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Households' willingness to pay for solar cookers as a remedy to conflict induced deforestation in peri-urban districts of Tigray

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Abstract
Inadequate access to electricity—particularly in rural and peri-urban regions—has resulted in a heavy reliance on traditional biomass sources for cooking, which in turn exacerbates environmental concerns, undermining agricultural productivity and human health. Using solar cookers as alternative energy for cooking could lead to reduced reliance on traditional fuels, lower energy costs, and positive environmental impacts. However, it is unclear whether households' are willing to pay (WTP) for solar cookers. We use data collected from two peri-urban districts of Tigray. A double-bounded contingent valuation (CV) survey along with follow-up questions employed to elicit relevant data. The Probit and Ordered Probit models are applied to predict variables influencing WTP. The findings indicate that the number of family members in productive age, age of the household head, and livestock wealth positively influences acceptance of the technology. Conversely, age in quadratic term, social capital and living far from all-weather roads negatively influences WTP. Individuals with more family members in the productive age, higher livestock wealth, wage income, and higher charcoal consumption are more inclined to pay higher bids. Conversely, participation in community organizations appears to decrease likelihood of paying higher bids, suggesting potential social dynamics that inclined towards lower bid offers. Further, the demand schedule indicates that lower bidding prices lead to increased demand, aligning with economic theory. This study can assist stakeholders—such as government agencies, clean energy proponents, and investors—in making informed decisions about investing in alternative solar cooker initiatives.

1. Background of the study

As global electricity demand surges and traditional energy costs rise amidst escalating environmental issues, there is an urgent need to explore and adopt alternative renewable energy sources like solar, wind, and hydroelectric power. These energy technologies not only provide viable solutions to energy-related challenges but also play a crucial role in promoting sustainable development (Khandker et al. 2013). Solar based technologies are a more practical solution than extending national grids, which can be expensive and challenging due to geographic and infrastructural barriers in rural areas (Tucho and Nonhebel, 2014). Off-grid solar systems are adaptable, user-friendly, and effectively meet the unique energy requirements of rural communities, thereby promoting access to energy in remote locations.

Access to electricity in sub-Saharan Africa stood at 50.6% in 2021 (Conti et al. 2016), but rural areas, particularly Ethiopia, see stark disparities with only 27% of rural Ethiopians having electricity access, pushing a significant portion of the population to depend on traditional biomass sources like wood, charcoal, and animal dung for cooking (Gebremeskel et al. 2021; Mondal et al. 2018; Eshetu, 2014; Tucho et al. 2014; Tesfay et al. 2014). This reliance on biomass sources of energy not only exacerbates deforestation, biodiversity loss, and environmental degradation but also undermines agricultural productivity and human health.

The increasing annual electricity consumption in Ethiopia, projected to rise by 9%, underscores the urgency of expanding access to electricity, particularly in rural regions where the population invariably depends on biomass fuels (Temesgen et al. 2023). Despite growth in national grid expansion plans, leveraging Ethiopia's substantial potential for alternative energy sources, solar in this context, could significantly address rising energy demands. The implementation of solar cookers in areas lacking grid access presents a viable solution for meeting cooking energy needs, potentially reducing forest destruction for fuel purpose and alleviating associated health issues linked to smoke (Meried, 2021). Primarily research regarding its acceptance and demand for off-grid alternative energy solutions and particularly solar cookers is critical in the study area. The region's natural resources and particularly its forest sites have been severely degraded by the two years (2020-2022) conflict in Tigray, northern Ethiopia (Hishe et al. 2024). Thus, solar cookers may be taken as a potential solution in forest restoration and biomass fuels shortage mitigation.

Few studies for example, Entele (2020) investigated potential demands for electric service connections and biogas in Ethiopia. Mekonnen et al. (2020); Tesfay et al. (2015), and Hassen et al. (2016) evaluated thermal efficiency of various designs for prototype solar cookers. But no research investigated potential demand for solar cookers in war—torn Tigray. In Tigray there were attempts to manage forest areas owned by local communities in a sustainable way. But, the consecutive 2020-2022 war in the region led to severe forest degradation directly and indirectly by dismantling the institutions that help to manage forest resources (Hishe et al. 2024; Meaza et al. 2024). In light of this setting, though introducing solar cookers may be taken as an energy solution and a remedy to limit forest degradation, evidence lacks whether the technology is viable in the study area. This highlights a gap in the literature concerning the potential users' demand for various solar cooking technologies, suggesting a need for more comprehensive study. Thus, this research tries to address a critical gap in understanding regarding the demand for solar cookers in the peri-urban districts of Tigray, Ethiopia, where energy consumption and reliance on biomass fuels are prevalent. By investigating households' willingness to pay (WTP) for solar cookers and the factors influencing this demand, the study aims to provide insights that could promote adoption

of renewable energy technologies, enhance energy access and reduce deforestation. Through a systematic examination of WTP data, the findings could also inform policy and initiatives that support sustainable energy solutions in the region.

The willingness-to-pay (WTP) analysis for a solar stove, particularly in peri-urban areas like Tigray facing environmental degradation and having limited access to electric connections, can provide valuable insights into consumer demand for alternative renewable energy solutions. By estimating the demand based on data from peri-urban districts, stakeholders can identify market segments and assess the value that consumers place on solar cookers. Solar cookers not only have the potential to reduce reliance on forest resources but also offer economic benefits by mitigating fuel expenses for households lacking electricity. Therefore, these findings are crucial for policymakers and businesses aiming to introduce and price solar cooking technologies effectively, ultimately promoting sustainable energy practices in regions with limited access to the national grid.

2 Methods

2.1 Description of the study area

This research is done in Tsrae Wonberta and Samre districts. Samre district is in the Middle Tekeze livelihood zone in Southern eastern Tigray. The elevation in the Woreda mostly ranges between 1,500 and 2,300 meters above sea level. The total population and households of Samre district is estimated to be 126,985 and 25,200 respectively (Vaitla et al. 2012). Tsrae Wonberta district located in the Eastern Plateau livelihood zone. According to the Agriculture and Rural Development Office of the district the total population of Tsrae Wonberta district is estimated to be 112,341. These districts have been chosen purposely based on their potential access to forest areas (biomass energy source). While Tsrae Wonberta district has potentially good access, Samre district has poor access to forest areas.

2.2 Data, experimental set up and empirical strategy

2.2.1 Data

Two sub districts HaykiMeshal sub district from Tsrae Wonberta and AmdiWeyane from Samre have been chosen to collect relevant data for this study. The data were collected in December 2024. When data for the study was collected, solar cookers were not available in the marketplace in the study area. They are purely hypothetical products. As such, consumers' actual decisions to purchase and price to pay cannot be observed. To address this issue, a contingent valuation (CV) survey was developed to gather consumers' stated preferences (willingness-to-pay) values. The data for this study was collected from both primary and secondary sources. The primary data was collected from a randomly selected 252 representative households through face to face interviews. But the final estimation is made using information collected from 232 observations/households only. Sixteen observations who show no interest in the hypothetical solar cooker were excluded in the subsequent interview for WTP questions. Besides 3 observations with a protest response for the WTP questions and 1 observation with incomplete information were dropped. Additional focus group discussion and personal observation had also been made to gather supplementary information. Supplementary secondary data regarding the socio-economic and demographic characteristics of the study area has also been obtained from the respective districts.

Interviews are made to elucidate detailed information with regard to the variables under investigation from the targeted populations by field enumerators. The enumerators interviewed an adult household member in every selected household. A semi structured questionnaire was applied

to gather relevant information from sample households. The household questionnaire consisted of 5 sections. The first section dealt with basic household demography and socioeconomic information. The second section is concerning the impacts of the Tigray war on natural resources. The third section of the questionnaire is about households' participation in environmental restoration. The fourth section is about institutions that govern natural resources management. The fifth section was a series of questions on the adoption of alternative energy sources and willingness to pay for solar cookers of the respective families.

2.2.2 Experimental setup

Researchers typically apply various methods to elicit WTP from respondents. For example, Entele (2020) and Afriyie et al. (2024) employed the contingent valuation and choice experiment methods respectively. WTP represents the maximum price a consumer is willing to pay for a good or service. This section explains the experimental setup we used to elicit WTP to buy a hypothetical solar cooker. Information has been collected using contingent valuation (CV) surveys with follow-up questions. This is the double-bounded model. In a double-bounded CV survey, two questions are presented to respondents (Venkatachalam, 2004; Bateman et al. 2002). The first question is ''would you agree to pay X Birr?''. The second, or follow-up, question is similar but asks for a higher bid offer if the initial answer is yes and a lower bid offer otherwise. This bidding process yielded four possible outcomes:

(1) "Yes–Yes" where both bids were accepted, meaning the WTP was higher than the upper bid;
(2) "Yes–No" indicating initial acceptance followed by rejection, meaning the WTP was between the initial bid and the upper bid;
(3) "No–Yes" showing initial rejection followed by acceptance, meaning that the WTP was between the lower bid and the initial bid; and
(4) "No–No" where both bids were declined, meaning that the WTP was between zero and the lower bid.

The contingent valuation experiment used in this study is similar to that used in Entele (2020) and Bellemare and Novak (2017). This technique is suited for eliciting WTP for a product that has yet to be released to the market (Bateman et al. 2002; Venkatachalam, 2004).

To minimize hypothetical bias only respondents who show an interest in a solar cooker that enabled cooking of different food stuff and boiling water within one hour during a sunny day were asked in the WTP question. Prior to field-testing the questionnaire, we held a focus group discussion to determine the starting WTP bid. The initial bid was chosen based on previous studies, real market price in other countries, and data obtained from focus group discussion.

2.2.3 Empirical Strategy

Although the value households place on the proposed solar cooker is a continuous, we believe the most reliable data generated from the bidding game are the set of yes/no responses to the discrete prices asked to respondents. The observed dependent variable obtained from the bidding game procedure is not the maximum amount the household would be willing to pay but, rather, an interval within which the "true" willingness to pay falls. If the proposed price is higher than a given household's maximum willingness to pay (WTP), the household will choose not to use the hypothetical solar cooker.

Our research design attempted to test whether WTP bids are systematically related to the variables suggested by economic theory. Economic theory suggests that an individual's demand for a good is a function of extrinsic (observable) or intrinsic (unobservable) factors. Observable

factors may include the age, gender, income, education, places where the households live, price of the goods, prices of substitute and complementary goods. An individual's risk tolerance, tastes, desire to fit in with others, level of passion about a given subject are all examples of intrinsic differences that may influence willingness to pay.

Both probit and an ordered probit models have been used to analyze the results. We applied probit model to predict what variables influence households WTP of the initial Bid. An ordered probit model is appropriate to deal with the variations in WTP bids. Let w_i be the actual maximum willingness to pay of individual households for the proposed solar cooker. We would hypothesize that the households' WTP bid is a function of income, the cost of obtaining alternative energy sources, the education of household members, and the individual's perception of the quality of the existing traditional cooking technologies.

$$w_i = a + X_i\beta + e_i \quad (1)$$

Where X_i is vector of household characteristics and the attributes of the proposed solar cooker, a and β are parameters of the model, and e_i is a random error term with a standard normal distribution. Since w_i is not observable from the bidding game, equation (1) cannot be estimated. However, from the interview responses we know the ranges within which w_i will fall. Let $\gamma_1, \ldots, \gamma_m$ be the m prices which divide (bound) the range of WTP space into m categories, and let y_i be a categorical variable such that

$$y_i = \begin{cases} 1\ if & w_i < \gamma_1 \\ 2\ if & \gamma_1 \le w_i < \gamma_2 \\ 3\ \text{if} & \gamma_2 \le w_i < \gamma_m \\ 4\ if & w_i \ge \gamma_m \end{cases} \quad (2)$$

Let i = 1, …, m. From equation (2), we have $y_i = i$, that follows a particular order and holds the following inequality.

$$\gamma_{i-1} < a + X_i\beta + e_i < \gamma_i \quad (3)$$

$$\gamma_{i-1} - a < X_i\beta + e_i < \gamma_i - a \quad (4)$$

$$or\ (\gamma_{i-1} - a - X_i\beta)/\sigma < {}^{e_i}/_{\sigma} < (\gamma_i - a - X_i\beta)/\sigma \quad (5)$$

Assuming the standard deviation σ, of e_i follows a standard normal distribution (0, σ^2) then:

$$\begin{aligned} P(y_i = i) = {} & P(\gamma_{i-1} < w_i < \gamma_i) \\ & = P(u_{i-1} - X_i\beta) < e_i < (u_i - X_i\beta) \\ & = F(u_i - X_i\beta) - F(u_{i-1} - X_i\beta), \end{aligned} \quad (6)$$

Where $u_i = \gamma_i - a$ and $F(.) = \Phi(.)$is the cumulative standard normal density function of e_i, the ordered probit model in equation (6) can be specified as:

$$P(y_i = i) = \Phi(u_i - X_i\beta) - \Phi(u_{i-1} - X_i\beta)$$

As noted in Cameron and Trivedi (2009) and Verbeek (2017), while the order probit model is effective for analyzing variations in willingness to pay (WTP) bids, the binary probit helps to predict the factors influencing individuals' decision to accept solar cooker technologies. The

ordered probit regression not only identifies these factors but also measures the intensity of households' decisions, providing a more nuanced understanding of their choices regarding solar cooker technology adoption.

3 Results and discussion

3.1 Explorative analysis of descriptive results

The descriptive statistics summarized in Table 1 provides insights into the demographic and socio-economic characteristics of the respondents, revealing that approximately 67% of household heads were male, with an average age of 46 years and only 3 years of schooling, indicating low level of education. The typical farmer owned 1.72 tropical livestock units and was active in community life, as evidenced by the 54% affiliation with social organizations. Regarding charcoal consumption, these farmers consume an average of 1.38 units (69 kgs) of charcoal monthly for cooking and live in a distance that takes on average about one-third of an hour to reach the nearest all-weather roads. Financially, the mean annual cash income from non-farm wage employment was about Birr 8237, while the logarithmically transformed income from self-employment was approximately Birr 1.217 (around Birr 2,089.86).

Table 1. A summary for socio-economic characteristics of the sampled households

Variables	Description	Mean or %	SD
Gender (male=1)	Gender of the household head	67%	
Age (year)	Age of the household head in years	45.66	13.61
Education completed (years)	Household head years of schooling	3.09	3.5
Productive labor (number)	Number of household members with 18-64 years old	1.67	0.87
Livestock (TLU)	Livestock holding in TLU	1.72	1.58
Participation in community org. (Yes=1)	Whether at least one member of the household participates in community organizations	54%	
Monthly charcoal consumption (in 50 kgs)	Monthly household charcoal consumption	1.38	1.14
Dis.to all weather road (minutes)	Distance to the nearest all weather road	18.54	19.47
Nfarm wage_inc	Average annual household labor income in Birr	8237.49	14423.95
Lnself_inc (Birr)	Log. annual household self-employment income	1.217	3.17

3.2 Descriptive analysis of households' WTP for solar cookers

The survey results indicate a strong interest in solar cookers among the interviewed households, with 92% expressing interest and a remarkable 98.7% of those willing to pay between Birr 5 to 1000 with monthly instalment based payment. The frequency distribution highlights varying agreement rates to specific bid amounts, revealing that 56.71% accepted a bid of Birr 333, 29% agreed to Birr 500, and a noteworthy 75.76% consented to Birr 166 per month for one year. This suggests the availability of a significant market potential for solar cookers in the community.

Figure 1 indicates that approximately half of the respondent households showed positive interest in the initial bid of Birr 333/month irrespective of their response to the follow up higher bids, with around 25% responding "Yes-Yes" and about 32% "Yes-No." In contrast, a smaller proportion expressed their acceptance to lower bids, with about 18% responding "No-Yes" to the initial bid of Birr 333/month and follow-up offers of reduced prices. And 25% of the respondents responded "No-No" to the initial bid of Birr 333/month and follow-up lower bids.

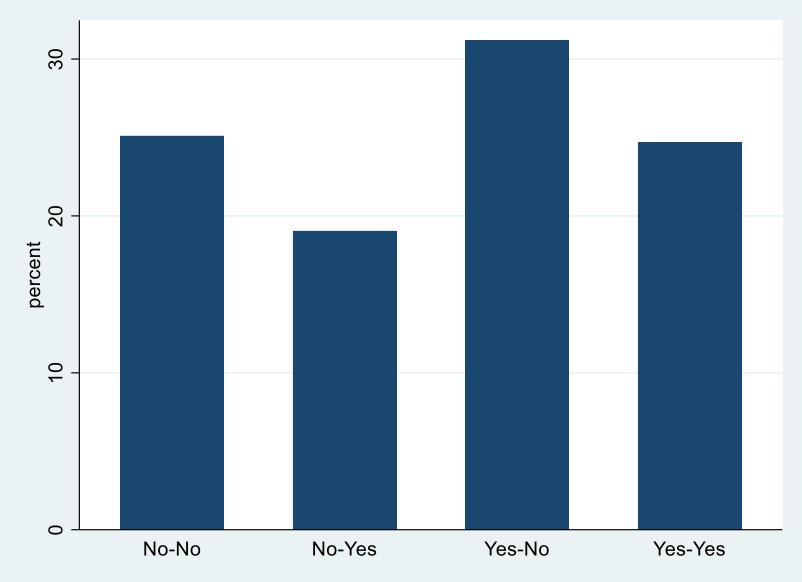


Figure 1. Percentage distribution of respondents' responses for initial and follow-up higher/ lower bids.

3.3 Determinants of farmers' willingness to pay for solar cooker

The comparison of the regression results between the binary probit and ordered probit models, as shown in Tables 2 and 3, reveals consistent general findings, yet highlights differences in their explanatory power and the significance of individual coefficients. Specifically, while both models identify similar relationships between predictors and the outcome variable, the ordered probit appears to provide a more nuanced understanding of the underlying data distribution. But it is weaker in terms of the individual coefficient estimates and overall fitness.

The results from the probit model indicate a strong statistical significance in predicting the likelihood of household adoption of solar cookers at an initial bid of Birr 333/month for one year. As evidenced by the chi-square statistic of 43.75 and corresponding p-value of 0.000, suggesting that the model effectively captures the factors influencing solar cooker demand at 1% significance level.

The analysis reveals that most independent variables align with the expected relationships. Key variables like the quadratic term for the household head's age, number of family members in productive age, livestock wealth, and participation in social organizations found to be statistically significant at 5% level. Additionally, the household head's age, monthly charcoal consumption, and distance to an all-weather road show significance at 10% level. Notably, the relationship between age and the likelihood of bidding for the solar cooker peaking at age 45 suggests a declining tendency beyond this age, highlighting a nuanced interplay between demographic factors and willingness to invest in renewable energy solutions. The result highlights a complex interplay

between social organization involvement and adoption of solar cookers among households, indicating that societal norms and rural social structures may foster skepticism towards new technologies. In contrast, livestock wealth has a strong positive association with acceptance of solar cookers, suggesting that those with more resources are more likely to accept the technology. Additionally, a higher number of family members in the productive age bracket positively correlates with the likelihood of purchasing the solar cooker. This may be because those in the productive age have the financial means to do so. Conversely, greater distance from all-weather roads tends to hinder technology adoption, as residents in remote areas may exhibit increased reluctance. Finally, higher monthly charcoal consumption (purchased), indicating more reliance on traditional energy sources, positively influences the likelihood of bidding for solar technology, reflecting a potential openness to cost-saving alternatives.

The variables gender and education of the household head, income from nonfarm self-employment, and distance to the community forest as well found to be insignificant. This suggests that these factors may not play a critical role in influencing the chance of buying the solar cooker at the initial bid.

Further, the ordered probit model effectively captures the likelihood of buying solar cookers at varying price points, with the chi-square statistics indicating strong overall significance ($p < 0.01$). This suggests that the model is robust in demonstrating the influence of price on the possibility of buying solar cooking technology within the community. The positive correlation between livestock holding and willingness to pay higher bids for solar cookers highlights the critical role of livestock as both a financial asset and a determinant of investment decisions among farmers. In agricultural communities, particularly in regions where livestock represent significant wealth, this relationship underscores the need to consider livestock holdings when promoting sustainable technologies, as they can enhance both economic resilience and willingness to adopt innovative solutions.

Farmers who engage in social organizations tend to favor lower bids, suggesting that social connectedness influences their perceptions of technology adoption, potentially leading them to view such innovations as less realistic or compatible with societal norms. This inclination may stem from shared values and collective experiences within these organizations, shaping their decision-making processes regarding new technologies. Wodaju et al. (2023) found similar results for WTP for weather index crop insurance policies in Ethiopia.

As family members in the productive age range and nonfarm wage income increase, the likelihood of farmers paying higher bids for proposed technologies rises, suggesting that these factors may serve as indicators of family income and financial capability. This correlation implies that with greater financial resources, farmers are more inclined to invest in solar cooker technologies. This result is in line with a similar study of WTP for alternative energies in Uganda by Bamwesigye (2023) that concluded age and income positively and significantly affects WTP. This result was also consistent with the results investigated by Meried (2021) in Ethiopia. Entele (2020) reported while income positively influences WTP for solar panels in general, age found to negatively affect WTP. This result cannot totally contradict with our context, because for household heads older than 45 years our result also indicated a decreasing WTP. Households who have higher monthly biomass energy consumption (proxy by the amount of charcoal consumption) tends to pay higher bids. This finding is in line to the result in Bamwesigye (2023).

Table 2. Probit estimates of factors influencing WTP for solar cookers (N=232)

Explanatory variables	Coefficients & standard error in bracket	P>|z|
Gender (male =1)	-.0846 (.2089)	0.686
Age (year)	.0718 (.0389)	0.065 *
Age2 (year)	-.0008 (.0004)	0.047 **
Education (years)	.0136 (.0274)	0.618
Prolabor	.3155 (.1211)	0.009***
Livestock (TLU)	.1419 (.0609)	0.020**
Participation in com. Org. (Yes=1)	-.4851 (.1848)	0.009 ***
Charcoal consumption	1298 (.0871)	0.136
Dist. all-weather road	-.0081 (.0045)	0.071 *
Lnself_inc	.0421 (.0283)	0.137
N = 232	.	
LR chi2(10) = 43.75		
Prob > chi2 = 0.000		

*** Significant at 1%, **significant at 5% and *Significant at 10%

Table 3. Order probit estimates of factors influencing WTP for solar cookers (N=232)

Explanatory variable	Coefficients standard error in bracket	P>|z|
Age (year)	-.0050 (.0055)	0.362
Livestock (TLU)	.1572 (.0479)	0.001***
Participation in com. org. (Yes=1)	-.3194 (.1468)	0.030 **
Productive labor	.1543 (.0832)	0.064*
Charcoal consumption	.1118 (.0630)	0.076*
Dis_alwroad	-.0024 (.0036)	0.499
Nfarmwage_inc (Birr)	9.68e-06 (5.16e-06)	0.060*
/cut1 -.3582		
/cut2 -.0179		
/cut3 .5371		
/cut4 1.4168		
/cut5 2.1436		

*** Significant at 1%, **significant at 5% and *Significant at 10%

3.4 Analysis of the demand for solar cookers

The results clearly indicate that the WTP bids are not random numbers but are systematically related to the variables suggested by economic theory. This can be validated using an ordered

probit model for predicting the variations in accepting the technology among community members if various prices were charged. To predict the category for each household based on the known intervals, we could compute the linear combination $X_i\beta$, where $X_i$represents the household characteristics and β signifies the estimated coefficients. Hence, by summing the predicted values for each category, we would generate the corresponding demand schedules illustrated in Table 3 and Figure 2, which visually represent the distribution of households across the defined price categories.

As we have only few WTP bids, in this study we did not use predicted probabilities and frequency data to estimate demand schedule. Instead, we estimated the demand schedule from the frequency of "yes" responses to the initial bid and follow up higher and lower bids. We enforce monotonic switching on the part of our respondents. That is, if a respondent answers "Yes" to the particular WTP bid, we code all lower WTP bids as "Yes" responses. Let the responses, y_i in equation (2) for a particular respondent's WTP of Birr 333/month is "Yes," and "No" to the follow up higher bid of Birr 500/month. His response to the vector of follow up lower bids (< 21, 21, 41.50, 83, 166, 333) would also be "yes". That is, a (yes, yes, yes, yes, yes, yes) answer to all questions that a respondent was not asked would be recorded.

The negative relationship between the proposed price and the demand for solar cookers (see Figure 2) aligns with the law of demand, which suggests that lower prices drive higher consumption of normal goods. A similar study by Entele (2020) states that bid price has negative and significant influences on households' demand for electricity services connection. The yes/no responses to varying price points in the bidding game effectively reflect the value that these households place on solar cookers. Those values may provide insights into consumer behavior and potential market dynamics.

By utilizing demand schedules derived from the willingness-to-pay (WTP) responses, stakeholders such as government bodies, clean energy advocates, and investors can make informed decisions regarding investments in solar cooker initiatives targeting rural or peri-urban communities.

Table 3. Demand schedule for solar cooker, (price vs number of potential users)

WTP (Birr /month) for 1 year)	number of potential users (where N=232)
21	209
41.5	201
83	196
166	175
333	131
500	67
750	21
750 < WTP ≤ 1000	21

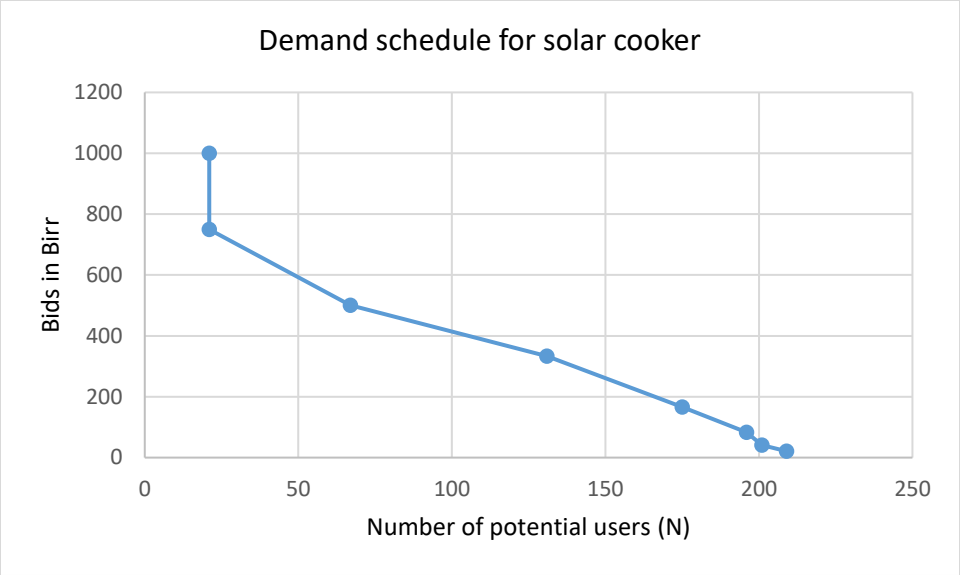


Figure 2. The number of potential users (x-axis) and willingness to pay bids (y-axis)

4. Conclusion

The analysis of households' willingness to pay (WTP) for solar cookers using both binary Probit and ordered Probit models revealed for the factors influencing potential acceptance of the technology. The Probit model shows strong statistical significance in predicting adoption, with the variables age of the household head, number of household members in the productive age bracket, livestock wealth, participation in community organization and distance to all-weather road significantly influencing WTP. Most of these results are inline to the prior expectations. In contrast, the ordered Probit model offers a detailed perspective on the likelihood of adopting solar cookers at varying price points, highlighting the importance of livestock holdings and socio-economic factors like participation in community organization, number of household members in the productive age, previous charcoal consumption and nonfarm wage labor income. Both models align with economic theory, showing that WTP bids correlate with household characteristics and price sensitivity, supporting efforts by stakeholders to promote solar cooking solutions in peri-urban areas based on demand insights. The demand schedules obtained from the responses to the initial and follow up higher and lower bids shows a negative relationship between demand and price. The demand schedule and corresponding graph in this study are estimated based on a single initial bid and follow up higher/lower bids. Though this may not be misled as the initial bid being selected carefully, we suggest future studies on the topic to provide alternative initial bids that randomly chosen to different respondents.

Declarations

Ethics approval and consent to participate

Appropriate ethical approval to conduct this research was obtained from the Research Affairs Directorate Office, Mekelle University, Ethiopia (RADO/EXTERNAL/SS008/2024) before commencement of the study. The University's ethical statements are in line with the international standards declaration, and which dictates researchers to apply moral and professional codes of conduct to the collection, analysis, reporting and publication of information about research subjects. The ethical statement includes receiving consent from participants and making

appropriate compensation and treatment for individuals harmed as a result of participating in research. In this study, the researchers were prepared a consent sheet in written form before the data collection begins. The consent statement encompasses the aim and relevance of the research undertaken, the information required from participants and potential effects of the research for them. Participants were informed that they were free to withdraw from the research at any time and that the data would be confidential, anonymous and treated in a way that protects privacy of participants. Then while participants who can read and write the consent form were made to read themselves, for the participants who were not able to read and write, the consent form was presented orally to them by enumerators. Once they understood the consent statement, they signed to participate in an interview voluntarily.

Consent for publication

A consent from all participants was obtained for research findings to be reported and published in an anonymous and summary form.

Clinical trial number

Not applicable

Availability of data and materials

The dataset used to analyze the study is available and ready to provide on request.

Competing interests

We know of no conflict of interest associated with publication, and the institution financially supported the work have no influence on its outcomes.

Funding

Mekelle University has provided us facilities to undertake this research.

Authors' contributions

The corresponding author (H.T) and the co-author (H.E) designed the questionnaire, managed and analyzed the data, and drafted the article. The co-authors (A.H) and (A. G) carefully searched, and reviewed state of the art literatures. Finally, all authors read the article thoroughly, revised and approved for publication in Discover Sustainability.

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