Journal of Forestry and Natural Resources
Vol 1(1), 2022

Research Article

Pastoralists' willingness-to-pay for rangeland improvement: A case of Yabello District, Southern Ethiopia

Deginet Berhanu [1*], Agena Anjulo[1], Kendisha Soekardjo Hintz[2]

Article Info

[1] Ethiopian Environment and Forest Research Institute, P.O.Box: 24536 (Code 1000), Addis Ababa, Ethiopia.
[2] Technische Universität Dresden, Institute of International Forestry and Forest Products, Chair of Tropical and International Forestry, Pienner Str. 7, 01037 Tharandt, Germany

*Corresponding author: berhanudeginet9@gmail.com

Citation: Berhanu D., et al. (2022). Pastoralists' willingness-to-pay for rangeland improvement: A case of Yabello District, Southern Ethiopia. *Journal of Forestry and Natural Resources, 1*(1), 29-38.

Received: 26 November 2021
Accepted: 1 February 2022
Web link: https://journals.hu.edu.et/hu-journals/index.php/jfnr/

Abstract

Rangeland degradation remains a major concern for pastoralists' livelihoods in Ethiopia. Several studies about rangeland resource management in Ethiopia hitherto focused on the biophysical aspects without considering the societal and cultural needs of the people. However, insights about pastoralists' demand for the improvement of rangeland environment using acceptable environmental valuation techniques remained a research gap. Thus, this study was aimed at estimating mean willingness to pay (WTP) for rangeland improvements in Yabello District, southern Ethiopia. A total of 172 households from two Kebeles were randomly selected. Bivariate probit model was used to estimate mean willingness to pay (MWTP) and binary logistic model was used to estimate the factors influencing pastoralists' willingness- to-pay. The estimated mean willingness-to-pay for the improvement was 11.86 man-days/month, which is equivalent to 830.2 ETB/month (17.93 USD). The aggregate WTP for the improvement was 38,426 man- days/year, which is 2,689,820 ETB/year (58,117.84 USD). Sex, age, family size, major livelihood activities, livestock holding and initial bid value have significant influence on pastoralists' willingness to pay. Hence these factors need to be considered in policy-making regarding rangeland rehabilitation projects involving pastoral communities. This study enlightens an entry point for future research in rehabilitation of degraded rangelands in Ethiopia.
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Keywords: Binary logistic, bivariate probit, contingent valuation, rangeland degradation, willingness to pay

1 Introduction

Rangelands cover a large proportion of the world and are a very important source of livestock feed as well as livelihood assets for pastoralists (Suttie and Reynolds 2003; Upton 2004). They provide the least costly feed resources to domestic and wildlife ungulates in arid and semi-arid parts of the world (Zerga Belay 2015). The values of rangelands resources range from providing primary materials for feed and food, shelter and medicines to "linking humanity to the sun and eventually to God" (Sabiiti 2004). In Africa, rangelands are the major source of feed, which support 59% of all ruminant livestock and constitute about 65% of the total land area (Friedel et al. 2000).

In Ethiopia, rangelands are located around the border line of the country. The majority of them are found below 1500m.a.s.l and estimated to cover an area of 78 million ha (Dawit Abebe 2000). The

rangelands of Ethiopia are home to many important plant species which contribute greatly to daily sustenance of local communities. These plants, which are diverse in nature, are primary source of fodder, fuel wood, resins, traditional medicines, etc., and in some cases, contribute significantly to food security in terms of wild food in marginal areas (Zerga Belay et al. 2018). Climatic condition in pastoral areas varies greatly based on the geographical and temporal setting. Several studies in Ethiopia revealed that rangelands have been degraded at an alarming rate (Asrat paulos et al. 2004; Berry and Campbell 2009). They need to be properly managed and utilized to optimize the benefits of the pastoral community and the country at large.

Borana rangeland is among the most important rangelands for the cattle production which is located in the southern part of Ethiopia (Oba et al. 2000). Borana rangeland are facing enormous natural and anthropogenic problems such as recurrent drought, floods, bush encroachment and pastoral-related conflict from resource competition.

Many development interventions were initiated to reverse the process of degradation and re-establish healthy grasslands. However, they focused more on the experimental work and biological aspects, and did not involve local communities to extend the research findings through social lens (Mohammed Musa et al. 2016; Kusse Kutoya et al. 2018). Additionally, attempts to rehabilitate degraded rangelands have failed as they placed more value on the physical and technical details of the interventions than the socioeconomic and cultural needs of the people (Mureithi et al. 2014). Hence, valuable strategies to improve the self-reliance and resiliency of the pastoral community are required.

The pastoral communities possess indigenous knowledge in managing their grazing lands acquired through extensive observation and continuous herding practice (Oba and Kotile 2001;). To stop and reverse the effects of rangeland degradation, an appropriate improvement strategy should be designed and implemented. Thus, in this study, rangeland improvement is understood as a range of activities, such as clearing invasive bushes, planting grass and permanent trees to provide shades and fodder, constructing permanent sources of water, building fundamental infrastructures (schools, health center, roads) in the area, to make suitable place to stay permanently. All these activities need direct involvement, contribution and participation of pastoral communities, so as to solve their primary problems. The contribution could be in terms of cash payment or labor contribution. As a result, understanding the willingness-to-pay (WTP) of the pastoralists and the factors influencing their WTP is a first step towards realizing rangeland rehabilitation.

The scholarly attention given to estimate the economic value of rangeland rehabilitation in the study area is, thus far, very low. Particularly, pastoralists' willingness to pay decision and determinants that affect their willingness to pay in terms of cash and labor had hitherto not been studied in Borana area. Therefore, this study was conducted with the aim of estimating mean willingness to pay and identifying the determining factors that affect the pastoralists' decision on willingness to pay for the rangeland improvement in Yabello district, using double- bounded contingent valuation method (CVM).

2 Material and Methods

2.1 Description of the study area

The study was conducted in Yabello district of Borana Zone, southern Ethiopia (Error! Reference source not found.). Borana Zone shares international boundary with Kenya to the south, regional boundary with Somali Regional State in the east and Southern Nations Nationalities and People's Region (SNNPR) in the north, northeast and Zonal boundary with Guji Zone in the northeast (Figure 1). The rangelands of Borana are located in the southern part of Ethiopian lowlands and cover a total area of 95,000 km2 (Coppock, 1994). The area extends from 30 N to 60 N latitude 360 E 420 E longitudes. The altitude ranges from 1000 m.a.s.l to 1700 m.a.s.l having peaks up to 2200m. The region is dominated by a semi-arid climate with annual mean temperatures varying from 19 to 24°C. The rainfall pattern of the study area is bimodal with the long rainy season between March and May and the short rainy season between September and November. There is variability in both the quantity and distribution of rainfall with an average annual rainfall ranging from 400 mm in the south to 600 mm in the north (Negasa Bikila et al., 2014). The Borana Plateau represents part of the remaining core area or cradle land of the southern highlands and rangelands from which the original Oromo culture expanded and conquered half of present-day Ethiopia during the 1500s (Teshome Abate, 2016). The core rangeland area contains historical Oromo shrines still worshipped by the population. The area has been reportedly shrinking since the early 1900s, largely because of induced habitat change and Somali encroachment from the east (Coppock, 1994).

The main livelihood strategy of the community is livestock production. Production units are defined as typically consisting of a male household head, one wife, two to three children

and perhaps several other live-in relatives dependent upon the livestock for which the household head assumes management responsibility. Men are largely the strategists for livestock production, while women carry out day-to-day management and retain primary responsibility for dairy-related activities. Labor allocation is profiled on a daily basis for married women in different seasons. Herding and watering animals dominate labor requirements overall. Labor budgets suggest that labor is likely to be a common constraint in dry seasons. Land use type in the Borana rangelands is largely known to be communal, but in recent decades, crop cultivation and private enclosures have been increasing (Negasa Bikila et al. 2014). In this extensive communal semi-arid rangeland of Borana, herbaceous plants are the major feed sources of grazers. Households in the area are highly dependent on livestock production as they are pastoralists and daily labor in different farming season.

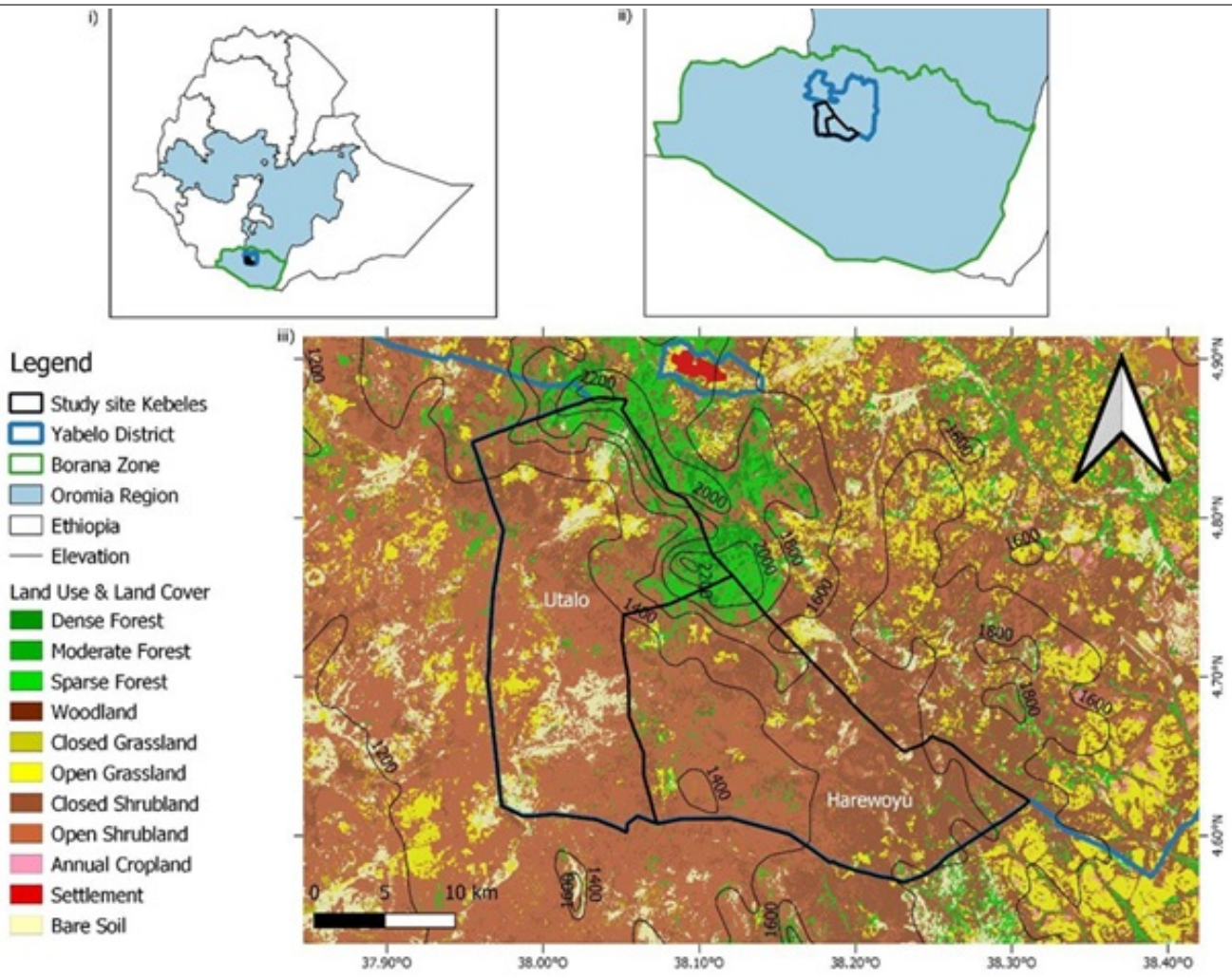

Figure 1: Location map of the study area showing i) Oromia region, ii) Borana Zone, and iii) the study site Kebeles

2.2 Sampling design and sample size

The study employed the embedded case study design, with the pastoralists as the unit of analysis (Yin 2018). We used multistage sampling technique. First, the study district was selected purposively based on people's rangeland access and use. Second, the study Kebeles (the lowest administration unit in Ethiopia), namely Harewoyu and Utalo, were randomly selected from Yabello district, which is considered as the representative of lowland areas of the Borana zone, southern Ethiopia. Due to large area coverage of Kebeles, only two Kebeles were selected from the district. Then the number of sample household respondents from each kebele were determined proportionally. Finally, each sample household was selected by simple random sampling. The number of sample respondent households was determined using the formula developed by (Yamane, 1967) cited by (Israel, 2012).

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

where n is the sample size, N is the total population, and e is the level of precision (7%). The total household count of the two kebeles is 1080 according to the Socio-demographic information of Yabello district (2019).

2.3 Data type, source and collection techniques

Both primary and secondary data were used for this study. The primary data were collected from sample respondents through household survey key informant interview (KII) and focus group discussions (FGD) using a structured questionnaire via face to face interview with the heads or working members of households. The developed questionnaire was tested before conducting the survey and was translated into the local language (Oromiffa), in order to have a clear understanding for the enumerators as well as respondents. Prior to the household survey, FGDs and KIIs were done to gather complementary data thereby enhancing the understanding of the context of the study. The FGD involved elders, women, men and youth who are native in each of the two kebeles. KIIs were conducted with Kebele officials, development agents, and elders who have a deep knowledge on environmental issues. Moreover, secondary data were collected from journals, books and pastoralist office of the Yabello

district.

Contingent valuation method (CVM) in the form of double-bounded dichotomous choice elicitation method with open ended follow up question was employed to elicit households' willingness to pay (WTP) for rangeland improvements in terms of labor contribution/day. The double-bounded dichotomous choice format (yes-no, no-yes responses) makes clear bounds on unobservable true WTP. According to Hoyos and Mariel (2010), pre-test survey with open ended questions can help to provide some information on the bounds of respondents' WTP. Besides, the yes-yes, no-no response sharpens the true WTP (Haab and McConnell, 2002). The double-bounded dichotomous choice format help to elicit more information about respondent's WTP than single bounded format.

2.3.1 Preliminary survey and bids

Before conducting the final survey, a pre-test survey was held to determine initial bids in terms of cash and labor using open-ended contingent valuation format with 24 randomly selected households for FGD. In addition to that, two Development Agents and two Chief Administrators of the two kebeles participated as key informants with other elders (long-lived residents) in the area to give supporting ideas about the payment vehicle suitable for the study regarding rangeland improvement. Indeed, the choice of the payment vehicle can be varied depending on the socio-economic characteristics of the communities where the research is being conducted. According to Ahlheim et al. (2010) money as a payment is not a good measure of valuation in developing countries, since WTP is harshly restricted by households' tight budget constraints. In this case also, the pre-test survey accepted and agreed only labor contribution as a payment vehicle for rangeland improvement in the context of the area. This is because of the genuine nature of Borana pastoralist communities who prefer to contribute for development intervention measures on an in- kind basis and labor rather than on cash. The discussion with focus groups also confirmed that the labor they are willing to contribute has high degree of respect to the rangeland improvement than willing to contribute on cash basis.

During the pre-test survey, respondents were openly asked to state their maximum willingness to pay in labor. Then, four starting bid values (frequent responses) determined in terms of labor days were 4, 8, 12 and 15 labor days per month and the group participants agreed for these initial bids (labor days) per month. In addition to this, they were reminded that the contribution of labor for the improvement will only work for one working season (winter) per year, meaning that every willing person will contribute predetermined labor days per month only for three months per year. Then, the total sampled households were divided randomly into four groups corresponding to the four initial bids (labor days) for the final survey. After the bids were designed, the respondents were asked a yes/no question to elicit their willingness to pay. If one's answer was yes for the first bid, the next higher amount (pre-determined amount) was asked to state his/her answer. Finally, the respondents were asked their maximum willingness to pay both for the bounded and unbounded values using open-ended questions to state the maximum amount they are willing to pay. If his/her answer was no, the next minimum amount followed by open-ended question was also employed to elicit his/her maximum amount. The field survey was successfully completed without protest responses/zeros' .

2.4 Methods of Data analysis

The primary data collected from the survey were analyzed using STATA software to estimate the mean willingness to pay for the improvement (MWTP) and to identify the factors influencing the likelihood of the WTP responses. The major data categories collected at the survey level included pastoralists' decisions on WTP for rangeland improvement.

The logit transformation has good properties, as it is linear in its parameters, continuous, and ranges from $-\infty$ to $+\infty$ depending on the scale of the independent variables. Maximum likelihood estimation (MLE) is used to estimate the parameters of the variables assumed to influence the payment decision.

2.4.1 Dependent and independent variables

The dependent variable to be estimated was pastoralists' willingness to pay for rangeland improvement in the study area given the explanatory variables. WTP is a powerful tool used for assessing the perception and acceptability of a social-ecological service. Many studies employed the method in various social-ecological settings in a similar manner. For instance, Köhlin (2001) used WTP for provision of social forestry in Orissa, India. Shyamsundar and Kramer, (1996) used willingness to accept format for land use restriction associated with a newly established national park in Madagascar. All respondents were asked if they were willing to pay if the rangelands were rehabilitated for purposes of providing pasture and maintaining the environment. For the respondents who are willing to pay, questionnaires with both payment vehicle, either in monetary or in labor were prepared and given. Bidding system was used to determine the minimum and maximum amounts which the respondents are willing to pay. The dependent variable, as a function of given set of explanatory variables, was as follows:

WTP =f (age, sex, marital status, family size, education level, cultivated land size, number of herds owned, satisfaction with status quo, type of housing, rangeland ownership and initial bid value). Error! Reference source not found. lists the hypothesized effect of the explanatory variables on the dependent variable.

2.4.2 Empirical model specification

Logit and probit models are popular statistical techniques in which the probability of a dichotomous outcome is related to a set of explanatory variables that are hypothesized to influence the outcome (Nupane et al. 2002). However, Pindyck and Rubinfeld (1981) acknowledged logistic probability function as computationally easier to use than the other types. Thus, logistic regression model was used

Table 1: Explanation, type, and expected sign of the independent variables

Independent variables	Explanation	Types of variable	Expected sign
sex	Sex of the respondent	Dummy variable	Positive
Age		Continuous variable	Positive/negative
Marital	Marital status of the respondent	Categorical variable	Positive
Totfam	Total family size of the respondent	Continuous variable	Positive/negative
Educat	Education of the respondent	Dummy variable	Positive
Major	Major livelihood activities of the respondent	Categorical variable	Positive
Totland	Total cultivated land size of the respondents	Continuous variable	Negative
TLU	Total livestock in tropical livestock unit	Continuous variable	Positive
Housing	Type of housing	Dummy variable	Positive
bid1	Initial bid value	Continuous variable	Negative
cons	Constant		-

for this study. The logistic regression analysis is a uni/multivariate technique which allows for estimating the probability whether an event will occur or not through the prediction of a binary dependent outcome from a set of independent variables (Bamlaku Ayenew et al.2019). The model was adopted and used by Hanemann

(1989); Branka and Kelly (2001); Yusuf et al. (2007); Adepoju and Omonona (2009). The pastoralists' responses to willingness to pay questions were regressed against the prices that they are willing to pay and other socioeconomic characteristics of the household. Thus, in this study we used two econometric models, Binary logistic and Bivariate probit model to answer the objectives of the study. The study used binary logistic model to identify the factors affecting pastoralists' decision on willingness to pay for the rangeland improvement and bivariate probit model to estimate the mean willingness to pay for the improvement. The regression logistic model is specified as:

The probability P_i is given by:

$$P_i = E(Y = 1 \mid X_i) = \frac{1}{1 + e^{\beta_0 + \beta_1 X_1}}$$

where:

- Y = pastoralists' response of willingness to pay question, which is either 1 if Yes or 0 if No,
- β_0 = constant,
- β_1 = coefficient of the bid price that the households are willing to pay for the improvement,
- X_1 = the bid price that the households are willing to pay for the improvement.

The response Y is modeled as:

$$Y = \frac{1}{1 + \exp(-Z)}$$

where:

- Y = responses of household WTP, which is either 1 for Yes and 0 for No,
- $Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$,
- $X_1, X_2, X_3, \ldots$ = explanatory variables,
- $\beta_0, \beta_1, \beta_2, \ldots$ = coefficients of explanatory variables.

The mean willingness to pay (WTP) for the improvement of degraded rangeland with no covariates was calculated using the formula adopted by Yusuf et al. (2007):

$$\text{Mean WTP} = \frac{1}{\beta} \ln(1 + \exp(\alpha))$$

where:

- α = coefficient for the constant term,
- β = coefficient for offered bids to the respondents.

Aggregation of benefit is an important issue related to the measurement of welfare using CVM or WTP (Mekonnen Alemu 2000). There are four important issues to be considered regarding sample design and estimating a valid aggregation of benefits:

- Population choice bias,
- Sampling frame bias,
- Non-response bias,
- Sample selection bias (Mitchell and Carson 1989).

None of the above biases were observed in the investigation. The study used face-to-face interviews, and there was no protest zero response, even though the expected protest zero was accounted for in the estimation of the total aggregate benefit of rangeland improvement in this study. Mean WTP was used as a measure of the aggregate value of rangeland improvement in this study.

3 Results and discussion

3.1 Sociodemographic characteristics of respondents

All of the 172 sample households had no data discrepancy. Thus all observations were included in the analysis. The summary statistics was computed for the total sample and compared with the willing and not willing respondents. The average age of the respondents was 44.9 years. The mean age of willing households was lower than the average age, so the willing pastoralists tend to be younger than non-willing households. The average family size of the willing respondents was 7.6, which was higher in comparison to the average family size of non- willing respondents which was 4.5. Respondents with large number of family size would contribute more labor for the improvement which is in line with Bamlaku Ayenew and Yirdaw Meride (2015). The average cultivated land of willing respondents was more than that of non-willing individuals. The average livestock holding of the willing and non-willing respondents were 13 and 4, respectively, meaning that those with more livestock tend to contribute more for rangeland improvement, which is in accordance with the finding of Getachew Belay et al. (2020). Error! Not a valid bookmark self-reference. summarizes the above-mentioned continuous variables.

In addition to that, the result revealed that 90% of the respondents were male-headed households of which 82% of them were willing to pay for rangeland improvement. About 19.7% of the respondents were literate households. Out of 34 literate households, 76.5% were willing to pay for the rangeland improvement. Literate households were more willing to pay for rangeland improvement, which is consistent with the finding of Bamlaku Ayenew and Yirdaw Meride (2015). Almost 93% of the willing respondents were permanent residents in the area. Around 68% were married and 72% of respondents' major livelihood activity is livestock production. Regardless of the willingness of the respondents, no respondent was found to be satisfied by the status quo level of rangeland resources in the area.

3.1.1 Households' WTP for the rangeland improvement

The mean WTP from responses of both the first and the second bids were estimated using double bounded dichotomous choice format. The result revealed that the correlation coefficient of the error term was less than one, which implies that the random component of WTP for the first question is not perfectly correlated with the random component from the follow-up question. The mean WTP from an open ended response was computed at 7.98 labor days per month, which is approximately 8 man-days per month (See Table 3). At 95% confidence interval, the average WTP from double bounded question for rangeland improvement varied between 16.06 to 7.08 man-days per month for the initial bid and second bid amount, respectively(See Table 3).The mean WTP from the double bounded dichotomous question is 11.57, which is approximately 12 man-days per month. The result shows that the mean WTP from bivariate probit model was greater than the mean WTP value from the open ended response. This indicated that respondents either try to free ride or the double bounded elicitation method has anchoring effect. This result is consistent with the various studies, such as Mekonnen Alemu (2000), Köhlin (2001), Carlsson et al. (2004), Bamlaku Ayenew and Yirdaw Meride (2015).

3.2 Estimation of the bivariate probit model

The results revealed that about 75.6% of the total sample households were willing to pay for rangeland improvement and their WTP is positive. To estimate the mean WTP from responses of both the first and the second bids offered, double bounded dichotomous choice format was used. The analysis was done using seemingly unrelated bivariate probit model (the equations are called seemingly unrelated because they are only related through the error terms). The estimation result of the model is reported in Table 4 below. The mean WTP from bivariate probit model was computed using the formula specified by Haab and Mconnell (2002).

3.3 Aggregate WTP for rangeland rehabilitation

As indicated in Table 5, the aggregate WTP was calculated by multiplying the mean WTP by the total number of households who were expected to have a valid response in the study area. Since there was no protest zero response from sampled households, there might not be expected protest zero response from the population as well. Based on the double bounded dichotomous questionnaires, the aggregate WTP for rangeland rehabilitation was computed at 38,426 labor days per year which is equivalent to 2,689,820 Birr (61435.49 USD). In terms of per household basis, it translates to 35.58 labor days per year. In contrast, based on the open ended questionnaires, the total WTP for the rangeland improvement was computed at 25,596 labor days which is equivalent to 1,791,720 Birr per year, or 23.7 labor days per year per household.

3.4 Determinants of pastoralists' willingness to pay

3.4.1 The binary logistic model estimation

The estimated result on factors affecting the households' WTP for rangeland improvement is presented in annex 1. The actual sign of most of the explanatory variables were as expected. Ten explanatory variables were included in the model to predict willingness to pay of the respondents in labor contribution. Table 6 shows the sign, magnitude, statistical tests significance level and odds ratio of each explanatory variable. Out of the total variables hypothesized to influence willingness to pay of the respondents in terms of labor, six variables were statistically significant at less than 1% (p-value ¡0.01) significance level. These variables are sex age, family size, major source of livelihood, livestock holding in tropical livestock unit and initial bid value. Marital status, land size, educational level and type of housing did not show statistical significance. The coefficients associated with sex, major livelihood activity, total family

Table 2: Definition, expected sign, and summary of the continuous variables

Variable name	Definition of variables	Measurement sign	Expected	Descriptive statistics (mean)		
			Willing n=130	Not willing n=42	Total n=172	
Age	Respondent's age	Continuous	-	44	51	44.9
Totfam	Total family size	Continuous	+	7.6	4.5	6.3
Tot land	Total cultivated land	Continuous	+	-	0.25	0.76
TLU	Livestock number in TLU	Continuous	+	13	4	12.5

Table 3: Pastoralists' WTP from Open-Ended Questions

Max WTP	Freq.	Percent
<10	72	41.86
11-14	69	40.12
15-18	31	18.02
n=172, Mean = 7.98, Std. Dev. = 6.81		

size and livestock holding are positive, while the coefficients associated with the age and initial bid value are negative.The results imply that variable sex is statistically significant and the coefficient is positive, which means that male household would be more likely willing to pay for the rangeland improvement. Female-headed households may have less resources and time, as they are fully responsible for more jobs other than keeping the cattle on the pasture in pastoralists' area. During the survey, most of the female respondents had no time to give full information about the issues included in the questionnaire. It was found that being male increases the chances of one's willingness to pay by 198% than female and is significant at less than 1% (p-value 0.002). In other words, men were 19.8 times more likely to be willing to contribute in labor for the rangeland improvements than women, which could also be attributed to the physically-intensive labor work, as reported in Getachew Belay et al. (2020). The influence of male gender on the willingness to pay can also be explained by the male- dominated society, whereby households' income and wealth are mainly controlled by men. This was also observed by Sabiiti and Tegegne (2004) during their feasibility study for the dry land husbandry project in Ethiopia. This implies that since the majority of cattle keeping are dominated by the male gender, the prospects of obtaining willingness to pay responses from male respondents to the cost sharing rangeland management are high.

Age of the household head had negative and significant effect on households' WTP in man-days contribution at less than 1% (p-value=0.000) level of significance. This may be older aged people tend to use the service provided with free of payment. On the other hand, young farmers may have a longer planning horizon and, hence, may be more likely to be willing for the improvement. Besides that, old- aged households tend to refrain from labor intensive activities. Keeping the influence of other factors constant, an increase in household head age by one year reduces the probability of willingness to pay in labor days by 90%. The negative relationship between WTP and age is consistent with the finding of Bamlaku Ayenew and Yirdaw Meride (2015); Getachew Belay et al. (2020).

The results also show that total family size was found to be statistically significant with the expected positive sign (p¡0.01). This indicates that the probability of pastoralists' WTP to support the proposed rangeland improvement increases as the total household size increases under the hypothetical market scenario. Keeping the influence of other factors constant, an increase in household size by one unit increases the odds of willingness to pay by 187% for the rangeland improvement. This could be explained by the fact that, rangeland improvement practices like bush clearing and local water storing ponds are labor intensive; hence, households with large labor power are willing to contribute more in these practices. This result is consistent with the findings of Gebremariam Gebrelibanos (2012); Bamlaku Ayenew and Yirdaw Meride (2015). Livestock holding in tropical livestock unit has been found to relate to the probability of WTP for rangeland improvement positively and significantly at 1%. As the number of livestock increases, the chance of WTP will also increase. This is because the benefit obtained from rangeland improvement increases with the number of livestock owned. The odds ratio shows that, keeping the other explanatory variables constant, for each additional increment of livestock in TLU, the probability of the households' willingness to pay for the improvement will increase by 143%. Positive sign indicates that one unit increase in TLU is associated with an increase in likelihood of WTP for rangeland improvement. This is consistent with the findings of Mezgebo Alem et al. (2013); Gebremariam Gebrelibanos (2012); Bamlaku Ayenew and Yirdaw Meride (2015).

Livestock as the major livelihood activity also determines respondents' decision on their WTP for the rangeland improvement. Rangeland resource is the base for livestock production and livestock is the major source of livelihood for pastoralists' community. As a result, major livelihood activity is expected to be significantly affecting pastoralists' decision on their WTP for rangeland improvement. Result of the survey shows that livestock production as major livelihood activities had positive and significant effect on pastoralists' WTP at p-value 0.000. Therefore, respondents whose major livelihood activity was livestock are more likely to pay for the improvement of degraded rangeland than those whose livelihood depends on crop production and safety net. The finding further revealed that the coefficient of starting bid price has negative sign and significant at less than 1% level of significance. The negative sign and the significance of this coefficient indicated that, as the starting

Table 4: Result of Bivariate probit model

Variables	Coef.	Std. Err.	z	P¿z	[95% Conf. Interval]	
bid1	-0.1270165	0.0293995	-4.32	0.000	-0.1846385	-0.0693946
cons	2.040007	0.3402047	6.00	0.000	1.373218	2.706796
bid2	-0.1422015	0.04067	-3.50	0.000	-0.2219133	-0.0624898
cons	1.00715	0.4554578	2.21	0.027	0.1144694	1.899831

Log likelihood = -176.92552, No. obs = 172
Wald chi2(1) = 0.010862, chi2(2) = 31.73, Prob ¿ chi2 = 0.000
LR test of rho = 0
Mean WTP = 11.86 (at 95% CI, 7.08 to 16.06)

Table 5: Summary of aggregate benefit

Method	Total households (Y)	Expected households to have a protest zero (X)	Expected households with valid responses (Z)	Mean WTP	Aggregate benefit (in labor days)
Double bounded questions	1080	0	1080	11.86	38,426
Open ended questions	1080	0	1080	7.9	38,426

Aggregate labor days = MWTP × 1080 × 3, where MWTP is mean WTP obtained from bivariate probit model, 1080 is total households of both study kebeles (Harewoyu & Utalo) and 3 indicates the total number of months that *pastoralists'* are willing to contribute per year.

bid value increases by one unit, the log odds of household's willingness to pay in labor reduced by 75.5%. This is consistent with the findings of Carlson et al (2004) and Mousavi and Akbari (2011). Finally, the goodness of fit, R2 =0.6258, meaning that the dependent variable (WTP) is explained by the independent variables by 62.6%, and the remaining 37.4% of the WTP variation is left unexplained. Thus, based on the results, there are a lot more factors that can contribute to pastoralists' decision on WTP. Before analyzing the data by using binary logistic model, correlation and multicollinearity tests for independent variables were done (Table 7).

4 Conclusion

In Ethiopia, where the human and animal population grows rapidly, rangeland degradation occurs at an alarming rate and the land becomes fragmented and over utilized to meet the demand for pastoral livelihoods activities. However, little attention was given to improve degraded rangeland resources so far. The present study investigated pastoralists' willingness to pay for the rangeland improvement and factors influencing their decision on WTP by using bivariate probit analysis & binary logistic model.

The results of the CVM survey showed that the households were willing to pay for the rangeland improvement. The annual mean WTP value of households for improving rangeland resource based on the double bounded dichotomous choice was computed at 35.58 labor day per year, which is equivalent to 2,490.6 ETB (53.83 USD). The annual total WTP from open ended format was also computed at 23.7 labor days per year which is equivalent to 1,659 ETB per year (35.86 USD). The aggregate benefit or aggregate WTP for rehabilitation from double bounded dichotomous was found to be 38,426 labor days per year, which is equivalent to 2,689,820 ETB (58,121.06 USD). The aggregate WTP for rehabilitation from open ended format was found to be 25,596 labor days per year, equivalent to 1,791,720 ETB (38,707.69 USD). This implies that pastoralists could play a bigger role in contributing to rangeland rehabilitation efforts if supported by relevant policies and institutional support actors.

Moreover, the study found that the value of rangeland rehabilitation from open ended format was significantly lower than double bounded elicitation format. The empirical findings of the study on the determinants of WTP indicated that such explanatory variables as sex, age, family size, major source of livelihood, total number of livestock in TLU and initial bid value have statistically significant influence on WTP decision. Therefore, continued efforts need to be done in Ethiopia to acknowledge and include pastoralists' involvement in policy-making and rangeland rehabilitation efforts.

Acknowledgements

First and foremost, we would like to extend our heart-felt thanks to the Almighty God for all things done. We are very much grateful to Ethiopian Environment and Forest Research Institute and highly appreciate the Borana pastoralists for their time and kindness in willing to share their accumulated knowledge. Special thank goes to Ms. Elisabeth Elias and Gizachew Zeleke (PhD candidate), they encouraged us in many ways to successfully accomplish this investigation. Competing interests: The authors declare that they have no competing interests.

Authors' contributions

All authors played crucial role during the study period. The corresponding author wrote the manuscript, collected, and performed statistical analysis, design to drafting the manuscript. Other authors participated in the study design and performed statistical analysis and finally, all authors read and approved the final manuscript.

Table 6: Correlation and multicollinearity tests for independent variables before analyzing binary logistic model

	sex	age	marital	educ	totfam	majorliv	totlan	TLU	housing
Sex	1.0000								
Age	-0.4234	1.0000							
Marital	0.0016	0.0564	1.0000						
Educ	0.1087	-0.1865	-0.2114	1.0000					
totfam	0.0275	0.4284	0.0350	0.0522	1.0000				
majorliv	-0.5003	0.3980	0.0189	-0.0664	-0.0948	1.0000			
totland	0.0571	-0.0015	-0.0579	-0.2020	0.0839	-0.0780	1.0000		
TLU	0.2252	-0.2904	-0.0081	0.1368	0.0745	-0.4480	0.0497	1.0000	
housing	0.0245	-0.0551	-0.0170	-0.0380	-0.0090	-0.0260	0.2225	-0.0260	1.0000

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