits, but the users and decision-makers are not adequately identified. As a result, the economic contribution of Noug seed in Ethiopia is declining below the potential because it is not significantly cultivated and not properly managed. Some important crops are neglected because gene bank cannot handle all crops. However, farmers and local community take a big share in saving seed loss (**Vernooy *et al.*, 2015**). On-farm resource conservation is increasingly recognized as sustainable conservation method for crop genetic diversity (**Sthapit *et al.*, 2012; Cheng, 2020**). Crop genetic resource conservation and management requires farmers' financial or labour contribution (**FAO, 2012**). However, Noug seed loss and its value as genetic resource

for human-wellbeing is not well valued in conservation and management decisions in Ethiopia. Noug crop is underutilized and neglected in Ethiopia because it is characterized by very low yield (**Tesfaye *et al.*, 2016**). But no comprehensive effort has been applied to systematically conserve and utilize *Guizotia abyssinica*. In addition, currently there is inadequate basic scientific knowledge on *Guizotia abyssinica* conservation. The contingent valuation method (CVM) is an important economic technique for the valuation of non-market goods and services (**Mitchell and Carson, 1989**). The contingent valuation method present hypothetical market scenarios for evaluation of certain intervention or specific program (**Mould-Quevedo *et al*., 2009**). In ecological economics, CVM has been used to estimate rice diversity conservation (Pant et al.2011), wilderness and endangered species (**Bandara and Tisdell, 2005**) and conservation Sinar donkey (**Melak *et al.*, 2020**). Several studies used willingness to pay approach to assess financial and labour contribution in conservation practices. **Gebremariam (2012),** used CVM to estimate value of soil and water conservation practices. **Hundie (2016),** used CVM to measure the value improved water supply services. **Ayenew *et al.* (2019**) and **Teshome (2020**) used CVM for evaluation of improved solid waste management, while **Girma *et al.* (2020),** used it for evaluation of lake restoration. Similarly, **Endalew and Wondimagegnhu** (**2019**) used CVM to estimate economic value of church forest conservation. Studies also show that farmers are willing to contribute 84 million USD dollars for the conservation program of crop varieties (**Tyack and Scasny, 2018**). Different socioeconomic and institutional variables like size of total livestock holding, credit and extension contact affect farmers' willingness to pay for communal land (**Belay *et al.*, 2020**). Furthermore, understanding socioeconomic variables and farmers' behaviours is vital for conservation program and better policy (**Friis-Hansen and Sthapit, 2000**). There is lack of information on farmer's willingness to support conservation contribute of Noug seed. Therefore, a societal preference on the topic is need to identify by conducting study. This can provide significant input for policymakers in support of informed and evidence-based decision-making on crop conservation in developing countries like Ethiopia. Furthermore, there is no study on household willingness to conserve Noug (*Guizotia abyssinica*) in the country. Therefore, this study attempted to empirically analyse factors that affect farmers' willingness to pay for Noug conservation using contingent valuation method.

LITERATURE REVIEW

From stated preference valuation techniques contingent valuation method is a most commonly utilized for valuation of non-market asset (**Cho *et al.*, 2008**). It is a survey-based method often used for setting money related values on ecological goods and services having no market value (**Hanemann, 1994; Carson, 2000**). Due to adaptability and the capacity to estimate total economic value of resources, contingent valuation method is acquiring prevalence in the environmental economics. Economists are interested in total welfare. This measure of welfare is formally expressed in a concept called willingness to pay (WTP). Willingness to pay is defined as the highest price an individual is willing to accept or pay for some goods or services (**Breidert, 2007**). It is a survey technique that gives the interviewees with imaginary situations about a certain mediation or explicit program which is intended to be evaluated (**Mould-Quevedo *et al.*, 2009**). WTP is monetary measures taken at individual level of economic agent, particularly in a simple form for a desired increase in the good, the maximum amount the agent would be willing to pay to obtain the upgrading, and for a loss, the minimum amount the agent would be voluntarily willing to receive in payment in exchange for accepting the loss.

The approach of measuring willingness to pay using contingent valuation methods has been used in many countries for policy evaluation in areas like improved rural water service provision (**Bogale and Urgessa, 2012**); valuing natural forest resource (**Chen and Jim, 2010; Bogale, 2011; Bakaki and Bernauer, 2016**); improved soil conservation practices, conservation on communal lands (**Gebremariam, 2012; Kasaye, 2015; Belay *et al.*, 2020**); water ecosystem services toward forest conservation (**Abdulkarim *et al.*, 2017**); valuation of environmental goods and services (**Yilma, 2019**); forest conservation for water quality protection (**Kreye *et al.*, 2014**); drinking water quality and protection (**Jordan and Elnagheeb, 1993; Lichtenberg and Zimmerman, 1999**); reduced risk of drinking water and ground water pollutants (**Shultz and Lindsay, 1990; Kim and Cho, 2002**); outdoor recreation (**Palmer, 1999; Jim and Chen, 2006; Andrews *et al.*, 2017**); economic value wetlands (**Bergstrom *et al.*, 1990**).

The four major elicitation methods in contingent valuation surveys are bidding game, payment card, and single bounded dichotomous choice and double bounded dichotomous choice. In open-ended question, the maximum willingness to pay asked respondents to value the amenity for which no amounts are given earlier. In bidding game question, individuals are iteratively asked whether they were willing to pay a certain amount or not. The amounts are raised up (or dropped down) based on whether the respondent is willing or not willing to pay the previously offered amount. It ends when the iterations have converged to a point estimate of willingness to pay.

The dichotomous choice asks simple yes or no questions like 'would you be willing to pay x amount?'. The dichotomous choice approach has become the probable method of elicitation for CVM practitioners. This method is usually preferred to enquiring an open-ended question about willingness to pay (**Watson and Ryan, 2007**). The double-bounded dichotomous choice is more efficient than single bounded dichotomous choice **(Arrow *et al.*, 1993)**, since it is helpful to address the strategic bias and improve measurable effectiveness over single-limited. **Haab and McConnell (2002**) stated that yes-yes; no-no response in the double bound dichotomous choice format improves unobservable true willingness to pay. The dichotomous format gained considerable acceptance because of its incentive compatibility and its substantial simplification of the cognitive task faced by

respondents. Double-bounded dichotomous technique is not free from critics and limitations like starting point bias which occurs when the respondent's WTP is influenced by the suggested initial value. It may arise if the product being valued is not well defined or the respondent may think the true value for the service to be around the starting point (**Boyle *et al.*, 1988**). Giving a detailed description of the good being valued and the whole purpose of the study can reduce this bias. Hypothetical bias of respondents is that they are not familiar with the scenario presented, their response cannot be taken as their real WTP. This bias can be dropped by a cautious explanation for the respondents. Entire bias happens when the respondent neglects to recognize between the parts of the good product being evaluated and the total group of the goods products into which that part falls. The dichotomous format elicitation method in contingent valuation survey has been employed. To biases was minimized by a careful designing of the survey, proper training of the interviewer, conducting a pilot survey and monitoring and supervision of the survey.

DATA AND METHODS

The study Area

This study was conducted in West Shewa Zone of Oromia national regional state, Ethiopia. It has 24 districts. Based on the census conducted in 2007 by the Central Statistical Agency of Ethiopia (CSA), this zone has a population of 2 million, of which 50% each were male. About 94% of its population is rural inhabitants. The agroecology of this zone is characterized by 40% mid altitude, 27% highland, and 33% lowland. West Shewa Zone is characterized by mixed crop-livestock farming systems. It's agoecology is suitable for production of crops like tef, *Guizotia abyssinica*, wheat, maize, barley, faba bean, and chickpea.

Sampling Techniques and sample size Determination

The multi-stage sampling procedure was employed in order to draw sample households. First, West Shewa zone, from Oromia was selected purposively due to agro ecological potential for *Guizotia abyssinica* production. Secondly, 4 districts are selected from West Shewa using sample random sampling techniques as shown (Table, 1). Thirdly, using update household list 160 households were selected using Cochran's population correction factors (1977) cited in **Bartlett *et al.*, (2001)** (Equation 1).

$$n = \frac{Z^2 * (p)(q)}{d^2} = \frac{1.96^2 * (0.12)(0.88)}{0.05^2} = 160 \qquad (1)$$

Where:

n desired sample size when population greater than 10,000;

Z standard normal deviation (1.96 for 95% confidence level);

p proportion of population to be included in sample i.e., $p = 0.12$

$q = 1 - 0.12 = 0.88$;

d margin of error (0.05)

Data Types, Sources and Method of Data Collection

Both primary and secondary data was utilized in this study. The primary data was gathered from sample household heads using structured questionnaire through face-to-face interviews in December, 2020. On the questionnaire format, socio-economic characteristics, land use, farmers' attitude and practices in seed conservation and other characteristics were considered. Questionnaire and checklist were prepared and pretested before data collection. Key informants drawn from development agents (DAs) and model farmers were interviewed for in-depth qualitative information and triangulating data from the household survey.

Table 1: Sampled distribution of households

District	Total number of households	Sampled household's
Dano	15,117	43
Bako Tibe	19,531	56
Ilu Gelan	10,689	31
Liben Jawi	10,255	30
Total	55,592	160

Source: West Shewa Agriculture office (2020)

Economic valuation method

To elicit respondents' willingness to pay in cash or contribute a labour CVM was used under a hypothetical scenario of conservation of *Guizotia abyssinica*. The scenario in CVM includes defining the baseline (status quo) and the proposed improvement(s) in a simple, meaningful and justifiable way (**Johnston *et al*. 2017**). First, the current status of *Guizotia abyssinica* genetic resource is defined. Second, a scenario for a hypothetical market was articulated. The hypothesis to the hypothetical market is 'each individual's reply to hypothetically quantified questions is equivalent with the individual response to the actual market'. Finally, the estimation practice begins by asking respondents the amount they will pay in real money or contribute labour to the scenario formulated in the hypothetical market (**Bateman and Willis, 2001; Cawley, 2008**). We formulated a hypothetical market called 'on farm *Guizotia abyssinica* conservation Program'. The hypothetical market has two scenarios: a status quo and an improvement scenario. In the status quo scenario, on farm *Guizotia abyssinica* conservation program' would work to keep on farm *Guizotia abyssinica* crop domestication, constant at current levels rather than having *Guizotia abyssinica* endangering. On the other hand, in the improvement scenario, 'on farm *Guizotia abyssinica* conservation program' would work to increase the *Guizotia abyssinica* domestication permanently and to improve its productivity.

Empirical model specification

The objective of the study is to determine the relationship between the individual characteristics and the probability of household WTP for a randomly offered initial bid values. For a given specified amount of cash payment (financial) and labour that has to be subtracted from a given households' financial and labour endowment for *Guizotia abyssinica* conservation. Farmers have the

choice either to accept the pre specified bid or not to accept for the dichotomous choice question of the CVM survey. Probit model was used for binary response (0, 1), that is whether households are willing to pay or not for the offered bid to improve conservation of *Guizotia abyssinica*. Farmers' willingness to pay decision for proposed conservation program can be modelled in a utility framework following Hahnemann (1984) as (Eq. 2).

$$U_i = U_i(M \text{ or } L,\ Z \text{ and } Q) \quad (2)$$

Where:
U_i utility of the household; M monetary/cash payment;
L total labour endowment of the household in a year;
Z socioeconomic characteristics of the household;
Q improved *Guizotia abyssinica* conservation perceived by the households.

Furthermore, let us assume that Q^* as the improve conservation to Guizotia *abyssinica* and Q as the conservation before the improved conservation practices for Guizotia *abyssinica* was undertaken. Then, according to **Subanti *et al.* (2017),**

$$U_i^1(M - bid, Z, Q^* or\ L - bid, Z, Q^*) + e_i \geq U_i^0(M - bid, Z, Q^* or\ L - bid, Z, Q^*) + e_0. \quad (3)$$

Where:
bid is the initial labour payment per year;
e_i *and* e_0 are the error terms which are with zero means and independently distributed.
Therefore, the probability that a household will decide to pay for the *Guizotia abyssinica* conservation is conditional indirect utility function for the proposed intervention is greater than the conditional indirect utility function for the status quo.
The i^{th} household will be willing to accept the initial bid when $U_i^1 \geq U_i^0$
Therefore, the choice problem can be modelled as binary response variable Y (Eq. 4)

$$Y_i = \begin{cases} 1, if\ U_i^1(M \text{ or } L - bid, Z, Q^*) + e_i \geq U_i^0 \geq \\ (M \text{ or } L - bid, Z, Q) + e_0 \\ 0, \text{otherwise} \end{cases} \quad (4)$$

Following **Hanemann (1984),** the probit model can be specified as Eq (5).

$$Y^* = \beta'\beta x_i + \epsilon_i \quad (5)$$
$$Y_i = 1 \text{ if } Y^* \geq bid1 \text{ and } Y_i = 0 \text{ if } Y^* < bid1$$

Where:
β vector of unknown parameters of the model; x is vector of explanatory variables;
Y^* unobservable households' actual WTP for *Guizotia abyssinica* conservation;
Y_i discrete response of the respondents for the WTP;
bid 1 = offered initial bids assigned arbitrarily to the i^{th} respondents;
ε unobservable random component d distributed N (0, σ).

Estimation of the Mean Willingness to Pay

The most general econometric model for the double–bounded data is: $WTP_{ij} = \mu_j + \varepsilon_{ij}$.
Where: WTP_{ij} represents the i^{th} respondent's willingness to pay, and j=1,2 represents the first and second answer. The mean for the first and second responses are represented by μ_1 and μ_2.

Following **Greene (2012),** a Probit model can be specified as Eq. 6.-Eq. 9.

$$Y_1^* = \beta_I x_i + \varepsilon_1 \text{ and } Y_2^* = \beta_2 x_{2i} + \varepsilon_2 \quad (6)$$
$$E(\varepsilon_1/x_i, x_2) = E(\varepsilon_2/x_i, x_2) = 0 \quad (7)$$
$$Var(\varepsilon_1/x_i, x_2) = Var(\varepsilon_2/x_i, x_2) = 1 \quad (8)$$
$$cov(\varepsilon_1, \varepsilon_2/x_i, x_2) = p \quad (9)$$

Where:
Y_1^* is i^{th} respondents' unobservable true WTP at the time of the first bid?
WTP = 1 if $Y_1^* > bid1$, otherwise zero. Y_2^* is the i^{th} respondent implicit underlying point estimate at the time of the second bid is offered.

RESULTS AND DISCUSSION

Socio demographic characteristics of households

Information on socio-economic, demographic characteristics, knowledge and attitude of the farmers is pertinent to increase in value their WTP to secure biodiversity. As shown in Table 2, out of 160 households interviewed about 97% were male head and 3% were female head. The average age for household head was 41 years. The overall mean of family size of household was found to be 7.7 per household. About 27.5% of the households have no formal education. About 59.38%, 11.25% and 2% attended primary, secondary school and certificate respectively. About 92.5% of 160 households interviewed are willing to pay for *Guizotia abyssinica* conservation. In addition, about 90% were perceived *Guizotia abyssinica* conservation problem. The average livestock holding of household was cows. The mean land owned by household was 3.78 hectare and the mean of land allocated to *Guizotia abyssinica* production was 1 hectare. The mean frequency of extension contact for household was 4 times per annum. On an average household received 2,258 Ethiopian birr credit. However, there is no statistically significant difference among the households willing and not willing to pay for conservation. The average annual income from farm activity of household was 58,783 Ethiopian Birr (ETB). The average income from off-farm activity was 3,062.5 Ethiopian Birr. The mean income of households from *Guizotia abyssinica* production was 9980 Ethiopian Birr. The average distance household from farmer training centre was 4 kilometres.

Willingness to pay for Noug (Guizotia abyssinica) conservation

The economic value of an item is measured by individual willingness-to-pay for the item. Ask for the people whether they would pay anything or not before asking

amount of their contribution is the first step in economic valuation (**Hanemann and Kanninen, 1996**). Subsequently, yes or no inquiries were intended to evaluate the willingness to pay decision of the respondents regarding financial and labour contribution. The study shows that 93.125% of household respondents were able to pay either financial, labour or both for conservation of *Guizotia abyssinica*. Among the households willing to pay for conservation, about 93.4% were able to pay both in cash and in labour, while 2.68%, 3.35% able to pay in cash and in labour, respectively, for *Guizotia abyssinica* conservation program. The result from contingent valuation study showed that the willingness to pay of households ranges from 50 to 2000 Ethiopian Birr (ETB) per hectare every year towards protection exercises of *Guizotia abyssinica*. As shown in Figure 1, the number of households' willing to pay decreases as bid gets higher and higher. This was because of the law of demand, which says that quantity demand for goods and service diminishes as cost increases. Based on the result, the mean of households' willingness to pay (465 ETB) was higher than the median (400 ETB), which implies that respondents were willing to pay less than the average WTP.

In addition to the cash payment, labour was used as a payment mechanism to measure the willingness to pay for the conservation of *Guizotia abyssinica*. After completing the yes-no questions for each formulated bid, the highest contribution of man-days for conservation of *Guizotia abyssinica* was elicited utilizing open-ended questions. The result also shows that the households' ability to contribute labour was from 10 to 70 man-days per year (Figure 2). The mean (33.4 man-days) and median (30 man-days) of their willingness to contribute work indicates that households are able to contribute labour (in man-days) near the mean of willingness to pay.

Reasons for not being willing to pay

According to **Stevens *et al.* (1994),** clarifications behind zero bids should be interpreted and used in decision making. It is possible to recognize the reasons for households not contribute cash or labour for conservation program. Detecting the protest bids is important for misunderstanding of zero value for conservation program. To well understand zero bids and true zero respondents were done through asking the reason for not contribute for improved conservation program. As shown in (Table 3).

Table 2: Socio demographic characteristics of households (n=160)

Variable name	Descriptive statistics (mean and percentage)			
	Total Mean	Willing households	Unwilling households	T-value or Chi- value
Age of household head	41	40.75	39.85	1.3
Sex of household (1 for male)	0.968	0.9	0.068	7.01***
Family size of household	7.7	7.64	6.85	0.1571
Perception of conservation problem (1 for yes)	0.15	0.8	0.68	1.64*
Education of household (1 for yes)	0.725	0.6812	0.044	14.94***
Livestock holding (in TLU)	5	4.34	6.272	1.89***
Land allocated for *Guizotia abyssinica* production in ha	1.02	1.1	0.4	1.45
Total land owned in ha	3.78	3.87	3.0384	1.2
Frequency of extension visit per year	3.987	3.87	5.30	1.12
Amount of credit received in Birr	2,258	2,274	2,076	1.24
Distance from farmer training centre in km	4	3.818	3.185	3.34***
Income from farm activities in Birr	58,783	62,248	19,592	2.46***
Income from off-farm activities in Birr	3,062.5	3,319.7	153.85	1.1
Income from *Guizotia abyssinica* in Birr	9,980	10,721	1,595	2.583***

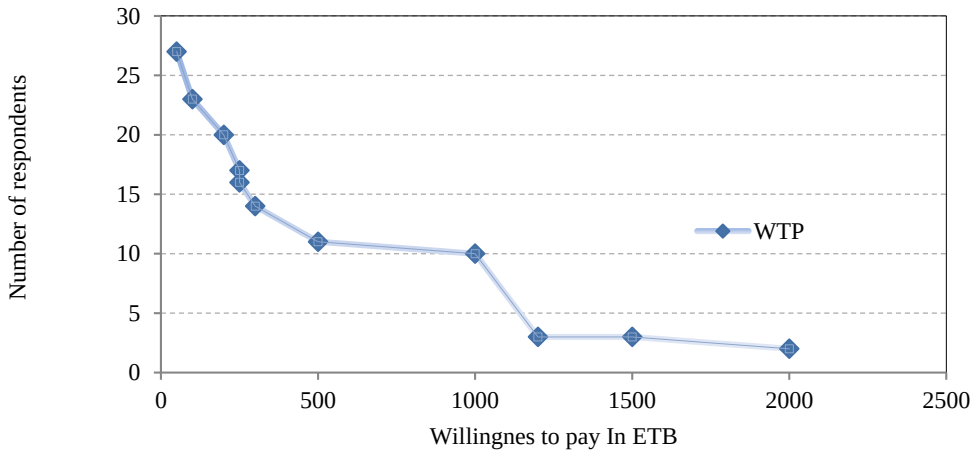

Figure 1. Household willingness to pay in cash (ETB)
Source: Own household survey result (2020)

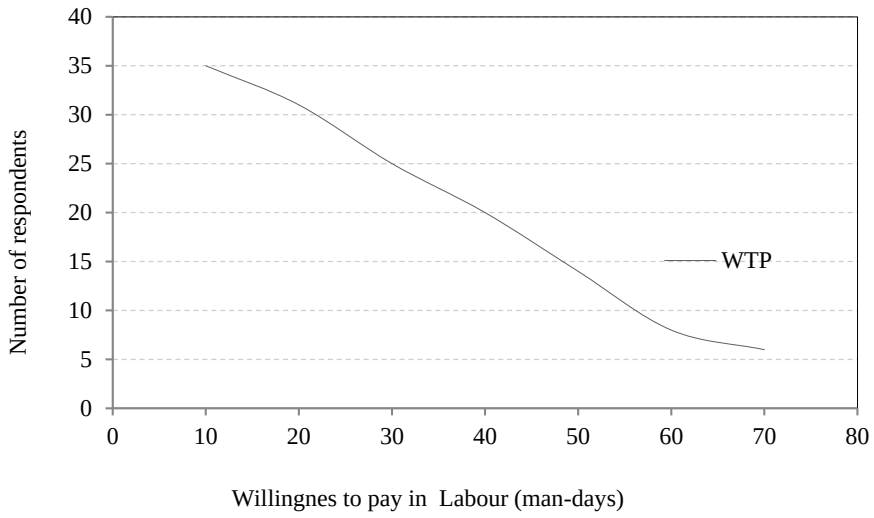

Figure 2. Household willingness to pay in labour (man-days)
Source: Own household survey result (2020)

Table 3: Reasons for being unwilling to participate in *Guizotia abyssinica* conservation

Reasons for not being willing to pay	Numbers of respondent	Frequency
Lack of labour and money	4	36.36
Lack of suitable land for *Guizotia abyssinica*	3	27.27
Lack of trust in conservation	4	36.36
Total	11	100

Source: Household survey result (2020)

These unwilling respondents are supposed to be valid (sensible) zero respondents. The grounds that they demonstrated their willingness to take an interest in the proposed conservation program. However, they couldn't bear the cost of any money for the conservation program. On the other hand, non-willing respondents expressed their justification not being willing to keep seed (27.27%) and Lack of suitable land for *Guizotia abyssinica* and lack of trust in the proposed conservation program (36.36%), respectively and they are supposed to be protest bidders.

Determinants of households' willingness to pay

To envisage determinants of households' ability to pay in cash and labour contribution for *Guizotia abyssinica* conservation fifteen independent variables were incorporated in the probit model (Table 4). The chi-square (χ^2) distribution is used to measure the overall significance of probit model estimation. The result shows that the chi-square distribution is 69.09% for cash, and 59.33% for labour (with 15 degree of freedom) at 1% level of significance. Among the variables in the model, frequency of extension contact, livestock holding, amount of credit received, income from farm activities, income from *Guizotia abyssinica* production and initial bid were statistically significant variables affecting household willingness to pay in cash. While livestock holding, amount of credit received, education of household head, perception of conservation problem sex of household head and initial bid were significantly affects household's willingness to contribute for conservation program in labour and livestock holding, amount of credit received and initial bid significantly affects household's willingness to pay labour and cash for conservation program.

The frequency of extension contacts of household had a positive and statistically significant effect on WTP. The most likely reason for the statistically significant relationship could be receiving enough access extension contact from development agent increase farmer's knowledge on seed conservation program. Studies indicated that access to agricultural extension affect farmers' private valuations of crop variety (**Asrat *et al.*, 2010**) and also farmers with more frequent extension more frequently participate on forest restoration program **(Mezgebo, 2012**). The marginal effect of variable showed that for each additional contact day with extension agents increased the likelihood of farmers WTP for conservation of *Guizotia abyssinica* by 1.4%, other factors being constant. This finding supported **(Belay *et al.*, 2020).** The household income from farm activities had a positive effect on their WTP for *Guizotia abyssinica* conservation. This result may be the household who gain more income from farm sources more management of seed and voluntary pay to conserve the crop. The study showed that amount of money that farmer earned positively affected their choice of any activity **(Asrat *et al.*, 2010).** When farmers are able to obtain high return from farming, they are not look for a supplementary source of income to satisfy at least the basic needs of their family and they will have allocated more time and money for conservation. The marginal effect of the variable indicated for one thousand increases in household farm income there is 33% increase their WTP for *Guizotia abyssinica* conservation, keeping other factors constant. The finding of **Ayalneh, (2012)** and **Mezgebo (2015)** show that household farm income

positively affects willingness to pay for improving of urban and rural water service provision. Income from *Guizotia abyssinica* production had also a positive effect on the household's willingness to pay cash for its conservation program. The more the farmers received profitable income from *Guizotia abyssinica* production; the more they allocate lands and more efforts for its conservation. For one thousand increases in income from *Guizotia abyssinica* production would increase the WTP for *Guizotia abyssinica* conservation by 1.3%, holding other factors constant. Similar findings indicated that income received from irrigation increased households' willingness to pay for improved irrigation **(Alhassan, 2013).** On the other hand, the total Livestock holding has a negative effect on the households' willingness to conserve *Guizotia abyssinica* in both financial and labour contribution. The possession of large numbers of livestock leads to a decrease in households' willingness to pay for *Guizotia abyssinica* conservation at 1% level of significance. The probable reason is livestock. It is considered as a measure of wealth in the rural households, but grazing lands for livestock became very critical in Ethiopia. As a result, farmers with large numbers of livestock (TLU) have allocated more land, budget and labour for livestock, than *Guizotia abyssinica* conservation. For each additional increment of livestock holding (TLU), the probability of households WTP will decrease by 1.2% in cash and 5.7% in labour. Studies indicated that there is low production of *Guizotia abyssinica* production in Guder and Ameya districts of Oromia because they give more focus for livestock production, allocating more land for the production of feed resources **(Tesfaye *et al.*, 2016).**

The proportion of land allocated to *Guizotia abyssinica* production had positive and significant effect on WTP in cash at 1% level of significance. The farm households who have large land were less likely to say no for the offered bid value for conservation program than households with small land. A one hectare allocated for *Guizotia abyssinica* production would increase the WTP for *Guizotia abyssinica* conservation by 54.2%, keeping other factors at constant mean. In addition, the amount of credit received was found to have positive and significant effect on the household's WTP for *Guizotia abyssinica* conservation. As the farmers receive large amount credit they are able to buy seed, labour and rent land for production and conservation of *Guizotia abyssinica.* A one thousand increase in household credit utilization would increase households' willingness pay in cash by 16.6% and 6.4% labour contribution. Farmers' perception about the problem of *Guizotia abyssinica* conservation has positive and significant effect on households' willingness to contribute labour. The awareness of households on the problem of Guizotia *abyssinica* seed endangering and its negative impacts motivated farmers to contribute the conservation program. The result show that household willingness for conservation increases by 54% for perceived farmers than the other counterfactual. This finding supported by **Asrat (2004)** and **Gebremariam, (2012).** The probit model has revealed a negative and significant effect of the initial bid at a 1% and 1% level of significance for both the cash payment and labour contribution respectively. The result is consistent with the economic theory of the law of demand, which says that quantity demand for goods diminishing as price rise up. The marginal analysis indicated that as the initial bid price rise by one unit, the probability of a household's WTP will drop by 7.1%, ceteris paribus. The marginal effect labour indicates that a one person-days increase for the contribution of the proposed project reduces the probability of being willing to pay by nearly 1.6%. This result supported by **Walle (2015), Ayenew and Meride (2015**) and **Ayana (2017).** The education level of the household head had positive and significant relation with household WTP for *Guizotia abyssinica* conservation. For each year additional increment of household education, the probability to contribute labour for *Guizotia abyssinica* conservation will increase by 25%, ceteris paribus. Age of the household head had negative effect on the willingness to pay of households for *Guizotia abyssinica* conservation. The result shows that for 1year increase in farmer's age the WTP to conserve *Guizotia abyssinica* will decrease by 2.9%, keeping other factors at mean. Studies show that there is negative relationship between age and WTP for investment in environmental protection (**Gebremariam, 2012**).

Welfare Measure and Aggregation benefit

The population choice biases, sampling frame bias, sample none response bias and sample selection bias are the four significant issues to be considered with respect to sample design and implementation to have a valid aggregation of benefits (**Mitchell and Carson, 1989**). A protests zero response was omitted from the analysis and probability of protest zeros was accounted in the assessment of the aggregated benefit. Hence, none of the above biases were expected in the analysis as shown in (Table, 5 and 6), the total economic value in cash and man-days were calculated as the mean WTP by the total number of households in 4 districts of West Shewa. As a result, the aggregate value of *Guizotia abyssinica* conservation in the study area was 1,718, 059 man-days and 23, 260, 839.15 Ethiopian Birr (ETB) per year.

CONCLUSION AND RECOMMENDATION

Sustainable development cares for conservation of endangered crops and environmental resources to optimize welfare of present and future generations. Conservation and management of crop genetic resources require farmers' financial and labour contribution. *Guizotia abyssinica* is one of the oil crops originated from Ethiopia, which is underutilized, neglected and poorly managed. This study was conducted to estimate farmers' willingness to pay for conservation of *Guizotia abyssinica* in West Shewa zone of Ethiopia. A probit model was employed to analyse the effect of different variables on farmers' willingness to pay for *Guizotia abyssinica* conservation program.

Table 4: Factors affect households' willingness to pay for *Guizotia abyssinica* conservation

Variable Name	Willingness to pay in ETB			Willingness to pay in day man labour		
	Coefficient	Standard Error	dy/dx	Coefficient	Standard error	dy/dx
Constants	9.3***	2.739	-	7.012	2.455702	-
Age of household	-0.038	0.028	0.032	-0.069	0.023	-0.029***
Sex of households	-1.187	1.022	-0.095	0.426	1.45	0.012
Family size of household	0.197	0.125	0.016	0.141	0.871	0.609
Perception of conservation problem	1.088	0.741	0. 091	1.240	0.599	0.54**
Education of households	0.294	0.378	-0.023	-0.523	0.250	0.023**
Livestock holding	-1.478***	0.642	-0.012	-1.331	0.481	-0.0577**
Proportion of land allocated for *Guizotia abyssinica* production	0.953**	0.542	-0.790	-0.046	0.261	-0.002
Total land owned	0.150	0.293	0.001	-0.022	0.129	-0.093
Frequency of extension contact	0.169***	0.067	0.014	-0.047	0.054	-0.002
Amount of credit received	0.198***	0.092	0.166	0.140	0.076	0.064**
Distance from FTC	0.420	0.233	0.035	0.030	0.164	0.013
Income from off-farm activities	0.060	0.062	0.005	0.034	0.045	0.148
Income from farm activities	0.0392**	0.0201	0.330	0.057	0.76	0.247
Income from *Guizotia abyssinica* production	0.152**	0.832	0.013	0. 024	0.030	0.600
Initial Bid value	-0.02***	0. 01	-0.071	-0.21***	0.010	-0.016
Number of observations			160			160
LR chi2(15)			69.09			59.33
Prob > chi2			0.000			0.000
Pseudo R2			0.668			56.5
Log likelihood			-22.468			-30.62

Note: *, ** and *** represents significance level at 10%, 5% and 1% probability level, respectively.

Source: model output of household survey result (2021); STATA 15

Table 5: Welfare measures and aggregate benefits by households in ETB

Name of District	Households District	Household sampled	Household protest	% of Protest Zeros	Expected protest	Households with valid response	Mean WTP	Total WTP by district in ETB
Dano	15117	43	5	0.1163	1758	13359	465	6211935
Iln Gelan	10689	31	3	0.097	1037	9654.58	465	448937
LibenJawi	10255	30	2	0.667	684	9571.33	465	4450669
Bako Tibe	19531	56	6	0.107	2089	17438.4	465	8108856
Total	55592	160	16	0.1	5559.2	50033		23260839

Source: Own computation from household survey results (2020)

Table 6: Welfare measures and aggregate benefits by households in labour man-days

Name of district	Households in district	Household sampled	Household protest	% Protest Zeros	Expected protest	Households with valid response	Mean WTP	Total WTP by district man labour
Dano	15117	43	2	0.047	710.5	14413.89	33.4	481423
Iln Gelan	10689	31	4	0.13	1390	9310	33.4	310954
Liben Jawi	10255	30	3	0.1	1026	9230	33.4	308282
Bako Tibe	19531	56	3	0.054	1055	18485	33.4	617399
Total	55592	160	12	0.2	11118.4	51423	33.4	1718 059

Source: Own Computation from household survey results (2020)

The result showed that households' WTP for *Guizotia abyssinica* conservation was in cash, in labour, or both. Total livestock holding, amount of credit received, frequency of extension contact, proportion of land allocated for *Guizotia abyssinica* production, income from *Guizotia abyssinica* production and income from farming activities have positive and significant effect on household WTP for *Guizotia abyssinica* conservation in cash, while age of households, farmers perception on problem of *Guizotia abyssinica* conservation, households education and amount of credit received had negative and significant effect on households WTP for conservation in labour contribution. To improve the *Guizotia abyssinica* conservation, policies should aim to improve frequency of farmers' extension contact, farm household education and solve financial constraints of farmers. Providing training for farmers on land use and management, conservation practice and attitude is also recommended to increase farmer's willingness to pay for *Guizotia abyssinica* conservation.

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