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Smallholder Farmers' Demand for Rice Harvesting Technology: Analyzing Willingness to Pay Using One-and-One-Half Bounded Contingent Valuation Method in Northwestern Ethiopia

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Abstract: ***Background:*** This study was designed to measure farmers' willingness to pay for mechanized rice harvesting technology rental service. Specifically, the study addresses how much they are willing to pay and what factors hinder farmers' WTP for mechanized rice harvesting technology by using a one and one-half bounded elicitation Contingent Valuation method and the Craggit econometric model. ***Methodology:*** Selecting representative samples for this study involved using a multi-stage sampling strategy. A total of 190 smallholder farmers were randomly selected to collect primary data. ***Results:*** The result revealed that nearly four-fifth of the sample respondents were willing to pay for mechanized rice harvesting technology rental service. Besides, smallholder farmers' willingness to pay for mechanized rice harvesting technology rental service varies between 200 and 1900 birr, with an average value of 890.46 birr per timad. ***Conclusion:*** Moreover, the model result indicated that sex of the respondent, family size, access to extension service, access to training, participation on field day, and livestock ownership had positive and statistically significant effect on mechanized rice harvesting technology rental service. Thus, in order to offer smallholder farmers with more access to technology at a reasonable rental cost, policymakers, development workers, researchers, and rental service providers should collaborate.

Keywords: Smallholder farmers', harvesting technology, contingent valuation method, willingness to pay, craggit model.
JEL Classification: O14, O33, Q1.

Research Paper

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INTRODUCTION

Agriculture has a major role in the Ethiopian economy. To maintain their standard of living, around 84% of the country's population works in various agricultural activities and generates income for their household consumption to sustain their livelihood (Yenewa & Molla, 2022). According to ATA (2018), Getahun (2020), and Senbeta (2018), Ethiopian agriculture contributes 33.3% of the country's GDP and 72.7% to employment. The government of Ethiopia initiated the Agricultural Development-Led Industrialization (ADLI) program, aiming primarily to promote the commercialization of agricultural development (Mazengia, 2016). However, according to Sims and Kienzle (2006), the agricultural operation is characterized by post-harvest loss, fragmented land holding, subsistence farming, low productivity, and antiquated farming techniques. Additionally, smallholder production systems dominate the agricultural production system (Mazengia, 2016). Dessale (2019) emphasized that the smallholder production system is inadequate to sustain a rapidly increasing population. Consequently, agricultural mechanization emerges as a crucial strategy to enhance both crop production and productivity. In Ethiopia, agricultural practices are characterized by their labor-intensive nature and a significant dependence on draught animal power (Kelemu, 2015).

The level of agricultural production and productivity remains significantly low due to outdated farming practices and a limited adoption of agricultural technology (Workneh *et al.*, 2021). Furthermore, agricultural mechanization plays a crucial role in substituting manual labor and draft animals, thereby enhancing agricultural productivity (Quan and Doluschitz, 2021). In addition, the implementation of agricultural mechanization facilitates greater participation of farm households in various income-generating activities, as it reduces the time required for labor-intensive tasks such as land preparation and

harvesting (Workneh *et al*., 2021). Moreover, a lack of adequate farm power results in delays in essential farming operations, which ultimately contributes to a decline in agricultural productivity and farm income (Sims *et al*., 2016). The Ethiopian government has actively encouraged the adoption of agricultural mechanization to enhance both land and labor productivity, reduce the time needed for farm plot preparation, and minimize post-harvest losses (Workneh *et al*., 2021). However, the management of mechanization technology within smallholder production systems frequently falls short of optimal capacity and proves to be economically unviable (Mekonnen, 2021), as approximately 55% of smallholder farmers cultivate one hectare or less (Chanyalew *et al*., 2010; Gecho *et al*., 2014). Additionally, these farmers often lack the financial means to invest in mechanization technology due to their limited land holdings and financial constraints (Tesfaye *et al*., 2021). Consequently, access to such technology is primarily through private and group-owned hiring services (Tesfaye *et al*., 2021; Wanglin *et al*., 2018).

In the study area, Crop production and productivity is characterized by backward agricultural technologies, shortage of pre-harvest and post-harvest agricultural mechanization, and low level of smallholder farmers' awareness of adoption of agricultural mechanization. Fogera National Rice Research and Training Center has been working to promote production and dissemination of recommended farm tools and implements through field demonstration and training of farmers, development agents, and local manufacturers. Among the technologies, the mechanized harvester is one of them. According to Solomon (2017), walking tractor is used to provide a power source for harvester to smallholder farmers. It is a multipurpose hand tractor designed primarily for tilling and other operations like harvester as a power source on small farms (Kathirvel *et al.*, 2000). Cognizant of this, Woreta Machinery Supplier Company strives to provide mechanized harvester rental service in Amhara region. As a result, farmers are getting harvester in a form of rental services. However, understanding smallholder farmers' willingness to pay for mechanized harvester technology rental service has a vital role to balance rental service price with farmers' demand, give insight for potential mechanized harvester rental service providers and evaluate the cost-benefit analysis of mechanized harvester rental service. But, smallholder farmers' willingness to pay for mechanized harvester rental service was not investigated. Therefore, this study was undertaken to measure smallholder farmers' willingness to pay for mechanized harvester rental service using one and one-half bounded format and to analyze determinants of their willingness to pay using craggitt econometric model.

MATERIALS AND METHODS

Description of the study area

The study was conducted in North western 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 $11^0$23'15 "and $11^0$53'30" north and longitudes $37^0$25'45 "and $37^0$54'10" 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 $11^0$46 and $11^0$59 north and longitudes $37^0$33 and $37^0$52 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).

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 mechanized harvester. 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 male and 22 female were drawn using systematic sampling.

Quantitative primary data were gathered to address the objectives of this study. 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 to 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 startup bids for the actual survey. For this purpose, 13 households were selected at random for the pretest survey. Accordingly, a draft questionnaire was modified based on the pretest survey. Moreover, four most frequent bids were selected as starting bids. These are 530, 650, 700 and 950 Birr per timad. Finally, well trained and experienced enumerators were employed to administer the actual survey.

Method of Data Analysis

Contingent Valuation Method (CVM)

CVM 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 game, payment card, 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 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 of 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 response to the first bid is always inconsistent with response to the second bid, resulting in a lower WTP (Mulat *et al.*, 2019). So, one and one-half bounded format was 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 format, like single and double bounded formats, is 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 format has rarely been used. To elicit a smallholder farmer's willingness to pay for mechanized harvester rental service, this study used a one-and-one-half bounded format followed by an open-ended question.

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 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 question 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 variable. 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 lack 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 i.e. Y_{1i}^{*} and Y_{2i}^{*} (Cragg, 1971; Rufino, 2016). Craggit model integrates the probit and the truncation models to determine the probability and continuous values of the dependent variables, respectively (Burke, 2009). Therefore, Craggit command of Stata was applied to analyze the determinants of smallholder farmer's willingness to pay for mechanized harvester rental service. The model is specified as follows (Cragg, 1971).

$$Y_{1i}^{*} = X_{1i}^{'}\beta_{1i} + \mu_{1i}$$

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

X_{1i} = 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:

$$Y_{2i}^{*} = X_{2i}^{'}\beta_{2i} + \mu_{2i}$$

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,

Y_{2i} is maximum WTP of smallholder farmers

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

X_{2i} = Vector of explanatory variables

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

μ_{2i} = error term

RESULTS AND DISCUSSION

Descriptive Statistics Results

From the total surveyed respondents 141 (74.2%) were willing to pay for mechanized harvester technology whereas, the rest 49 (25.8%) were not willing to pay for mechanized harvester technology. The survey results indicated that nearly nine-tenth of sample respondents were males. Besides, more than three-fourth of male-headed households (70%) were willing to pay for mechanized harvester technology rental service; whereas, from the total female respondents about (4.2%) were willing to pay for the technology. On the other hand, about (18.4%) of male and (7.36%) female-headed households from the total respondents were not willing to pay for the technology rental service, respectively. Of the total respondents, (87.9%) were married, (6.32%) were divorced and (5.79%) were widowed.

The result also revealed literate household heads account for 48.9% of the total observations. Similarly, most of literate household heads (42.6%) were willing to pay for mechanized harvester 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 mechanized harvester rental service. Moreover, more than half of the respondents had training access about agricultural technologies. Similarly, about 51.1% of training access users were willing to pay for mechanized harvester. 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 mechanized harvester rental service. Additionally, more than nine-tenth of the sample respondents reported that their farm plots were suitable for harvester. Besides, more than three-fourth of suitable farm plot owners were willing to pay for mechanized harvester 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 mechanized harvester rental service (Table 1).

The average farming experience of the sample respondents was nearly 22 years. The mean farming experience of willing households (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. 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, family size,and livestock ownership, between willing and not-willing households were statistically significant (Table 2).

Table 1: Descriptive statistics results for Dummy variables

Variables	Willingness to pay for stated bid	Not-Willing to pay for stated bid	Total observation	Chi-square (X^2)
Sex of respondents (1 = male)	75.3	13.2	88.4	19.52***
Educational status (1 = literate)	42.6	6.3	48.9	5.02**
Marital status(1= married)	74.74	13.2	87.94	17.92***
Extension service (1 =user)	46.84	2.11	48.95	26.74***
Training access (1 = yes)	52.11	2.63	54.74	31.52***
Field day participation (1 = yes)	28.4	2.1	30.5	8.42***
Farm plot suitability (1 = yes)	76.8	14.2	91.1	18.44***
Model farmer(1=yes)	38.95	1.58	40.53	20.04***
Social position(1=yes)	40.53	1.05	41.58	24.75*

Source: own survey (2021)

Table 2: Descriptive statistics results for Continuous variables

Variables	Willingness to pay for stated bid	Not-Willing to pay for stated bid	Total observation	Chi-square/T-test
Age (number)	41.58	46.41	87.99	-2.25**
Farming experience (years)	20.96	24.35	22	-1.735*
Family size (number)	5.9	4.95	6	2.83***
Land size (hectare)	0.988	0.961	0.97	0.315
Livestock ownership (TLU)	5.08	3.92	4.9	2.69***
Market distance (km)	6.13	6.85	6.27	-0.78

Source: own survey (2021)

Major Crops Grown in the Area

According to the results of the survey conducted the dominant crops grown in the study area during the 2020/21 cropping season are Rice, Maize, and Onion respectively. From this (96.84%) respondents grow rice, (58.94%) grow maize and (55.3%) grow onion. Based on the results stated below (Table 3) from the total rice growers, (72.11%) farmers' were willing to pay for mechanized harvester rental service; while, (24.7%) of the respondents were not willing to pay for the service. On the other hand, (2.11%) of the farmers' were not growing the rice but were willing to pay and (1.05%) respondents did not grow the rice as well as not willing to pay for the service.

Similarly, from the total maize growers (45.26%) of the respondents were willing to pay for walking tractor rental service; while, (28.94%) of the respondents were not willing to pay for the service. On the other hand, (13.68%) of the farmers' were not growing the maize but were willing to pay and (12.11%) respondents did not grow the maize as well as not willing to pay for the service.

The result shown in (Table 3), from the total onion growers (43.68%) of the respondents were willing to pay for mechanized harvester rental service; while, (11.58%) of the respondents were not willing to pay for the service. On the other hand, (30.5%) of the farmers' were not growing the onion but were willing to pay and (14.21%) respondents did not grow as well as did not willing to pay for harvesting technology rental service.

Table 3: Willingness to pay vs major crops grown

Willingness to pay vs major crops grown					
Major crops		Willingness to pay		Not-willing	
		No.	%	No.	%
Rice	yes	137	72.11	4	2.11
	no	47	24.7	2	1.05
Maize	yes	86	45.26	55	28.94
	no	26	13.68	23	12.11
Onion	Yes	83	43.68	22	11.58
	no	58	30.5	7	14.21

Source: Own survey (2021)

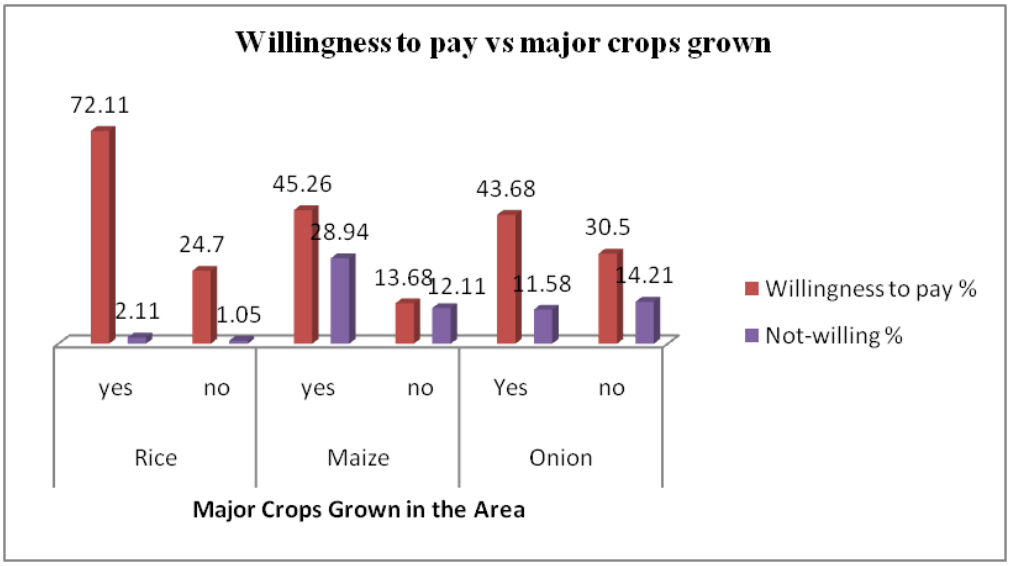

Fig. 1: Willingness to pay vs major crops grown

Farmers' Willingness to Pay for Mechanized Harvester 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-fifth of the sample respondents were willing to pay for a walking tractor rental service. Then, to

improve the efficiency of WTP measurement, follow-up questions were asked. If the answer was yes, a new question with a higher bid was asked, and if the answer was no, smallholder farmers were presented a new question with a lower bid (Cameron and Quiggin, 1994; Hoyos and Mariel, 2010). In the first scenario (bid 1), the data obtained from the survey depict that the initial bid amount was set and (63.2%) of sampled farmers were willing to pay the initial bid for mechanized harvester rental services for the first offering price and (11.1%) of the respondents were not willing to pay for initial bid for mechanized harvester rental services (refused to pay the initial bid).

In the second scenario, among respondents who replied to the first offered amount (willing), they were asked the next scenario (maximum bid) and accordingly, 44.7% of respondents were willing to pay the maximum amount over and beyond the stated bids (yes-yes). Conversely, 18.4% of 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, 10.5 % of sample respondents refused the initial bid but accepted the minimum follow-up bid.

Respondents were asked to state their maximum willingness to pay using an open-ended question to state the maximum amount they are willing to pay. The results revealed that smallholder farmers' willingness to pay for mechanized harvester rental service ranges from 200 to 1900 Birr per hectare. The average willingness to pay was 890.50 Birr per hectare. Additionally, about 54.5% 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 mechanized harvester rental services. Besides, an increase in bid amount results in a decrease in the number of respondents.

Table 4: Joint responses to stated bids

Joint response of willingness to pay		
Farmers Response	Frequency	Percent (%)
Yes-yes	85	44.7
Yes-no	35	18.4
No-yes	20	10.5
No-no	1	0.5
Total	141	74.1

Source: Own survey (2021)

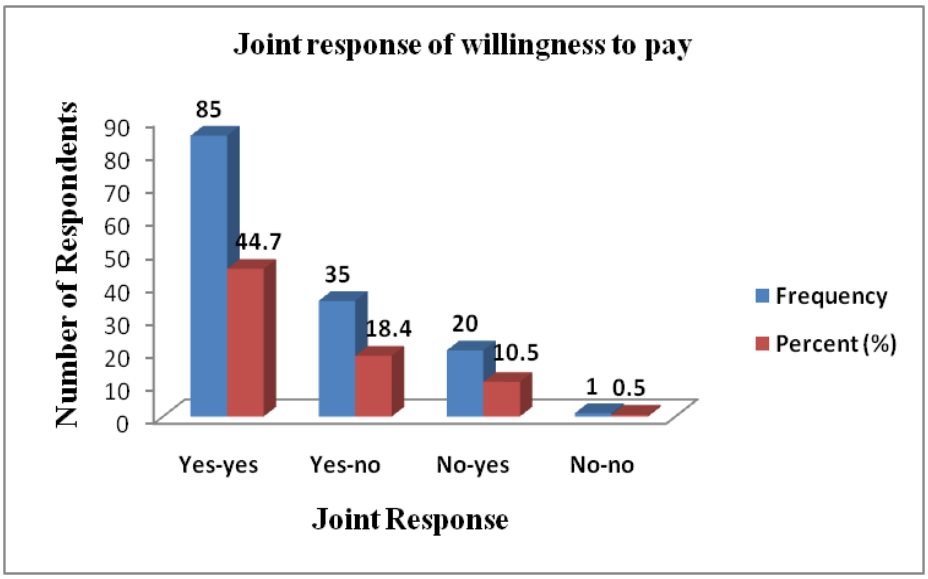

Fig. 2: Joint response of smallholder farmers for the first and the follow-up bids

Among respondents, (25.8%) were not willing to pay to the technology. So, they were asked to list out their major reasons that makes them to refuse to pay (Table 5). The result indicated that majority of the respondents (10.0%) mentioned that they have no interest about the technology for harvesting.

Table 5: Reasons for not-willing respondents

Reasons	**Frequency**	**Percent**
Not able to pay the stated amount because of shortage of income	18	9.5
Have no interest about technology for harvesting	19	10.0
Satisfied with man power with sickle	2	1.1
No enough land to harvest with the technology or Nature of land terrain	3	1.6
All factors make them to refuse to pay	7	3.6
Total	**49**	**25.8**

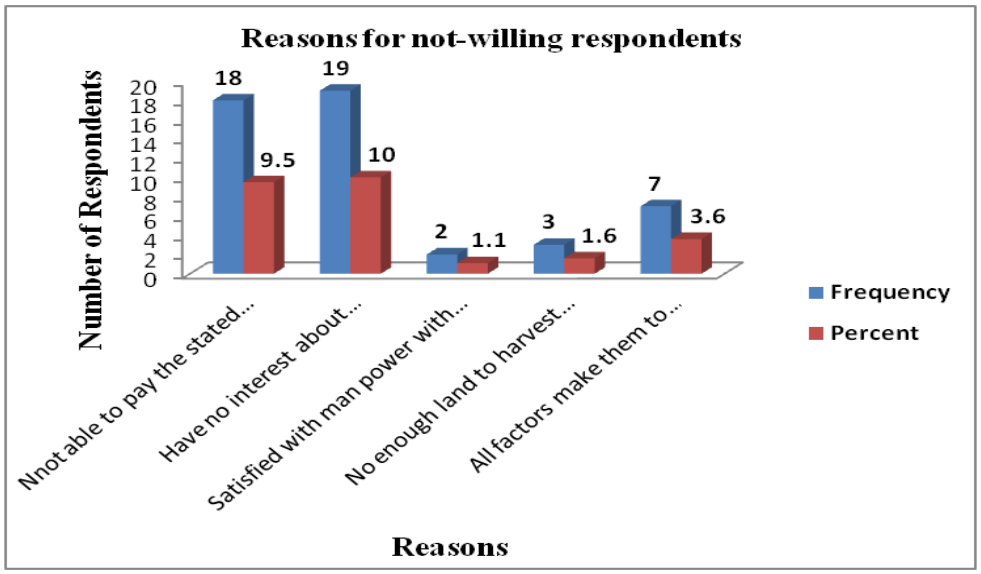

Fig. 3: Reasons for not-willing respondents

Determinants of WTP for Mechanized Harvester

Craggit econometric model was employed to identify determinants of smallholder farmers' willingness to pay for mechanized harvester rental service. Therefore, the model fitness was evaluated using log likelihood and 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 tractor and willingness to pay decision had a positive and statistically significant relationship at $p<0.01$ significant level. Additionally, sex of the respondents, extension service and field day participation had statistically significant and positive effect on willingness to pay decision at $p<0.05$ significance level. Likewise, sex of the respondents, farm size, farm plot suitability, household income, extension service and field day participation positively and significantly associated with the amount of willingness to pay at $p<0.01$ significance level. On the other hand, farm experience had statistically significant and positive effect on the amount of willingness to pay at $p<0.05$ significance level (Table 6).

Table 6: 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***

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: own survey (2021)

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 mechanized

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

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 mechanized harvester. 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 mechanized harvester 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 mechanization technology improves crop production efficiency while lowering labor and livestock costs. As a result, large farm owners are willing to pay a higher price for mechanized harvester. Similarly, Paudel *et al.,* (2019) underlined that farmers' willingness to pay for small-scale farm mechanization is positively influenced by farm size. Likewise, size of the farm is a key influencing factor that impacts agricultural mechanization practice (Rasouli *et al.*, 2009). Therefore, the finding of this study is 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 mechanized harvester. This means that the suitability of a farm plot for agricultural mechanization raises the willingness to pay decisions and amount of smallholder farmers'. The suitability of the farm plot determines the likelihood of smallholder farmers adopting agricultural mechanization. As discussed by Oduma and Oluka (2019), farm plot suitability increases harvesting capacity, decreases fuel consumption, increase field efficiency and plot preparation. Moreover, Challa (2014) stressed that plot suitability for harvester positively and significantly affect smallholder farmers willingness to pay for mechanized harvester 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 mechanized harvester than low-income farmers. Smallholder farmers' bargaining power rises as their household income increases. Likewise, the technology 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 technology service increases as their income increases.

Likewise, extension service had a significant and positive relationship with willingness to pay. This means that extension service increases smallholder farmers' willingness to pay in terms of both decision and amount. This is because extension service provides smallholder farmers with new information and raise awareness about improved agricultural technologies. Besides, extension agents educate farmers on the advantages of agricultural mechanization. This illustrated that extension service links smallholder farmers to agricultural technologies. Therefore, extension service users are more likely than non-users to be willing to pay for mechanized harvester. The discussion by Challa (2014) illustrated that extension service has 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. 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 technologies in order to increase their production and productivity.

CONCLUSION

This study used one and one-half bounded format 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 services providers will receive more income. However, an increase in the rental service price decreases the number of mechanized harvester 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 walking tractor rental service. Similarly, the more farm experience they have the higher 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. Mechanized harvester rental service providers' income will also rise when household income, extension service, and field day participants increase.

Therefore, the following recommendations are critical to increase 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 mechanized rice harvesting technology rental service users before price increment.

Besides targeting male-headed households, it is necessary to aware female-headed households about the role of walking tractor 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 mechanized rice harvesting technology.

Special priority should be given to design and implement strategies to encourage small farm size owners' willingness to pay for mechanized rice harvesting technology.

Rental service providers should target farm plot suitability for tractor to minimize the cost of fuel and effort.

It is advisable to provide extension service about mechanized rice harvesting technology so as to train and motivate smallholder farmers.

Mechanized harvester rental service providers should be invited during field days to explain the rental service price and benefits of mechanized harvester besides on farm demonstrations about how it works.

Policy makers, development workers, researchers and rental service providers should work together to change smallholder farmers' living standard by using improved farm technologies like mechanized harvester.

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