Willingness to Pay for Walking Tractor: Evidence from smallholder farmer's in Northwestern Ethiopia

Workineh Yenewa[1]* and Birara Endalew[2]

Article History: Received: 01 July 2022; Revised: 14 October 2022;
Accepted: 18 October 2022

Abstract

Although the government of Ethiopia strives to promote agricultural tractors, the cost of tractor purchase is unaffordable for smallholder farmers. Hence, tractor access is provided by private and group-owned hiring services. But, smallholder farmers' willingness to pay for walking tractor rental services was not investigated. Consequently, this study was conducted to measure and analyze smallholder farmers' willingness to pay for walking tractor rental services in Ethiopia using a one-and-one-half bounded format and the craggit econometric model. A total of 190 smallholder farmers were randomly selected to collect primary data. The result revealed that nearly four-fifths of the sample respondents were willing to pay for a walking tractor rental service. Besides, smallholder farmers' willingness to pay for a walking tractor varies between 200 and 3000 birr, with an average value of 718.50 birr per timad. Likewise, the sex of the respondent, farm experience, farm size, farm plot suitability, household income, extension service, and field day participation all had a positive and statistically significant effect on smallholder farmers' willingness to pay for walking tractor rental service. Hence, policymakers, development workers, researchers, and rental service providers should work together to increase access to smallholder farmers to get the tractor at an affordable rental price.

Keywords: Craggit; one and one-half bounded; smallholder farmer; walking tractor; willingness to pay

JEL Classification: J23, Q01, Q55

[1] Department of Agricultural-Economics, Fogera National Rice Research and Training Center, P.O. Box-1937, Bahir Dar, Ethiopia
Email address: wyenewa27@gmail.com
*Corresponding author
[2] Department of Agricultural Economics, College of Agriculture and Environmental Science, Bahir Dar University, Bihar Dar, Ethiopia

1. Introduction

In Ethiopia, agriculture accounts for 33.3% to Gross Domestic Product, and 72.7% of employment (ATA, 2018; Getahun, 2020; Senbeta, 2018). Ethiopia's government launched the Agricultural Development Lead Industrialization (ADLI) program with the primary goal of bringing commercialized agricultural development (Mazengia, 2016). According to ATA (2018), the most important aspect of agricultural transformation is shifting smallholder farmers from subsistence to market-oriented production. But the agricultural operation is characterized by subsistence farming, low output, fragmented land holding, outdated farming techniques, and postharvest loss(Sims and Kienzle, 2006). Besides, agricultural production is dominated by smallholder production systems (Mazengia, 2016). As Dessale (2019) underlined, the smallholder production system is not sufficient to feed the population growing at an alarming rate. Therefore, agricultural mechanization is the pathway to increase crop production and productivity. In Ethiopia, agricultural activities are labor-intensive and heavily rely on draught animal power (Kelemu, 2015).

Agricultural production and productivity are very low because of backward agricultural practices and a low rate of agricultural technology utilization (Workneh et al., 2021). Additionally, agricultural mechanization has a vital role in replacing manual labor and draft animals so as to improve agricultural productivity (Quan and Doluschitz, 2021). Moreover, agricultural mechanization increases farm households' involvement in different income-generating activities besides productivity improvement by shortening the labor-intensive land preparation and harvesting periods (Workneh et al., 2021). Besides, a shortage of farm power causes delays in the accomplishment of critical farm operations, which leads to a fall in agricultural productivity and farm income (Sims et al., 2016). Accordingly, the government of Ethiopia has promoted agricultural tractors to increase land and labor productivity, shorten the time required to prepare farm plots for production, and reduce post-harvest losses (Workneh et al., 2021). However, tractor management in smallholder production systems is frequently under capacity and uneconomical (Mekonnen, 2021), because approximately 55% of smallholder farmers farm on less than or equal to one hectare (Chanyalew et al., 2010; Gecho et al., 2014). Furthermore, smallholder farmers do not have the capacity to purchase tractors because of their limited farm size and financial position (Tesfaye et al., 2021). As a result, the mechanism of tractor access is through private and group-owned hiring services (Tesfaye et al., 2021; Wanglin et al., 2018).

In the study area, crop production and productivity are low because of backward agricultural technologies; shortage of pre-harvest and post-harvest agricultural mechanization; and a low level of smallholder farmers' awareness of the adoption of agricultural mechanization. Fogera National Rice Research and Training Center has been working to promote the production and dissemination of recommended farm tools and implements through field demonstrations and training of farmers, development agents, and local manufacturers. Among the technologies, the walking tractor is one of them. According to Solomon (2017), a walking tractor is designed to provide a power source for smallholder farmers. It is a multipurpose hand tractor designed primarily for rotary tilling and other operations on small farms (Kathirvel et al., 2000). Cognizant of this, Woreta Machinery Supplier Company, in collaboration with Fogera National Rice Research and Training Center, strives to provide a walking tractor rental service in the Amhara region. As a result, farmers are getting tractors in the form of rental services. Understanding smallholder farmers' willingness to pay for walking tractor rental service, on the other hand, is critical in balancing rental service prices with farmers' demand, providing insight for potential walking tractor rental service providers, and evaluating tractor rental service cost-benefit analysis. But, smallholder farmers' willingness to pay for walking tractor rental services was not investigated. Therefore, this study was undertaken to measure smallholder farmers' willingness to pay for walking tractor rental services using one and one-half bounded formats and to analyze determinants of their willingness to pay using Cragg's Double Hurdle model.

2. Materials and Methods

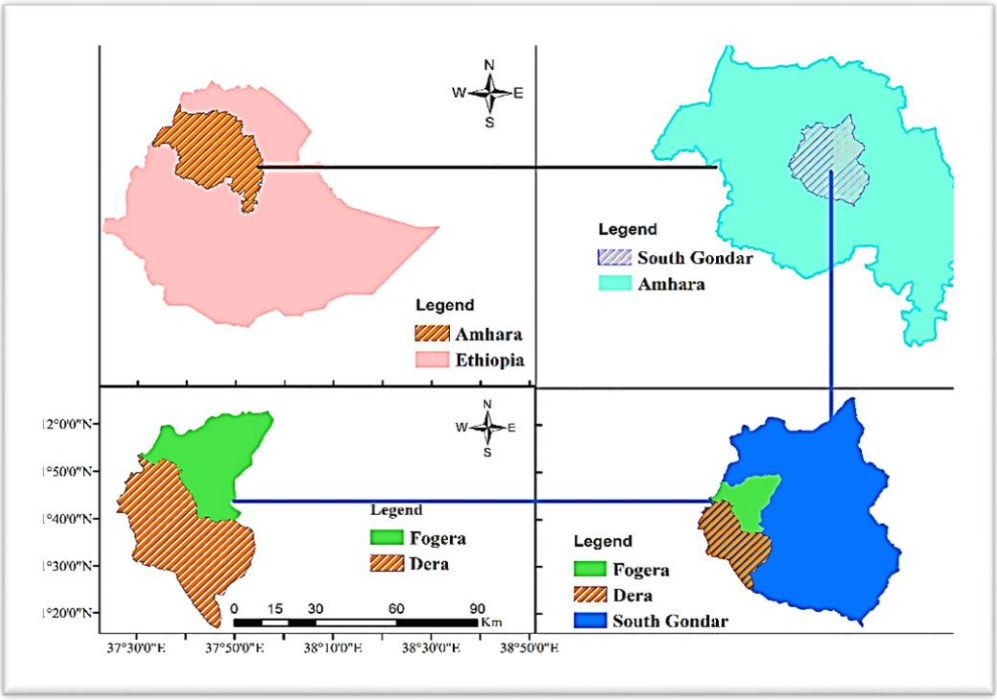
2.1 Description of the study area

The study was conducted in Ethiopia, particularly in Dera and Fogera woredas of the Amhara Region. Dera woreda is bordered on the south by the Abay River, on the west by Lake Tana, on the north by Fogera, and on the east by West Estie (Mirie and Zemedu, 2018). It is located at an altitude of 1,560 to 2,600 meters above sea level and between latitudes 11023'15" and 11053'30" north and longitudes 37025'45" and 37054'10" east. The woreda is characterized by the midland agro-ecological zone with an average rainfall ranging from 1000–1500 mm with a minimum and maximum annual temperature of 13 and 30 °C (Mirie and Zemedu, 2018). Around 37.6% of the land is devoted to crop production, 17.4% to

forests and herbs, 6.4% to west land, 18.5% to water bodies, 7.2% to housing construction, and the remaining 1.4% for others (Getahun, 2012). Teff, maize, rape seed, finger millet, and rice are the major crops cultivated in the woreda (Mirie and Zemedu, 2018).

Fogera woreda is bordered on the south by Dera, on the west by Lake Tana, on the north by the Reb River and on the east by Farta. According to Desta et al. (2021), Fogera Woreda is located at an altitude of 1774 to 2410 meters above mean sea level, between latitudes 11046 and 11059 north and longitudes 37033 and 37052 east. It is described by the midland agro-ecological zone with an average rainfall of 1216 mm. The land use system is characterized by about 59% cultivated land, 22.7% pastureland, 18.2% water bodies and the rest for others (Melese et al., 2018). Crop production is the primary source of income and food for Fogera woreda's smallholder farmers. It is also one of the surplus-producing woredas, with a diverse crop mix of annual and perennial crops (Gebey et al., 2012). The most common food crops in Fogera woreda are rice, maize, finger millet, barley, teff, niger seed, legumes, wheat, and pepper (Mohammed et al., 2019).

Figure 1: Map of the study area



2.2 Method of Data Collection

A multi-stage sampling technique was used to select sample kebeles and households for this study. Dera and Fogera woredas were purposefully selected in the first stage because they are suitable for implementing agricultural mechanization such as walking tractors. In the second stage, four kebeles representing the woredas of Dera and Fogera were selected randomly. In the third stage, sample respondents were stratified into male and female-headed households. Then, using probability proportional to sample size, a representative sample was drawn from each woreda and stratum. Finally, 190 sample respondents from this, 168 males and 22 females, were drawn using systematic sampling.

To address the study's objectives, quantitative primary data were gathered. A carefully designed contingent valuation survey questionnaire was applied to collect quantitative primary data. In addition, focus group discussions and key informant interviews were conducted in order to revise the research problem into a working hypothesis, prepare a draft survey questionnaire, and supplement the results of the quantitative data. A pretest is usually conducted prior to the final contingent valuation (CV) studies. Pretest surveys are used in CV studies to test the survey questionnaire's reliability and validity as well as to determine starting bids for the actual survey. For this purpose, 15 households were selected at random for the pretest survey. Accordingly, a draft questionnaire was modified based on the pretest survey. Moreover, the three most frequent bids were selected as starting bids. These are 500, 1000, and 1500 birr per timad. Finally, well-trained and experienced enumerators were employed to administer the actual survey.

2.3 Method of Data Analysis

2.3.1 Contingent Valuation Method (CVM)

CV derives the values of goods and services by directly eliciting respondents' willingness to pay (WTP) (Khalid, 2008). It asks people to express their willingness to pay directly rather than inferring it from observed behaviors in regular markets (Alberini and Cooper, 2000). According to Chien et al. (2005), open-ended, bidding games, payment cards, and dichotomous choice formats were developed to elicit more reliable responses from respondents. Recently, dichotomous choice has gained popularity among CVM formats due to its advantages in avoiding many of the biases known to be inherent in other formats

(Cameron and Quiggin, 1994). Furthermore, the National Oceanic and Atmospheric Administration (NOAA) panel protocol 1993 strongly suggests a dichotomous choice format (single, double, and one and one-half bounded) for CVM studies (Rahji and Oloruntoba, 2009).

In comparison, the statistical efficiency of the double-bounded format is higher than that of the single-bounded format (Jones et al., 2010). In the double-bounded format, the second bid is determined by the response to the first bid. When a "yes" response is given to the first bid, the second bid is twice the first bid; if the initial response is "no", the second bid is half of the first bid (Ezebilo, 2013). However, the double-bounded format has triggered a debate because the response to the first bid is always inconsistent with the response to the second bid, resulting in a lower WTP (Mulat et al., 2019). So, one and one-half bounded formats were introduced to reduce potential response biases caused by inconsistency of the follow-up bid in the double bounded format (Cooper et al., 2002). According to Hanemann et al. (1991) and Oerlemans et al. (2016), one and one-half bounded formats, like single and double bounded formats, are used to identify respondents' bounded and unbounded WTP but not the exact amount. Consequently, the follow-up open-ended question is used to determine the respondent's maximum willingness to pay (Albertini and Cooper, 2000; Green et al., 1998). In CVM studies, one and one-half bounded formats have rarely been used. The respondent is presented with a range [Bj-, Bi+], where Bi- < Bi+.

One of these two prices is selected at random, and the respondent is asked whether he/she would be willing to pay that amount. He/she is asked about the second price only if that is compatible with her response to the first price. If the lower price, Bi-, is randomly drawn as the starting bid, the three possible response outcomes are (no), (yes, no), and (yes, yes). If the higher price, Bi+ is randomly drawn as the starting bid, the possible response outcomes are (yes), (no, yes) and (no, no).

To elicit a smallholder farmer's willingness to pay for a walking tractor rental service, this study used a one-and-one-half bounded format followed by an open-ended question.

2.3.2 Statistical analysis

The collected data was analyzed and reported using percentage, frequency, mean, and the tobit and truncated econometric models to be run simultaneously using the Craggit command. The econometric models are selected based on the

nature of the dependent variable. As a result, this study used a one-and-one-half bounded format followed by open-ended questions to generate continuous values of the dependent variable, including zeros. Consequently, the dependent variable of this study had both zero and non-zero values. Multiple linear regression and Tobit models are often used as the right models to estimate the relationship between explanatory variables and continuous dependent variables. For example, multiple linear regression estimates become biased and inefficient when the number of zeros in the data set increases in proportion to the number of observations (Wilson and Tisdell, 2002). As a result, estimation of this data set using a multiple linear regression model produces misleading results. Similarly, Stewart (2009) underlined that Tobit has been the most popular model in recent research studies where some observations in the sample lacked the data or had zero values. Following this, previous studies applied the Tobit Econometric model to analyze determinants of willingness to pay (Cho et al., 2005; Kalbali et al., 2014). But, the single hurdle process underlying both the willingness to pay decision and the amount of willingness to pay is a very unrealistic assumption of the Tobit Model (Cragg, 1971). Many economists are uncomfortable with this assumption (Rufino, 2016). As a result, John G. Cragg suggested two independent latent variables as an alternate formulation to the Tobit Model that is, Y_{1i}^{*} and Y_{2i}^{*} (Cragg, 1971; Rufino, 2016). The Craggit model integrates the probit and the truncation models to determine the probability and continuous values of the dependent variables, respectively (Burke, 2009). Therefore, the Craggit command of Stata was applied to analyze the determinants of smallholder farmers' willingness to pay for walking tractor rental service. The model is specified as follows (Cragg, 1971).

$$Y_{1i}^{*} = X_{1i}^{'}\beta_{1i} + \mu_{1i} \quad \textbf{(1)}$$

WTP= 1 when $Y_{1i}^{*} > 0$

WTP = 0 when $Y_{1i}^{*} \leq 0$

Where: WTP is the binary dependent variable which takes 1 if the respondent is willing to pay and 0 otherwise

Y_{1i}^{*} = unobserved latent dependent variable for the probit equation

X1i = Vector of explanatory variables

β_{1i} = Vector of unknown parameters to be estimated.

μ_{1i} = error term

The selection equation of the truncated dependent variables is specified as follows:

$$Y_{2i}^{*} = X_{2i}^{'}\beta_{2i} + \mu_{2i} \quad \textbf{(2)}$$

For the truncated regression model with the observed willingness to pay,

$$Y_{2i} = Y_{2i}^{*} \; when \; Y_{1i}^{*} > 0 \; and \; Y_{2i} = 0 \; when \; Y_{1i}^{*} \leq 0 .$$

Where: Y2i is maximum WTP of smallholder farmers

Y_{2i}^{*} = unobserved latent dependent variable for the truncation regression

X2i = Vector of explanatory variables

β_{2i} = Vector of unknown parameters to be estimated

μ_{2i} = error term

3. Results

3.1 Descriptive Statistics Results

The survey results indicated that nearly nine-tenths of sample respondents were males. Besides, more than three-fourths of male-headed households (75.3%) were willing to pay for a walking tractor rental service. The result also revealed literate household heads account for 48.9% of the total observations. Similarly, most literate household heads (42.6%) were willing to pay for walking tractor rental services. The survey result showed that about 48.95% had received extension service. The majority of extension service users were willing to pay for a walking tractor rental service. Moreover, more than half of the respondents had access to training about agricultural technologies. Similarly, about 52.1% of training access users were willing to pay for a walking tractor. Moreover, about 30.5% of sample respondents participated in field days to visit and share best practices in crop and livestock production. The majority of field day participants were willing to pay for a walking tractor rental service. Additionally, more than nine-tenths of the sample respondents reported that their farm plots were suitable for tractors. Besides, more than three-fourths of suitable farm plot owners were willing to pay for a walking

tractor rental service. As the chi-square test result illustrated, the sex of the respondents, educational status, extension service, participation in field days, and suitability of plots had statistically significant associations with willingness to pay for walking tractor rental service (Table 1).

The average farming experience of the sample respondents was nearly 22 years. The mean farming experience of willing households (which is nearly 24 years) was higher than that of not-willing households (nearly 21 years). The mean household size was 6 members. The mean household sizes of the willing and not-willing respondents were 6 and 5, respectively. The average livestock ownership was 4.9 TLU. On average, willing respondents owned more livestock (5.1 TLU) than not-willing respondents (3.9 TLU). Similarly, the average farm size of sample respondents was 0.97 ha. The average farm size of willing and not-willing households was nearly the same. The average income of willing households (69751.73 Birr) was higher than that of the total observation (63343.45 birr), unlike the income of not-willing households (36844.32 Birr). Sample respondents walk 6.27 km to access the woreda market. On average, willing households were farther away from the woreda market (6.13 km) as compared to not-willing households (6.85 km). The T-test result confirms that the mean farming experience, household size, livestock ownership, and income difference between willing and not-willing households were statistically significant (Table 1).

3.2 Farmers' Willingness to Pay for Walking Tractor Rental Service

As proposed by Hoyos and Mariel (2010), smallholder farmers were asked to answer 'yes' or 'no' to the WTP question (are you willing to pay X birr for walking tractor rental service). According to the results, nearly four-fifths of the sample respondents were willing to pay for a walking tractor rental services. Accordingly, 47.9% of respondents were willing to pay the maximum amount over and beyond the stated bids (yes-yes). Conversely, 18.9% of the sample respondents were willing to pay the first bid but refused to pay the higher bid (Figure 2). On the contrary, a small percentage of respondents have rejected the initial and follow-up lower bids. In contrast, 12.6 % of the sample respondents refused the initial bid but accepted the minimum follow-up bid.

Respondents were asked to state their maximum willingness to pay by using an open-ended question to state the maximum amount they were willing to

pay. The results revealed that smallholder farmers' willingness to pay for a walking tractor rental service ranges from 200 to 3000 birr per hectare. The average and median willingness to pay were 718.50 birr and 750 birr per hectare, respectively. Additionally, about 56.9% of sample respondents' willingness to pay was higher than the mean willingness to pay. This implies that the majority of respondents were willing to pay more than the average WTP because smallholder farmers have a high demand for walking tractor rental services. Besides, an increase in bid amount results in a decrease in the number of respondents (Figure 2). Likewise, the total revenue generated by the provision of a walking tractor rental service was estimated. According to the estimated results, service providers could earn a total of 3,379,536 birr/Timad[3]. This implies that increasing the size of the farm will increase the revenue of the service providers. (The above total revenue is not from a single individual's timad land. Rather, it is for all wiling respondents to pay for the technology. The formula for obtaining it is given in Table1 below).

Table 1: Estimated total willingness to pay in terms of cash (ETB)

Class limit (WTP)	Class mark (A)	Sample HHs		Total HHS		Sample HHS WTP		Total HHs WTP
		Fi	%	Fi	WTP	Fi	%	
200-512	356	50	26.31	1596	568,176	153	80.53	54468
513-825	669	60	31.58	1916	1281804	103	54.21	68907
826-1138	982	35	18.42	1118	1097876	43	22.63	42226
1139-1451	1295	3	1.58	96	124320	8	4.21	10360
1452-1764	1608	3	1.58	96	154368	5	2.63	8040
1765-2077	1921	1	0.53	32	61472	2	1.05	3842
2078-2390	2234	0	0	0	0	1	0.53	2234
2391-2703	2547	0	0	0	0	1	0.53	2547
2704-3016	2860	1	0.53	32	91520	1	0.53	2860
Total		153	80.53	4887	3379536			

Source: Own computation

Note: Total HHSWTP= Fi(G)*class mark

[3] 1 hectare = 4 timad

3.3 Determinants of WTP for walking tractor

A craggit econometric model was employed to identify determinants of smallholder farmers' willingness to pay for walking tractor rental service. Therefore, the model fitness was evaluated using log likelihood and a chi-square test. The evaluation result revealed that the log likelihood values decreased by 40.88 units after 12 explanatory variables were incorporated into the craggit model. The statistically significant decrement of the log likelihood value indicates that the model estimation fitness is powerful. Finally, the model result revealed that farm plot suitability for tractors and willingness to pay decisions had a positive and statistically significant relationship at a $p<0.01$ significant level. Furthermore, at the p 0.05 significance level, the gender of the respondents, extension service, and field day participation had statistically significant and positive effects on willingness to pay decision. Likewise, sex of the respondents, farm size, farm plot suitability, household income, extension service, and field day participation were positively and significantly associated with the amount of willingness to pay at a $p<0.01$ significance level. On the other hand, farm experience had a statistically significant and positive effect on the amount of willingness to pay at a $p<0.05$ significance level (Table 2).

4. Discussion

Socioeconomic conditions, plot characteristics, and institutional factors all influenced smallholder farmers' willingness to pay. Among the variables, the sex of the household head had a positive and statistically significant effect on willingness to pay for a walking tractor rental service. This implies that male-headed households are more likely than female-headed households to be willing to pay for a walking tractor. This is due to the fact that male-headed households have more financial strength, production capacity, and resource ownership than female-headed households. Conversely, female-headed households, on the other hand, are involved in domestic activities such as child care, house management, cooking, and sanitary issues. These activities significantly decrease female-headed households' participation in crop production activities. Furthermore, female-headed households shared their land with male-headed households because crop production involves time-consuming activities in order to increase production and productivity. Besides, female-headed households own fewer farms than male-headed households. Due to

small farm size, labor shortages, and the burden of domestic responsibilities, female-headed household heads are discouraged from participating in crop production. As a result, female-headed households are less likely to pay for a walking tractor rental service. Similarly, Takele and Selassie (2018) found out that the sex of the household head has a positive and statistically significant impact on tractor hiring services.

Farm experience and willingness to pay had a positive and statistically significant relationship. This implies that as one's farm experience grows, so does one's willingness to pay for a walking tractor. Farm experience teaches smallholder farmers about agricultural mechanization, production practices, and market forces. As a result of their farm experience, they can compare previous farming practices and crop yield, allowing them to implement yield-boosting technologies. Furthermore, more experienced farmers are more easily able to adopt crop production technologies in order to increase production and productivity. This explains why experienced farmers are willing to pay more for walking tractors than inexperienced farmers. This finding is similar previous research findings (Rahman and Sujan, 2021).

Similarly, an increase in farm size will also increase smallholder farmers' willingness to pay. This is due to the fact that large farm-size plot preparation requires more labor, livestock, and time, resulting in a decrease in the efficiency of smallholder farmers' crop production. Additionally, large farm owners have higher financial capacity and are more willing to adopt new agricultural technologies than small farm owners. Therefore, the walking tractor improves crop production efficiency while lowering labor and livestock costs. As a result, large farm owners are willing to pay a higher price for a walking tractor. Similarly, Paudel et al. (2019) underlined that farmers' willingness to pay for small-scale farm mechanization is positively influenced by farm size. Likewise, the size of the farm is a key influencing factor that impacts agricultural mechanization practice (Rasouli et al., 2009). Therefore, the findings of this study are consistent with previous findings (Paudel et al., 2019; Rahman and Sujan, 2021; Rasouli et al., 2009; Takele et al., 2018).

Similarly, there was a positive and statistically significant relationship between farm plot suitability and willingness to pay for a walking tractor. This means that the suitability of a farm plot for agricultural mechanization raises the willingness to pay decisions and the number of smallholder farmers'. The suitability

of the farm plot determines the likelihood of smallholder farmers adopting agricultural mechanization. Tractor owners inquire about the suitability of the farm plot for the tractor before asking for a rental fee. As discussed by Oduma and Oluka (2019), farm plot suitability increases plowing capacity, decreases fuel consumption, increases field efficiency and plot preparation. Moreover, Challa (2014) stressed that plot suitability for tractors positively and significantly affects smallholder farmers' willingness to pay for tractor rental service.

Moreover, an increase in smallholder farmers' income results in an increase in their willingness to pay. This implies that high-income smallholder farmers are willing to pay more for a walking tractor than low-income farmers. Smallholder farmers' bargaining power rises as their household income increases. Likewise, the walking tractor saves smallholder farmers time and effort spent on farm plot preparation. As a result, it creates a favorable environment for them to invest their time and effort in additional production and income-generating activities. As discussed by Onomu and Aliber (2020), smallholder farmers' willingness to pay for a tractor hire service increases as their income increases.

Likewise, extension service had a significant and positive relationship with willingness to pay. This means that extension services increase smallholder farmers' willingness to pay in terms of both decision and amount. This is because extension services provide smallholder farmers with new information and raise awareness about improved agricultural technologies. Besides, extension agents educate farmers on the advantages of agricultural mechanization. This illustrates that extension services link smallholder farmers to agricultural technologies. Therefore, extension service users are more likely than non-users to be willing to pay for a walking tractor. The discussion by Challa (2014) illustrated that extension service has a positive and statistically significant influence on farmers' willingness to pay. Similarly, field day participation and willingness to pay had a positive and statistically significant relationship. This implies that field day participants are more willing to pay the decision and amount than non-participants. A field day is a discussion and dissemination platform for new technologies and best practices. As a result, researchers, non-governmental organizations, and development agents organize field days to raise awareness among smallholder farmers through theoretical and practical activities. Model farmers, technology innovators, and researchers, in addition to the audience, are invited to share their knowledge with field day participants. As a result, participants gain practical knowledge about model farmers' production practices, the role of yield-enhancing technologies, and

the living standards of technology beneficiaries. This encourages smallholder farmers to adopt agricultural mechanization in order to increase their production and productivity.

5. Conclusion

This study used one and one-half bounded formats and the craggit model to measure smallholder farmers' willingness to pay and analyze its determinants, respectively. As a result, willing smallholder farmers account for nearly four-fifths of all the observations. Furthermore, the willingness to pay of the majority of smallholder farmers was higher than the mean of the total sample. As a result, private or group rental service providers will receive more than three million birr per timad. However, an increase in the rental service price decreases the number of walking tractor rental service users. Additionally, socioeconomic conditions, plot characteristics, and institutional factors influenced smallholder farmers' willingness to pay. Male-headed households, for example, had a positive and statistically significant effect on willingness to pay for a walking tractor rental service. Similarly, the more farm experience they have, the higher the amount they are willing to pay for a walking tractor. Smallholder farmers' willingness to pay is also influenced by farm size. Furthermore, those who own suitable farm plots are more willing to pay than those who do not. Walking tractor rental service providers' income will also rise when household income, extension service, and field day participants increase.

Therefore, the following recommendations are critical to increasing smallholder farmers' willingness to pay, which leads to an increase in rental service providers' income:

- The rental service providers should take into account the responsiveness of walking tractor rental service users before price increment.
- Besides targeting male-headed households, it is necessary to make female-headed households aware of the role of walking tractors on crop production, productivity, and household income.
- It is better to organize experience-sharing workshops and conferences so as to capacitate smallholder farmers who have less experience in walking tractor.

- Special priority should be given to designing and implementing strategies to encourage small farm owners' willingness to pay for walking tractors.
- Rental service providers should target farm plot suitability for tractors to minimize the cost of fuel and effort.
- It is advisable to provide an extension service about walking tractors so as to train and motivate smallholder farmers.
- Walking tractor rental service providers should be invited during field days to explain the rental service price and benefits of walking tractor, besides on-farm demonstrations about how it works.
- Policymakers, development workers, researchers, and rental service providers should work together to change smallholder farmers' living standards by using improved farm technologies like walking tractors.

References

Alberini, A., and Cooper, J. (2000). Applications of the contingent valuation method in developing countries: A survey (Vol. 146): FAO.

Albertini, A., and Cooper, J. (2000). Application of contingent valuation method in developing countries. Economic and social development paper, 146, 49-92.

ATA. (2018). Ethiopian gricultural transformation agency Annoual report.

Burke, W.J. (2009). Fitting and interpreting Cragg's tobit alternative using Stata. The *Stata Journal*, 9(4), 584-592.

Cameron, T.A., and Quiggin, J. (1994). Estimation using contingent valuation data from a. *Journal of environmental economics and management*, 27(3), 218-234.

Challa, T.G. (2014). Tractor service price determinants among smallholder farmers in Ethiopia. Open Science Repository Agriculture(open-access), e45011808.

Chanyalew, D., Adenew, B., and Mellor, J. (2010). Ethiopia's agricultural sector policy and investment framework: 2010–2020. Federal Democratic Republic of Ethiopia, Ministry of Agriculture and Rural Development Final Report. Addis Ababa, 1-39.

Chien, Y. L., Huang, C. J., and Shaw, D. (2005). A general model of starting point bias in double-bounded dichotomous contingent valuation surveys. Journal of Environmental Economics and Management, 50(2), 362-377.

Cho, S. H., Newman, D. H., and Bowker, J. M. (2005). Measuring rural homeowners' willingness to pay for land conservation easements. Forest Policy and Economics, 7(5), 757-770.

Cooper, J. C., Hanemann, M., and Signorello, G. (2002). One-and-one-half-bound dichotomous choice contingent valuation. Review of Economics and Statistics, 84(4), 742-750.

Cragg, J. G. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. Econometrica: *Journal of the Econometric Society*, 829-844.

Dessale, M. (2019). Analysis of technical efficiency of small holder wheat-growing farmers of Jamma district, Ethiopia. Agriculture and Food Security, 8(1), 1.

Desta, M.A., Zeleke, G., Payne, W.A., and Abebe, W.B. (2021). Temporal and Spatial Changes in Crop Patterns, Use of Inputs and Hydrological Alteration in the Case of Fogera Floodplain, Ethiopia.

Ezebilo, E. (2013). Willingness to pay for improved residential waste management in a developing country. *International Journal of Environmental Science and Technology*, 10(3), 413-422.

Gebey, T., Lemma, T., Hoekstra, D., Tegegne, A., and Alemu, B. (2012). Participatory smallholder dairy value chain development in Fogera woreda, Ethiopia: Experiences from IPMS project interventions: ILRI (aka ILCA and ILRAD).

Gecho, Y., Ayele, G., Lemma, T., and Alemu, D. (2014). Rural household livelihood strategies: Options and determinants in the case of Wolaita Zone, Southern Ethiopia. Social Sciences, 3(3), 92-104.

Gedefaw, E. (2019). Determinants of Adoption of Improved Maize Bh540 Variety Among Smallholder Farmer: The Case of Dera Woreda, South Gondar Zone Amhara National Regional State, Ethiopia.

Getahun, A. (2012). A Study on the Factors Influencing the Adoption of Motorized Water Pump for Irrigation: the Case of South Gonder Zone, Dera Woreda, Amhara Region, Ethiopia. St. Mary's University.

Getahun, A. (2020). Smallholder Farmers Agricultural Commercialization in Ethiopia: A Review. Agriculture, Forestry and Fisheries, 9(3), 67-74. doi: 10.11648/j.aff.20200903.14

Green, D., Jacowitz, K.E., Kahneman, D., and McFadden, D. (1998). Referendum contingent valuation, anchoring, and willingness to pay for public goods. Resource and energy economics, 20(2), 85-116.

Hanemann, M., Loomis, J., and Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*, 73(4), 1255-1263.

Hoyos, D., and Mariel, P. (2010). Contingent valuation: Past, present and future. Prague economic papers, 4(2010), 329-343.

Jones, N., Evangelinos, K., Halvadakis, C. P., Iosifides, T., and Sophoulis, C. M. (2010). Social factors influencing perceptions and willingness to pay for a market-based policy aiming on solid waste management. Resources, Conservation and Recycling, 54(9), 533-540.

Kalbali, E., Borazjani, M., Kavand, H., and Soltani, S. (2014). Factors affecting the willingness to pay of Ghorogh forest park visitors in Iran. *International Journal of Plant, Animal and Environmental Sciences*, 4(3), 368-373.

Kathirvel, K., Job, T., and Manian, R. (2000). Development and evaluation of power tiller-operated ladder. AMA, Agricultural Mechanization in Asia, Africa and Latin America, 31(1), 22-26.

Kelemu, F. (2015). Agricultural mechanization in Ethiopian: experience, status and prospects. *Ethiopian Journal of Agricultural Sciences*, 25(1), 45-60.

Khalid, A. R. (2008). Economic valuation of the goods and services of coastal habitats. The Regional Training Workshop, March 24 – 28, 2008.

Mazengia, Y. (2016). Smallholders commercialization of maize production in Guangua district, northwestern Ethiopia. World Scientific News, 58, 65-83.

Mekonnen, Y. (2021). Factors affecting farmers' hiring decision on agricultural mechanization services: A case study in Debre Elias Woreda, East Gojam Zone, Ethiopia. St. Mary's University.

Melese, T., Dessie, A. B., and Abate, T. M. (2018). Determinants of commercialization by smallholder onion farmers in Fogera district, South Gondar Zone, Amhara National Regional State, Ethiopia. *Journal of Development and Agricultural Economics*, 10(10), 339-351.

Mirie, T., and Zemedu, L. (2018). Determinants of market participation and intensity of marketed surplus among teff producers in Dera District of South Gondar Zone, *Ethiopia. Journal of Development and Agricultural Economics*, 10(10), 359-366.

Mohammed, H., Birhane, Z., and Alemayehu, G. (2019). Determinants of market outlet choice decision of tomato producers in Fogera woreda, South Gonder zone, Ethiopia. Cogent Food and Agriculture, 5(1), 1709394.

Mulat, S., Worku, W., and Minyihun, A. (2019). Willingness to pay for improved solid waste management and associated factors among households in Injibara town, Northwest Ethiopia. BMC research notes, 12(1), 1-6.

Oduma, O., and Oluka, S.I. (2019). Effect of soil type on power and energy requirements of some selected agricultural field machinery in south-east Nigeria. Poljoprivredna tehnika, 44(3), 69-77.

Oerlemans, L. A., Chan, K. Y., and Volschenk, J. (2016). Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. Renewable and Sustainable Energy Reviews, 66, 875-885.

Onomu, A.R., and Aliber, M. (2020). Smallholders' willingness to pay for mechanization (tractor services) in Delta and Benue States, Nigeria. *Journal of Human Ecology*, 72(1-3), 297-308.

Paudel, G. P., Kc, D. B., Khanal, N. P., Justice, S. E., and McDonald, A. J. (2019). Smallholder farmers' willingness to pay for scale-appropriate farm mechanization: Evidence from the mid-hills of Nepal. Technology in society, 59, 101196.

Quan, X., and Doluschitz, R. (2021). Factors Influencing the Adoption of Agricultural Machinery by Chinese Maize Farmers. Agriculture, 11(11), 1090.

Rahji, M., and Oloruntoba, E. O. (2009). Determinants of households' willingness-to-pay for private solid waste management services in Ibadan, Nigeria. Waste management and research, 27(10), 961-965.

Rahman, M. S., and Sujan, M. H. K. (2021). Determinants of Small-Scale Mechanization for Potato Farming: A Case from Bangladesh. *Journal of Nepal Agricultural Research Council*, 7, 75-82.

Rasouli, F., Sadighi, H., and Minaei, S. (2009). Factors affecting agricultural mechanization: A case study on sunflower seed farms in Iran.

Rufino, C. C. (2016). Microeconometric analysis of the eating-out behavior of modern Filipino households: The Tobit, the Craggit and the Heckit models. DLSU Business and Economics Review, 26(1), 50-69.

Senbeta, A. N. (2018). Review on Determinants and Impacts of Smallholder Agricultural Commercialization in Ethiopia. *International Journal of Agriculture and Agribusiness*, 1(1), 124-132.

Sims, B., Hilmi, M., and Kienzle, J. (2016). Agricultural mechanization: A key input for sub-Saharan Africa smallholders. Integrated Crop Management (FAO) eng v. 23 (2016).

Sims, B., and Kienzle, J. (2006). Farm power and mechanization for small farmers in sub-Saharan Africa.

Solomon, A. (2017). Performance evaluation of walking tractor drawn wheat planter. *Ethiopia Acad Res J Agric Sci Res*, 5, 529-538.

Stewart, J. (2009). Tobit or not Tobit. U.S. Bureau of Labor Statistics.

Takele, A., and Selassie, Y. G. (2018). Socio-economic analysis of conditions for adoption of tractor hiring services among smallholder farmers, Northwestern Ethiopia. Cogent Food & Agriculture, 4(1), 1453978.

Takele, A. D., Selassie, Y. G., and Tekset, S. (2018). Farmers' Willingness to Pay for 2-Wheel Tractor Hiring Services in Northwestern Ethiopia: A Contingent Valuation Study. *Asian Journal of Agriculture and Food Sciences*, 6(6).

Tesfaye, A., Getnet, B., Deribe, Y., and Kang, T. G. (2021). Benchmarking the Status of Agricultural Mechanization in Ethiopia: Ethiopian Institute of Agricultural Research.

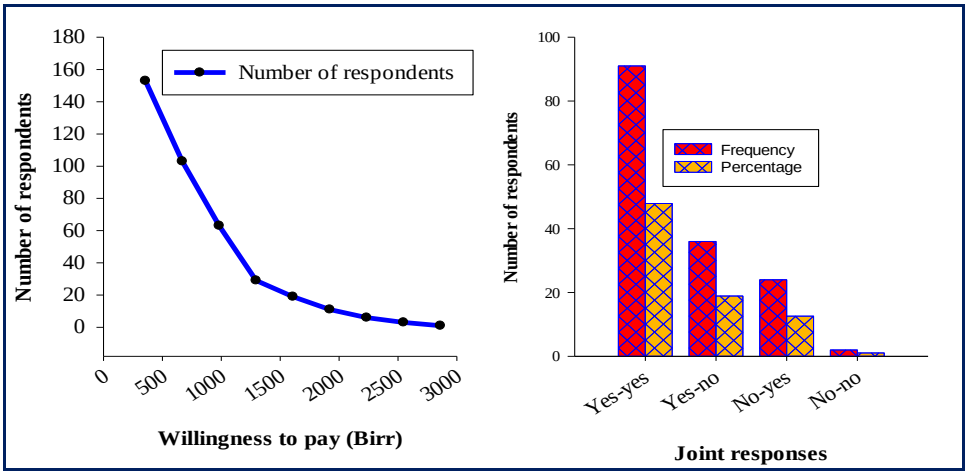
Wanglin, M., Renwick, A., and Grafton, Q. (2018). Farm machinery use, off-farm employment and farm performance in China. *Australian Journal of Agricultural and Resource Economics*, 62(2), 279-298.

Wilson, C., and Tisdell, C. A. (2002). OLS and Tobit estimates: When is substitution defensible operationally?

Workneh, W. A., Ujiie, K., and Matsushita, S. (2021). Farmers' agricultural tractor preferences in Ethiopia: A choice experiment approach. Discover Sustainability, 2(1), 1-15.

Appendices

Figure 2: WTP curve and joint response of smallholder farmers for the first and the follow-up bids



Source: Own survey (2021)

Table 1: Descriptive statistics results of household, plot and institutional characteristics

Variables	Willingness to pay for stated bid	Not-Willing to pay for stated bid	Total observation	Chi-square/ T-test
Sex of respondents (1 for male)	75.3	13.2	88.4	19.52***
Educational status (1 for literate)	42.6	6.3	48.9	5.02**
Extension service (1 for user)	46.84	2.11	48.95	26.74***
Training access (1 for yes)	52.11	2.63	54.74	31.52***
Field day participation (1 for yes)	28.4	2.1	30.5	8.42***
Farm plot suitability (1 for yes)	76.8	14.2	91.1	18.44***
Farming experience (years)	20.96	24.35	22	-1.735*
Household size (number)	5.9	4.95	6	2.83***
Farm size (hectare)	0.988	0.961	0.97	0.315
Livestock ownership (TLU)	5.08	3.92	4.9	2.69***
Household income (birr)	69751.73	36844.32	63343.45	3.54***
Market distance (km)	6.13	6.85	6.27	-0.78

Source: Own survey (2021)

Table 2: Parameter estimates of craggit econometric model

	WTP	MWTP
Sex of respondent	0.755(0.362)**	0.377(0.121)***
Educational status	0.249(0.293)	0.018(0.063)
Household size	0.138(0.081)	0.003(0.019)
Farm experience	0.027(0.012)	0.006(0.003)**
Farm size	0.233(0.514)	0.359(0.118)***
Farm plot suitability	1.109(0.400)***	0.721(0.140)***
Household income	0.106(0.066)	0.097(0.019)***
Livestock ownership	0.009 (0.063)	0.027(0.013)
Extension service	0.816(0.410)**	0.347(0.077)***
Training access	0.075(0.415)	0.333(0.079)
Market distance	-0.033(0.029)	-0.007(0.007)
Field day participation	0.868(0.353)**	0.211(0.066)***
Constant	-2.288(0.960)	4.686(0.296)
Number of observations	190	
Log likelihood value	-117.66	
Wald chi-square	40.88***	

Source: own survey (2021). Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1