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Farmers' Perception and Willingness to Pay for Bamboo Forest Ecosystem Conservation in the Case of Tongo Woreda (Mao Komo Special Woreda), Western Ethiopia

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Abstract: Non-timber forest products such as bamboo constitute an important source of livelihood for millions of people from forest fringe communities across the world. In Ethiopia Non-timber forest products are associated with socio-economic and cultural life of forest dependent communities inhabiting in wide ecological and geo-climatic conditions throughout the country. Despite all this importance to the livelihood of the communities**,** bamboo forests in Tongo Woreda (Mao Komo Special Woreda) are facing man-made and natural challenges. This study was designed to assess local farmers' perception and willingness to pay for bamboo forest ecosystem conservation. The main objectives were describing farmer's perception or level of awareness toward bamboo forest protection, to estimate the amount of money local farmers are willing to pay for the bamboo forest ecosystem conservation and to identify factors affecting the amount of money local farmers are willing to pay for the bamboo forest conservation in Tongo Woreda (Mao Komo Special Woreda), western Ethiopia. For this study primary and secondary data sources were used. The random-sampling techniques were used in selecting 122 respondents following a probability proportional to size sampling method. Besides, data was collected using household survey, focus group discussions (FGDs), and key informant interviews. The value-elicitation used was double bounded dichotomous elicitation format followed by open ended questions. The data were analyzed using descriptive statistics and bivariate probit model. From the bivariate probit model result the mean willingness to pay for the conservation and rehabilitation of bamboo forest was found 7.77 Ethiopian birr and 2.25 man-days per month per household in cash and labor, respectively. The annual mean willingness to pay of local farmers was estimated to be 93.24 birr in cash and 27 man-days in labor per household. The results indicated that local farmer's literacy status, total cultivable land owned and contact with extension agents had positive and significant effects on WTP, while age of the respondent, distance of the respondent from bamboo forest and initial bid had a negative and significant effect on willingness to pay. The study showed that the farmers in the study area have already understood that intensive mass flowering of bamboo in the area and massive depletion of forest and, they are willing to participate in the conservation of bamboo forest ecosystem to regenerate and return back to original position. The policy implications drawn from the study findings include the need for improvement to keep up the contribution of community in conservation of bamboo forests ecosystem and other environmental resources and quick rehabilitation and mass bamboo restocking policy that should be designed by the regional government in order to regenerate and conserve the bamboo resources.

Keywords: Bamboo Forest, Local Farmers, Conservation, Cash, Labor, Bivariate Probit Model

1. Introduction

1.1. Back Ground of Study

Bamboo (Bambusa species) is one of the major non-timber forest products in the tropical and sub-tropical forests that perform important ecological functions and support sustainable environmental management [6]. Ethiopia has the greatest bamboo resources in Africa representing a significant proportion of Africa's total bamboo resources. It

has above 1 million hectares of bamboo which is 67% of African bamboo resources and more than 7% of the world total areas covered by bamboo are found in Ethiopia [1]. Bamboo natural forests provide large number of non-timber forest products (NTFPs); provide tangible economic benefits to poor rural communities and conserving biodiversity [10]. Forests have not only those directly observable use values which have market price but also the non-use values and services which cannot be expressed in market price system. Some of these services forests provide to economic activity have the characteristics of public goods that cannot be handled properly by the market system of the economy. In this case, market fails to allocate appropriate price system for the non-use values of natural recourses, so there is a need to quantify the value of these goods and services provided by forests to the economy, provided that there is no direct market price system [7]. So contingency valuation is the direct valuation method involves direct estimation of forest value based on the responses of individuals to the hypothetical valuation questions and hence it does not depend on market information [13].

It has most important role in income diversification, socioeconomic development and environmental protection. The importance of bamboo forest in Ethiopia is reflected by its characteristics. More recently, the full extent of the direct and non-cash contribution of forests to livelihoods has received more attention [8]. Furthermore, bamboo forest ecosystem resources are important for soil and water conservation, watershed protection, nutrient recycling, nitrogen fixation, amenity and recreation, creation of micro-climate, wild life habitat, gene conservation and carbon sequestration. But in a very densely populated country like Ethiopia, shimal bamboo and its Culm are exposed to diverse uses, resulting in degradation [9]. Ethiopian Bamboo is represented by two species namely, Yushania alpine (highland bamboo) and Oxytenantheria abyssinica (lowland bamboo). Of the two species, western Ethiopian has 440, 000 hectares of Shimal bamboo (Oxytenanthera abyssinica) which at present-day is mainly used for subsistence uses such as housing, fencing, kitchen utensils, and agricultural implements and shoots for food (Ethiopian press agency Tuesday, 07, August. 2019). Some people earn a small income by selling bamboo poles to people in western Ethiopian for use in traditional houses, and by selling small pieces of poles as fuel wood.

However, despite its importance to the livelihood of the communities, bamboo forests in Tongo Woreda (Mao-komo special woreda) are facing man-made and natural challenges. Mass flowering which leads to mass death of bamboo in particular is the major threat to the resource in the woreda. Currently, almost all bamboo forests in the woreda have flowered and dried. This condition is a threat to its survival and consequently a threat to its biodiversity and to the livelihoods of the community that directly or indirectly depends on it.

Valuation of the goods and services provided by bamboo forests and nature areas is needed because these areas are under great pressure and are in fact disappearing. Lack of knowledge and awareness about the value of the goods and services provided by these resources will obscure the ecological and social impact of the conversion of forests into construction materials, infrastructure, industrial areas, houses or agriculture. Even when these impacts are understood, there is often a lack of financial resources for conservation of forests and nature areas.

The challenge now is to utilize natural resources in a sustainable manner in order to develop the economy, while at the same time conserving the environment to avoid the adverse impacts of pollution, soil erosion, deforestation and general degradation. To avoid this continuing environmental degradation, Ethiopia government introduced in Ethiopia PFM in the mid of 1990s, by International Non-Governmental Organizations, with the objective of promoting sustainable management and conservation of forest ecosystems and improving the livelihood of people living in or around these resources [12] to achieve PFM, clear discussion with communities, strengthening existing benefits and created related one's and providing more extension services, information and supports are required to improve farmer's participation in degraded forest rehabilitation practices [15].

1.2. Statement of Problem

Bamboo resource is rapidly diminishing mainly due to mass flowering which results in mass death of the bamboo resources Tongo Woreda (Mao Komo Special Woreda), western Ethiopia. Currently, almost all bamboo forests in the Tongo Woreda (Mao Komo Special Woreda), western Ethiopia have flowered and dried. This condition is a threat to its survival and consequently a threat to its biodiversity and to the livelihoods of the community that directly or indirectly depends on it. Due attention was not given to conserve the resource. Rather some agricultural investment activities and settlement programs are negatively affecting the bamboo forest and its biodiversity. Activities like Collecting seeds, establishing seedling sites, preparing conservation and rehabilitation strategies were done by GOs and (NGOs) to conserve and rehabilitate bamboo forests though they are late. But, the conservation and rehabilitation programs to be effective it should involve the community in each phases of the process [2]. The information generated from this study showed the economic interests of the local community in the conservation of bamboo forest. Practitioners can be informed on farmer's perception and the extent of awareness about bamboo forest in the local area and incorporate the information in future intervention activities. The findings of the study can also be used for other researchers, government, policy makers and NGOs to design conservation and rehabilitation strategies and programs.

Although there has been some previous research done on willingness to contribute labor for bamboo forest ecosystem conservation by [11], his study was limited to determinant of labor contribution for bamboo forest ecosystem conservation only. But rural house hold not contributes only labor for

bamboo forest ecosystem conservation. They also contribute cash in birr for bamboo forest ecosystem conservation. To the knowledge of the researcher's, no study has ascertained local farmers perception or level of awareness toward bamboo forest ecosystem protection and factors affecting the amount of money local farmers are willing to pay for the bamboo forest ecosystem conservation in the study area. Therefore, this study was designed to fill up existing research gap.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of the study was to assess the Farmers' Perception and Willingness to Pay for Bamboo Forest Ecosystem Conservation in the study area through contingent valuation method.

1.3.2. Specific Objectives

1) To assess farmers perception or level of awareness toward bamboo forest protection
2) To estimate the amount of money local farmers are willing to pay for the bamboo forest ecosystem conservation
3) To identify factors affecting the amount of money local farmers are willing to pay for the bamboo forest conservation

2. Research Methodology

2.1. Description of the Study Area

This survey study was conducted in Tongo woreda (Mao Komo Special Woreda) which is one of the 22 Woredas in the Benishangul Gumuz Region of Ethiopia. Based on the 2019 Census conducted by the CSA agency of Ethiopia, this district has a total population of 50,061; out of this 25,055 are men and 25,006 women. 3,392 or 6.78% of population are urban inhabitants. A total of 9,844 households were counted in this woreda, which results in an average of 5.08 persons to a household, and 9,503 housing units.

Tongo Woreda (Mao-Komo) has an agro-ecology which is 15% midland and 85% lowland and the altitude of the Tongo woreda (Mao Komo Special Woreda) ranges up to 2300 m.a.s.l. which allows varieties of crops to be cultivated. The area is categorized by a comparatively one long rainy season extending from March to October and one dry season extending from November to February. The minimum and maximum temperature of the Tongo Woreda (Mao Komo Special Woreda) ranges from 12°C to 35°C, respectively. At present, the Woreda is divided into 32 Keble's out of which 18 kebeles are occupied by settlers and 5 kebeles are occupied by native people and in the rest kebeles both the settlers and the native people live together.

2.2. Data Collection Methods

2.2.1. Sample Size and Sampling Techniques

In order to select representative sample multi-stage random sampling technique was applied to select sample from the population. In the first stage, out 32 kebeles of Tongo woreda (Mao Komo Special Woreda) 8 kebeles that are neighboring the bamboo forest were purposively selected. Selected kebeles were stratified into 2 groups on the basis of the origin of households that are whether they are from native or settler. Natives are those who are indigenous to kebeles and settlers are those who came from other region or neighbor country like sudan.4 kebeles from native and 4 kebeles from settler that are bordering the bamboo forest (Lake Forest) were stratified into 2 groups on the basis of the origin of the households. In the second stage, a total of 4 kebeles, 2 kebeles from each stratum were randomly selected. Those 4 sample kebeles are Ganshuba and Damshir from settlers, Bang Targo and Yaha Masara from natives.

2.2.2. Sample size Determination

In this study, a simplified formula provided by [14] is used to determine the required sample size at 95% confidence level, 0.5 degree of variability and 8.5 % level of Precision.

$$n=\frac{N}{1+N(e)2}$$

Where n is sample size, N is the population number (bamboo producer households), and e is level of precision.

The 4 selected kebeles has 1007 bamboo producer households. Hence, the chosen sample size is equal to:

$$n=\frac{1007}{1+1007(0.085)2}=122$$

Sample size distribution of household head of bamboo producers is (n) = 122

2.2.3. Types, Sources and Methods of Data Collection

For this study primary and secondary data sources were used. The primary data were collected by using different data collection methods including household survey, focus group discussions, and key informant interviews. The secondary data were obtained from reports of government institutions, Publications document, and different websites.

It incorporates demographic, socioeconomic and institutional variables, perception of respondents about the benefits of the forest, and forest rules and enforcement mechanisms.

Household survey-The household survey was administered on 122 randomly selected households. Both open and closed ended questions were used for the household survey. The closed-ended questions were used for scoring and quantification of responses. The use of open-ended questions would allow respondents to have control over their responses rather than agreeing or disagreeing with questions posed by the researcher. Hence it would help respondents to freely express their views and opinions on the questions.

To enable high 'response rate' from the respondents, five data collectors were hired, trained in the administration of interviewing skills, collecting and conducting relevant, valid and reliable data-collection exercise. This has helped the researcher to address as many households as possible, use

time and finance efficiently and allowed the researcher the space to record responses promptly.

Focus group discussions -The focus group discussions conducted with representatives of the community of four kebeles. They were conducted to draw opinion of those individuals who represent the community including women and male groups. It was done in order to triangulate points of view of participants. The Focus Group discussion helped to elicit qualitative data to supplement and complement both quantitative and qualitative information provided by the interview guides. The number of participants in each focus group ranged from 6 to 10 persons. For this discussion, an average of one hour session was used in each kebele. In each kebele two independent focus group discussions of elders and women groups were conducted.

Key informant interviews-A total of twelve key informant interviews were conducted to share their experiences and opinions about awareness of the people and their willingness to pay for the bamboo forest conservation in the study area. These informants were experts and leaders of different offices including Woreda agriculture and Natural Resource Offices, elders, model farmers, women and kebele authority's representatives and Agricultural Development Agents. To collect the necessary data for the study, checklists, also referring to as standardized interview were used.

2.3. Methods of Data Analysis

Descriptive statistics was used to understand socio-economic, institutional and demographic characteristics of the respondents and their willingness to pay for bamboo conservation. Chi-square test and an independent t-test were employed to compare willing and non-willing farmers in terms of different variables. The chi-square test was presented to compare some qualitative characteristics of the willing and non-willing conservation of bamboo. The bivariate probit model was engaged to analyses the data. The bivariate normal density function is attractive to statisticians in the sense that it allows the non-zero correlation, whereas the logistic distribution does not [3].

The general expression for the model is formulated following [4] two related equations as:

$$Y_1 = \alpha_1 + \beta_1 B_1 + \sum_{i=1}^{n} \beta_i x_i + \varepsilon_1 \quad (1)$$

$$Y_2 = \alpha_2 + \beta_2 B_2 + \sum_{j=2}^{m} \beta_j x_j + \varepsilon_2 \quad (2)$$

$$\text{Corr}[\varepsilon_1, \varepsilon_2] = \rho \quad (3)$$

Where: Y_1 and Y_2 are the binary responses to the WTP questions; B_1 and B_2 are the bids in the first and second bid questions; $x_i$represents explanatory variables and α's and β's are the coefficients to be estimated. The explanatory variables of model 1 can be different from the explanatory variables of model 2. But for the study the explanatory variables of both models are the same ($x_i = x_j$).

Following, [5] the econometric modelling for the formulation of double-bounded data is given as:

$$WTP_{ij} = \mu_i + \varepsilon_{ij} \quad (4)$$

Where

WTP_{ij} is the j[th] respondent's WTP and i=1, 2 represents first and second answers;

μ_1, μ_2 = mean value for first and second response;

ε_{ij} = unobservable random component.

Setting $\mu_{ij} = X_{ij}\beta_i$ allows the mean to be dependent upon the characteristics of the respondents (demographic and socio-economic variables).

To construct the likelihood function, the probability of observing each of the possible two-bid response sequences (yes-yes, yes-no, no-yes, no-no) are given as follows. The probability that the respondent j answers to the first bid and to the second bid given by [5]:

$$pr(yes, no) = pr\left(WTP_{1j} \geq t^1, WTP_{2j} < t^2\right) \quad (5)$$

$$= pr(\mu_1 + \varepsilon_{1j} \geq t^1, \mu_2 + \varepsilon_{2j} < t^2)$$

$$pr(yes, yes) = pr(WTP_{1j} > t^1, WTP_{2j} \geq t^2)$$

$$= pr(\mu_1 + \varepsilon_{1j} > t^1, \mu_2 + \varepsilon_{2j} \geq t^2)$$

$$pr(no, no) = pr(WTP_{1j} < t^1, WTP_{2j} < t^2)$$

$$= pr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} < t^2)$$

$$pr(no, yes) = pr(WTP_{1j} < t^1, WTP_{2\text{j}} \geq t^2)$$

$$= pr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} \geq t^2)$$

The j[th] contribution to Likelihood function becomes;

$$L_j\left(\frac{\mu}{t}\right) = pr\left(\mu_1 + \varepsilon_{1j} \geq t^1, \mu_2 + \varepsilon_{2j} < t^2\right)^{YN}$$

$$Xpr(\mu_1 + \varepsilon_{1j} > t^1, \mu_2 + \varepsilon_{2j} \geq t^2)^{YY}$$

$$Xpr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} < t^2)^{NN}$$

$$Xpr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} \geq t^2)^{NY}$$

Where

t^1= first bid price, t^2= second bid price

YN=1 for yes -no answer, 0 otherwise;

YY=1 for yes-yes answer, 0 otherwise

NN=1 for no-no answer, 0 otherwise;

NY=1 for no- yes answer, 0 otherwise.

This formulation is referred to as the bivariate discrete choice model. Assuming normally distributed error terms with mean 0 and respective variances σ^2_1 and σ^2_2, then WTP_{1j} and WTP_{2j} have a bivariate normal distribution with means μ_1 and μ_2, variances σ^2_1 and σ^2_2 and correlation coefficient ρ. Given the dichotomous responses to each question, the normally distributed model is represented as bivariate probit model. The j[th] contribution to the bivariate probit likelihood function is given as:

$$L(\mu/t) = \Phi_{\varepsilon 1 \varepsilon 2}(d_{1j}(t^1 - \mu_1)/\sigma_1), d_{2j}(t^2 - \mu_2)/\sigma_2), d_{1j}d_{2j}\rho) \quad (6)$$

Where

$\Phi_{\varepsilon 1 \varepsilon 2}$ = the bivariate normal cumulative distribution function with zero means

$d_{1j}= 2y_{1j} -1$, and $d_{2j} =2y_{2j} -1$

$y_{1j}= 1$ if the response to the first question is yes, and 0 otherwise

$y_{2j}=1$ if the response to the second question is yes, and 0 otherwise

ρ= correlation coefficient

σ=standard deviation of the error.

After running regression of dependent variable (yes/no indicator), on a constant and on independent variable consisting of the bid levels, the mean WTP value is determined as follows depending on the normality assumption of WTP distributions [5]:

$$MeanWTP = -\alpha/\beta \quad (7)$$

Where

Mean WTP= the mean willingness to pay for conservation of bamboo forests; α=the coefficient for the constant term, β= a coefficient for offered bids to the respondents.

3. Results and Discussion

3.1. Demographic and Socio-Economic Characteristics of the Sample Households

From the total sampled households, 74.6% were willing to give labor and 25.4 %were not willing at all. Whereas, 55 % of the respondents were willing to contribute cash and the rest 45% were not willing to contribute cash. Farmer's willingness to pay for in cash is less than their willingness to pay in kind. So that it is important to identify factors affecting amount of money local farmers' are willing to pay for the bamboo forest conservation which is one of specific objective of the study.

Table 1. *Distribution of willing and non-willing respondents.*

No.	Means of payment	Willing		Non-willing		Total	
		N	%	N	%	N	%
1	Cash in birr	67	55	55	45	122	100
2	Labor in man-days	91	74.5	31	25.4	122	100

3.1.1. Literacy Status of Households

Out of the total surveyed respondents, 58.19 have formal or informal education and they can read and write whereas the rest 41.8% were illiterate. There was a statistical significance difference between willing and non-willing households in both initial and second bids in terms of literacy as shown by the chi-square value.

3.1.2. Origin of Households

From the total surveyed respondent's 43.5 % and 56.5 % respondents were settlers and natives, respectively. Natives are those who are indigenous to a land or kebeles and settlers are those who came from other location or region or neighbour country like south sudan. The chi-square value indicates that there was a significance difference between willing and non-willing respondents between native and settler households in both bids.

Table 2. *Literacy, origin of the sample household heads.*

Item	WTP the Initial Bid					WTP the Next Bid						
	Willing		Non-willing		χ^2	Willing		Non-willing		χ^2	Total	
	N	%	N	%		N	%	N	%		N	%
Literacy status												
Literate	50	40.98	21	17.27	16.4910***	48	39.34	23	18.85	29.7591***	71	58.2
Illiterate	17	13.93	34	27.87		9	7.38	42	34.34		51	41.8
Origin of household												
Native	45	36.8	24	19.6	6.8051***	41	33.6	28	23	10.2897***	69	56.55
Settler Total	22	18	31	25.4		16	13.1	37	30.3		53	43.44

***, **,*Statistically significant at 1%, 5 %and 10%, respectively *Source:* own survey result

3.1.3. Family Size of Households

According to Table 3 Below, the average family size of the total sample respondents was about 5. The mean family size difference was significant between the willing and non-willing in the initial bid and in the second bid.

Table 3. *Family size, dependency ratio and mean age of the respondents.*

Item	WTP the Initial Bid					WTP the Next Bid						
	Willing		Non-willing		t-value	Willing		Non-willing		t-value	Total	
	N	Mean	N	Mean		N	Mean	N	Mean		N	Mean
Family size	72	5.15	50	7.28	2.8***	35	4.05	87	6.82	3.426***	122	6.024
Age	50	33.42	72	53.98	11.38***	35	36.23	87	44.1	2.8744***	122	41.84

***, ** and * significant at 1%, and 10 % level of significance. *Source:* own survey result

3.1.4. Age of Household Head

The survey result showed that the mean age of the total sampled farmers was about 41.84 years. The t-value result indicated that there was a statistically significance difference in the mean age between the willing and non-willing respondents which was 33.42and 54 years for the first bid

and 36.23 and 44.1for the second bid respectively.

3.1.5. Farm Size

The descriptive statistics result shows that the minimum and maximum cultivable land size owned was 0 ha and 20 ha, respectively. The average size of cultivatable land for the total sample farmers was about 3.22 ha. As presented in Table 4, there was significant difference between the willing and non-willing respondents in both the initial and second bid in terms of cultivable land.

3.1.6. Total Livestock Unit

According to the result from the survey, 55.38% of the total sample farmers did not own ox and 23.85 and 20.77 percent of the respondents owned a single ox and a pair of oxen respectively. Households were also asked about the major problems of livestock rearing and virtually all of the respondents replied that animal diseases like Anthrax, is the major problem which kills lots of livestock every year. The mean differences for livestock ownership were significant at 5% in both initial and second bids.

Table 4. *Resource ownership of respondents.*

Item	WTP the Initial Bid		t-value	WTP the Next Bid		t-value	Total
	Willing	Non-willing		Willing	Non-willing		
	Mean	Mean		Mean	Mean		Mean
Total cultivated land	4.225	2.288	-2.8066	5.45	2.62	-3.8859	3.43
Total livestock unit	6.92	7.03	0.4861	7.188	6.8705	-1.2732	6.97

3.1.7. Income from Agriculture

The mean gross annual income from agricultural activities for the willing respondents was Birr 4832.8 and 5320Birr for the initial and for the second bids, respectively. The corresponding figures for the non-willing respondents were birr 4115and 3775for initial and second bids in that order. The mean difference of gross income from agriculture between willing and non-willing respondents was statistically significant for follow up bid.

3.1.8. Income from Sale of Bamboo

The survey result indicated that about 57 % of the respondents got cash income from the sale of bamboo and its products. The maximum amount of income gained by a typical household from bamboo in 2019 was about 16940 birr, the mean being about 4380 birr. The mean difference of income from bamboo was significant among willing and non-willing respondents of the second bid and also significant first bid.

Table 5. *Households' income portfolio.*

Source of income	WTP the Initial Bid		t-value	WTP the Next Bid		t-value
	Willing	Non-willing		Willing	Non-willing	
	Mean	Mean		Mean	Mean	
Inc.Agri	4832.8	4115	-1.55***	5320	3775	-3.486
Inc.bamboo	6033.3	2344.86	-2.1164*	6939.69	1660.33	-3.17***

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

3.1.9. Contact with Extension Agents

As showed in Table 6 below, from total farmers surveyed, 55% had contact with extension agents in the production year of 2019. The rest 45% of the respondents had no contact with extension agents. The chi-square value indicated that there was statistically significant difference between the willing and non-willing respondents in terms of extension contact in the both bids.

3.1.10. Training

The survey result also showed that among the total respondents 60% have got training related to the conservation of bamboo forests. The rest 40% of respondents did not got training. There was significant difference between the willing and non-willing respondents in both bids in terms of training on bamboo conservation.

Table 6. *Institutional factors.*

Item	WTP the Initial Bid					WTP the Next Bid					Total	
	Willing		Non-willing		χ^2	Willing		Non-willing		χ^2		
	N	%	N	%		N	%	N	%		N	%
Extension Contact												
Yes	54	44.2	13	10.6	39.5*	48	39.3	19	15.5	37***	67	55
No	13	10.5	42	34.4		9	7.38	46	37.7		55	45
Training												
Yes	53	43.4	20	16	22.***	47	38.2	26	21	22.77***	73	60
No	14	11.8	35	26		10	8.20	39	31.9		49	40

***, ** and * significant at 1%, 5% and 10 % level of significance *Source:* own survey result

3.2. Farmers' Perception or Awareness Level Towards Bamboo Forest Conservation

Farmers 'perceptions for the protection of bamboo are summarized in Table 7. About 50.82 % of households expressed that bamboo forest system is important to their livelihoods; about 23.77 % of households said it is very important while 14.75 % and 10.66% of the households said that bamboo forest is less important and not important at all to their livelihoods, respectively. These households were asked to express their interest in the bamboo forest by saying at what level they perceived the current status of bamboo forest is worth discussion. About 9.84% of households reported that bamboo forest is a critical (very) serious issue worth discussion while 20.49% and 51.64 % said the current status of bamboo is a serious and very serious worth discussion respectively. In addition, 10.66 % and 7.37 % of households notice that the current status of bamboo is less serious and not important worth discussion respectively. The explanation to these last percentages can be found in the fact that they either life far from the bamboo hence do not have a lot of information on it or they do not directly benefit from it and so they do not give much interest to the bamboo forest. The protection of bamboo forest is required by a specific forest Law. Households were asked if they knew the existence of government regulation on bamboo forest use and access and what they knew about it. Knowing these forest regulations is key to explaining their role in protecting the forest, which could be a reason to why a household would be willing to pay for protecting the forest or not. Most of the households (68.85) said that they knew the forest Law N° 72/2018 while said that they knew the government regulation on bamboo forest use and for the protection of forest. The general aspects of the forest law and measures of protection of environment and forest in general which were known by households include: the protection of wild animals in the bamboo forest like giantpanda, T a tiny bat, mountain gorilla lemurs of Madagascar, rodent and spectacled bears all need species of bamboo to survive. These are summarized in Table 7. The households' knowledge about who is accountable for the conservation of bamboo forest is among factors that can explain their awareness to its protection. About 40.16% of households known that the duty of protecting forest is for all of the stakeholders while 28.69 % of households put this duty to the whole community. In addition, 23.77 % of them consider that it is the government's duty and only 7.38% of respondents provide that accountability to private interest groups.

Table 7. *Household's attitude towards conservation of bamboo forest.*

Attitudes	frequency%
Importance of bamboo forest ecosystem to the respondent	
Very important	23.77
Important	50.82
Less important	14.75
Not important at all	10.66
Perception of current status of bamboo forest as worth discussion	
Critical	9.84
Very serious	20.49
Serious	51.64
Less serious	10.66
Not important	7.38
Knowledge of the forest law 1995	
Heard	31.15
Not heard	68.85
Knowledge of government measures for the protection of forest	
No	34.43
Yes	65.57
Knowledge on the general responsibility in conserving and of forest	
Government	23.77
Community	28.69
Collaboration among all stakeholders	40.16
Others	7.38
Knowledge about own responsibilities in conserving of forest	
No role	10.66
Follow government measures, encourage others and report illegal	72.95
Resources contribution toward implementation of necessary activities	16.39
Overall satisfaction with the actual bamboo forest management	
Satisfied	59.84
Unsatisfied	40.16

3.3. Farmers' Willingness to Pay Towards Bamboo Forest Conservation

3.3.1. Contingency Valuation Survey

From the survey result, 45% of the households were not willing to pay for the conservation of bamboo forests in cash. The reason for all non-willing respondents was they have not enough money for the scenario. From total respondents, 25.4% were not willing to contribute labor. Shortage of labor in the household and disability were reasons for their non-willingness.

4 sets of bid prices which were identified from the pilot

survey were used for this study. These are (2, 4, 1), (4, 8, 2), (6, 12, 3) and (8, 16, 4) birr in cash; and (1, 2, 0.5), (2, 4, 1), (3, 6, 1.5) and (4, 8, 2) man-days per month which were distributed to the survey questionnaires stated as starting point bid to focal group discussion.

Out of total respondents, 36 percent responded "Yes" for both the first and second bid in terms of cash. When we see at the "Yes" and "No" distribution for the first and second bids diagonally the initial bids, as the initial bid gets higher the occurrence of "Yes" responses for both cash and labor bids decreases.

Table 8. *Distribution of responses to double bounded question through the bid sets for cash per month.*

Set of Bids	Households' response for DB questions across bid sets in Birr									
	Yes-Yes		Yes- No		No-Yes		No-No		Total	
	N	%	N	%	N	%	N	%	N	%
(2, 4, 1)	22	73.3	4	13.3	0	0	4	13.33	30	100
(4, 8, 2)	12	40	2	6.6	6	20	2	33.33	30	100
(6, 12, 3)	6	19.3	12	38.7	2	6.4	5	35.55	31	100
(8, 16, 4)	4	12.9	12	38.7	5	16	11	32.5	31	100

As indicated in Table 8 above, out of 30 respondents offered two Birr initial bid price, about 73.3 % accepted both the first and second bid, and 13.3 % accepted the first bid and rejected the follow up higher bid and 13.3 % of the respondents were found non-willing and rejected both the first and the second bid. From the 30 respondents of the four Birr as initial bid, about 40% accepted both first and second bid, 33.33 % rejected both bids, 6.6% accepted the first bid and rejected the follow up higher bid, and the remaining 20% rejected the initial bid and accepted the second lower bid. similarly, from 31 respondents to whom six birr was given as initial bid, about 19.3 % of them accepted both the initial and the second higher bid, 38.7 % accepted the first bid and rejected the next higher bid, 6.4 % rejected the first bid price and accepted the follow up lower bid value and 35.5 % rejected both the first and the second lower bid price. Finally out of 31 households who were given a eight Birr initial bid, 12.9% accepted both bids, 32.3 % rejected both the initial and the next lower bid value, 38.7 % accepted the first bid and rejected the second higher bid and 16% of the respondents rejected the initial bid and accepted the second lower bid price. Generally, one can notice that as the initial bid gets higher, the number of "Yes" response decreases.

Table 9. *Joint frequency of discrete response for cash.*

Joint Response	Frequency	Percentage
Yes- Yes	44	36
Yes-No	30	24.6
No-Yes	13	10.7
No-No	35	28.7

As indicated in Table 9, 36% responded "Yes-Yes" for both the first and second bids, 28.7% responded "No-No" for both bids, 24.6% responded "Yes-No" and the remaining 10.7% responded "No-Yes".

Out of total respondents, 41percent responded "yes" for both the first and second bid in man-days. Like in the cash case discussed above, as the initial bid gets higher the frequency of "Yes" response decreases and the frequency of that of "No" response increases across the different initial bids of labor in man-days. Table 10 indicated that out of the 30 respondents who are given the first set of bids (1, 2, 0.5) in man-days per month, 50 % respondents accepted both the first and the follow up higher bid and 6 % who were all non-willing rejected both the initial and the second lower bid. Whereas 20% respondent accepted the first bid and rejected the follow up higher bid price in man-days. Similarly, from 30 respondents who were given the second bid set (2, 4, 1) man-days, 33.3,46.6, 13.3and 6.6 percent respondents accepted the initial and second higher bids, accepted the initial bid and rejected the follow up higher bid, refused to accept the initial bid and willing to pay the lower second bid, and rejected both bid values in man-days, respectively. Out of 31 respondents to whom 3 man-days were given as initial bid, about 19.35% of them accepted both the initial and the second higher bid, 41.9% accepted the first bid and rejected the next higher bid, 12.9% rejected the first bid price and accepted the follow up lower bid value and 32.25 % rejected both the first and the second lower bid price. Finally, from the respondents of the four man-days initial bid, 9.6,22.5, 9.50 and 22.58 percent accepted both bids, accepted the first bid and rejected the second higher bid, rejected the first bid price and accepted the second lower bid price and rejected both the initial and the next lower bid values in man-days, respectively.

Table 10. *Response to double bounded question through the bid sets for labor in man-days per month.*

Sets of bids	Households' response for DB questions across bid sets in man-days									
	Yes-Yes		Yes- No		No-Yes		No-No		Total	
	N	%	N	%	N	%	N	%	N	%
(1, 2, 0.5)	26	86.66	2	6.6	0	0	2	6.67	30	100
(2, 4, 1)	12	40	5	16.67	3	10	10	33.33	30	100
(3, 6, 1.5)	7	22.58	3	9.67	8	13	13	41.93	31	100
(4, 8, 2)	5	16.13	12	38.7	9	5	5	16.13	31	100

The joint frequencies of discrete responses indicated that about 41% responded "Yes-Yes" for both the first and second bids in man-days, 24.6% responded "No-No", 18% responded "Yes-No" and 16.4 percent responded "No-Yes". The percentage of "Yes-Yes" to pay in cash per month per household (36%) was less than the percentage of "Yes-Yes" to contribute in labor man days per month per household (41%). This shows that the sample households are more willing to contribute labor than paying for cash.

3.3.2. Aggregate Mean WTP

Calculating the class intervals by simple statistics for maximum willingness to pay as follows

$$K = 1+3.322(\log N) \quad (8)$$

Where, K is the number of willingness to pay classes
N is the total number of respondents (N = 122)

$$K = 1+3.322(\log 122) = 8$$

We have approximately 8 class of willingness to pay interval and the width of the class is determined by the ratio of range to willingness to pay class. The aggregate willingness to pay of the sampled respondents with non-parametric approach is calculated using mean willingness to pay of total sample respondents and aggregate willingness to pay of all the total households living in 4 kebeles is approximated by multiplying the total number population and non-parametric mean willingness to pay. The total sample respondents of non-parametric mean of open-ended maximum willingness to pay can be calculated using the formula [5]:

$$\text{MWTP}=\frac{\sum(MWTPi)(ni)}{N} \quad (9)$$

Where, MWTP = Mean willingness to pay for the total respondents

MWTPi = ith Mean willingness to pay

ni = Number of respondents willingness to pay the ith amount (column-3)

N = Total number of sample respondents (N= 122).

Table 11. *Non parametric estimation of willingness to pay in cash for Bamboo conservation.*

Class boundary (1)	Average WTP/month (2)	Frequency (3)	Total number of HHS (4)	Total WTP/month (5)	Total HHS WTP at least that amount (6)
0-4.25	2.125	46	380	807.5	1007
4.25-8.5	6.375	31	256	1632	627
8.5-12.75	10.625	23	190	2018.75	371
12.75-17	14.875	11	91	1353.625	181
17-21.25	19.125	6	50	956.25	90
21.25-25.5	23.375	3	25	584.375	40
25.5-29.75	27.625	1	8	221	15
29.75-34	31.875	1	8	255	10
Sum		122	1007	7828.5	
Max =34 Min=0 Mean WTP=7.77					

The table 11 indicates that as the price for forest conservation (WTP) increases from Birr 2.125 to 31.875 the number of households willing to pay decreases definitely. The mean WTP in cash for the respondents was 7.77 birr per month per household. Source: Own design, 2019.

Table 12. *Mean willingness of farmer's contribution in labor.*

Class boundary (1)	Average WTP/month (2)	Frequency (3)	Total number of HHS (4)	Total WTP/month (5)	Total HHS WTP at least that amount (6)
0 - 1.125	0.5625	42	347	195.1875	1007
1.125 - 2.25	1.6875	30	248	418.5	660
2.25-3.375	2.8125	20	165	464.0625	412
3.375-4.5	3.9375	18	149	586.6875	247
4.5-5.625	5.0625	5	41	207.5625	98
5.625-6.75	6.1875	4	33	204.1875	57
6.75-7.875	7.3125	2	16	117	24
7.875-9	8.4375	1	8	67.5	8
Sum		122	1007	2260.6875	
Max=9 Mean WTP=2.25					

The table 12 indicates that as the amount of labor offered for bamboo conservation increases from 0.5625 to 8.4375 labors in man-days the number of the households willing to Contribute labor decreases definitely. The mean willingness of local farmer to contribute labor was estimated to be about 2.25 man-days per month per household. The annual mean WTP was estimated to be 93.24 ETB birr and 27man-days in cash and labor, respectively. Mean WCL estimated to be 27 man- days (2160 ETB) based on market wage rate (80) for daily labor in the study area during 2019. This entails that the cash equivalent of the mean willingness to pay in terms of labor contribution is higher than in terms cash contribution. So that it better to focus on investigating

factors related to the amount of money local farmers are willing to pay.

3.4. Factors Affecting Farmer's Willingness to Pay for Bamboo Forest Conservation

Before running the econometric model, the presence of outlying, multi co linearity and heteroscedasticity problems were tested. The result showed that there was no serious multicollinearity problem between the variables. Similarly, to correct the heteroscedasticity problem, the robust standard errors were used. Thus, the explanatory variables which affected willinness to conserve bamboo were discussed as follows.

Table 13. *Bivariate probit results.*

Variable	WTP Initial Bid (Birr)		WTP Second Bid (Birr)	
	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.
Bid1 amount	-.1661529	.1028366 ***		
Bid2[1] amount			-.098540	.0460901**
Age	-.0287131	.0109495*	-.005916	.0140279
Sex	-.1402852	.4500979	.5880692	.4828837
Literacy	.34927	.3632599**	.2706638	.4112103
Nearness of plot to bam. Forest	.2844153	.35377	.1802315	.5160414
Total Cultivable land	.0897956	.0622223***	.2373949	.099334*
Distance	-.466832	.18822**	.093851	.2854064
Contact with extension agent	1.127741	.548348***	1.163166	.7632713*
Income from bamboo	.0000157	9.65	.000249	.000127
Total livestock owned in TLU	.0346382	.1290019	.1826311	.1586395
Non -farm income	8.24	.0000178	9.17	.0000198
Training	.6760153	.567545	.5444926	.5062502
Family size	-.0619303	.0353653	-.009627	.0710824
Dependency ratio	-.0946074	.1253686	-.540443	.1752927
Income from agriculture	.0000139	.0000256	..000054	.0000491
Origin of household	-.5424751	.356615	-.585134	.5202952
Cons	3.189607	1.4449	-.549260	1.644848
ρ ***				
Log psedolikelihood		-50.21		

***, **, *significant at 10%, 5% and 1% levels, respectively

Note: Bid1/Bid2[1]=Bid1 is used in the first model whereas Bid2 is used in the second model

Table 14. *Marginal effects of explanatory variables.*

Variables	Marginal Effects	Std. Error
Bid1	-.0623883	.03761
Age	-.0075349	.00704
Sex	-.2607694	.18346
Literacy	.3041764	.16456
Nearness of plots to bamboo. Forest	.189665	.12981
Total cultivable land	.0934472	.03291
Distance	-.1380744	.05879
Contact with extension agent	.5952577	.07147
Income from bamboo	.0000614	.00001
Total livestock owned in TLU	.0142372	.08203
Non-farm income	5.23e-07	.00002
Training	.0706007	.16483
Family size	-.03444	.0154
Dependence Ratio	-.1553495	.07072
Income from Agriculture	.0000247	·00001
Origin of household	-.5076857	.19424
Bid2	-.0359872	.01667

Age of the household head: Age of respondents has a negative sign as expected and it was significant at 1% in the initial and is insignificant in the second bid equations. The result points out that young people are more willing to pay for the conservation and rehabilitation of bamboo forests than old people in the first equation. This might be because young household heads may have longer planning possibility and hence may be more likely to invest in conservation and rehabilitation of bamboo whereas older people may not be interested and willing to pay for the conservation and rehabilitation of bamboo forests as the investment in conservation may take time before it gives return.

Literacy status of the household head: This dummy variable determines the respondent willingness to pay positively and is significant at 5% level in the first equation. The reason behind is that literacy increases household's knowledge about the benefits of conserving and rehabilitating bamboo forests and the bio-diversity in the

forests.

Total Cultivable Land: Cultivable land owned was positively affected the willingness of respondents to pay for the conservation of bamboo forests at 10% significance level in the first equation and 1% significant level in the second equation. The reason for this result might be that household heads with a relatively large size of cultivable land may produce enough and expected to have better income.

Distance of the respondents from the bamboo forest; the result from survey states that farmer, those reside far from bamboo forest negatively and significantly related to the WTP of farmers in the first equation at 5 % level and insignificant in the second equation. This indicates that farmers who live far from the bamboo forest not use bamboo for many purposes; rather they use other trees which can substitute bamboo. Due to this they don't contribute more for bamboo forest conservation and rehabilitate the forest.

Contact with extension agents: From the model this variable had positive effect and significant at 10% and 1% level in the first equation and second equation, respectively. This is because of respondents those have contact with extension agent have knowledge on the conservation strategy and they know bamboo forest development strategy and bamboo forest law which enable them to give more for conserving forest mainly bamboo forest in the area. Marginal effect result shows that probability of being willing to pay for both bid prices of farmers who have contact with extension agent increases by 85%, ceteris paribus.

Initial Bid (Bid1): The coefficient of initial bid was negative and significant at 10% for the first question. The second bid which depends on the response of the first bid is also significant at 5% and has a negative coefficient in the second question. As the bid amount increases, the probability that the respondents accept the initial bid would be decrease.

4. Conclusion and Recommendations

This study has analyzed Farmers' perception and Willingness to Pay for Bamboo Forest Ecosystem Conservation in the Tongo Woreda (Mao Komo Special Woreda), Western Ethiopia.

The bivariate probit model revealed that the mean WTP in cash for the respondents was 7.77 Ethiopian birr per month per household. The mean willingness of local farmer to contribute labor was estimated to be about 2.25 man-days per month per household. The annual mean WTP was estimated to be 93.24 Ethiopian birr and 27man-days in cash and labor, respectively. Mean WCL estimated to be 27 man- days (2160 Ethiopian birr) based on market wage rate (80) for daily labor in the study area during 2019. This entails that the cash equivalent of the mean willingness to pay in terms of labor contribution is higher than in terms cash contribution. So that it better to focus on investigating factors related to the amount of money local farmers are willing to pay in cash. Mean WTP of households both in cash and labor could be an indicator to the importance of bamboo in the local farmers' livelihood and the significance of conservation and rehabilitation of the resource to the community in the study area.

The result of the model identified important variables which explain the households' WTP for the conservation and rehabilitation of bamboo forests. The important variables identified in this study to determine farmers' WTP for bamboo forest conservation are literacy status of household head, total cultivable land owned and contact with extension agent were all found to positively and significantly relate to the probability of WTP. Whereas, distance of the household head from bamboo forest, age of the house hold head, and initial bid offered were found to negatively and significantly influence the probability of WTP for the conservation of bamboo forest ecosystem.

The outcome of the study discovered that the local farmer have already familiarity with the existing degradation of the bamboo forests due to mass flowering and are willing to participate and contribute for the conservation and rehabilitation of the resource regardless of the various problems and their poor economic situations. This is against the general belief that poor rural communities are not willing and able to pay for the conservation and rehabilitation activities.

Based on the findings from the survey, it can be concluded that the majority of rural households are willing to participate in the conservation of bamboo forests by contribution of cash and labor. But most of the respondent preferred to contribute labor than in terms of cash for conservation and rehabilitation of bamboo forests, because they don't have enough money to pay. Local farmer knows the exiting degradation of bamboo forest and are willing to participate and contribute for the conservation and rehabilitation of the resource because they well understood the importance of bamboo for their livelihood. Thus, the participation of the community should be ensured in every decision making and formulation of policies and strategies which are related to the conservation and rehabilitation of bamboo forests. This promotes the commitment of the community for the conservation and rehabilitation programs and helps them to develop a sense of ownership which has its own contribution for the sustainability and effectiveness of the conservation and rehabilitation of the forest.

On the basis of the results of this study, the following recommendations are forwarded. The negative relationship between distances of the forest from the home has a negative impact on participation made on degraded forest conservation practices due to information asymmetry, time delay and fewer direct benefits obtained from the forest. Therefore, improvement of rural infrastructures such as road and transportation and timely providing information to improve household's participation and the level of participation in degraded forest rehabilitation activities in the study will increase the farmer' willingness's to pay. The bivariate probit model showed that age of the household head and literacy status of the household head have negative and positive influence on the households' WTP for the conservation and rehabilitation of bamboo forests,

respectively. Hence, expanding and providing adult education targeting on younger household heads is necessary to enhance their level of understanding about the resource degradation and environmental problems and sustain their willingness to participate in the conservation and rehabilitation programs. But older people should not be ignored as they may influence the program positively or negatively using their reputation in the community and they may have useful indigenous knowledge and experience for the conservation and rehabilitation process as well. Thus, it is vital to increase the awareness of the old aged households by teaching them about the use and non-use value of bamboo forests for their own consumption and for the future generation which may increase their WTP for the conservation and rehabilitation of bamboo forests. Contact with extension agents about the conservation and rehabilitation of bamboo have a positive and significant effect on the probability of a households' WTP for the conservation and rehabilitation activities. This is because agricultural extension has great responsibility in creating awareness for the farmers and transmitting agricultural and forestry strategy from the government to the people. Also agricultural extension services should be properly provided focusing on increasing awareness and teaching and providing technical support about consequences of mass flowering of bamboo and the methods of conserving and rehabilitating the resource. Delivering these services will have a vital role in enhancing the willingness of the households to participate in the conservation of the bamboo forests in particular and environmental resources in general. Additionally, farmers in the study area have positive attitude towards the regeneration of the degraded bamboo forest. Hence the regional government in collaboration with the federal government should use this opportunity to mobilize the community to combat the problem through implementing the draft strategy which was prepared by the region. On the other hand, the government should clearly demarcate the bamboo forest boundaries and monitor so as to control the encroachment for finding additional land. Moreover, the investment and settlement programs of the government should be implemented by giving a due attention to the bamboo resource as these programs are considerably damaging bamboo forests. Even though, including the interest of urban households on the forest can have significant implications for the success of the rehabilitation and conservation programs, the study excludes the urban households who derive various direct and indirect benefits from the bamboo forest ecosystem. The suggestion is, therefore, to undertake further researches that assess the willingness of urban households, its link to rural livelihood and determinants of rural households' willingness to contribute labor.

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