Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.13, No.23, 2022

Farmer's Willingness to Pay for Teff Threshing Services in West Shawa Zone

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Abstract
Farmer's Willingness to Pay for Teff Threshing Services using the contingent valuation method was considered as a solution for more scaling up of teff threshing machine. These studding assessed farmers mean willingness to pay for and to identify the determinant of farmers', mean willingness to pay for threshing services. In this study, three-stage sampling procedure was used to select four districts, six kebeles and 142 specific sample farm households. Descriptive and econometric analyses were employed. out of the 142 household heads, 90 (63%) of them said "yes" or they were willing to accept the initial bids and the remaining 52 (37%) said "no" or they were not willing to accept the initial bids. 116 birr was the mean willingness to pay for one quintal of teff threshing services. Based on these values, the aggregate WTP for threshing services was computed at 6,704,556 birr per one quintal services in the selected four districts based on the mean from the double bounded dichotomous choice. The results obtained through Bivariate Probit model to examine factors affecting mean willingness to pay showed that age of households (hhs) head, education level of hhs heads, hhs whom is student left from school for threshing services and land holdings under teff in 2011/12 were identified to have significant positive influence to willingness to the practices. While no. of male family member with age more than fifteen years engaged on agriculture with full time and distance of hhs residence from main market, first bid and second bid were identified to have significant negative influence on willingness to pay for threshing services.
Keywords: Contingent valuation method, teff threshing services, threshing machine and Willingness to Pay
DOI: 10.7176/JESD/13-23-03
Publication date: December 31st 2022

I. Introduction

In Ethiopia cereals accounted for about 11 million hectares (80%) of the total grain cultivated area and cereals production accounted quintals 87.23% of the total grain crops produced in Ethiopia. In 2017, Teff accounts for 24% of the grain area, followed by maize (17%) and sorghum (15%) in the country. Oromia is major regions, and account 47.8% of the teff area of production [1]. On the other hand due to the high labor requirement to produce teff imposes negative impacts on return on investment (ROI). For instance, according to [2] estimate the ROI of teff as 3.88%, which is very low compared to wheat (31.6%). According to research conducted by [3] in Ethiopia, traditional methods of threshing is arduous process, time intensive, and often keeps children out of school during harvest and threshing. Teff grains are manually harvested by sickles and threshed with ox tramping on it [4].Thus traditional threshing in the Ethiopian can no longer support due to lack of oxen because of low productivity of livestock, lack of sufficient feed, high costs of rearing livestock, lack of sufficient grazing and pasture land, [5].

Furthermore, in many developing countries have been facing rapid labor out-migration [6], which has led to an acute labor shortage in the agriculture sector and delays in crop cultivation practices [7].In order to overcome these challenges with the traditional threshing system and to decrease the cost of production associated and when Agricultural mechanization was considered as one of the pillars of agricultural transformation in the country[8]. So, Bako agricultural engineering research center has introduced and promoted teff thresher in in the study area to overcome the constraints in traditional threshing. The effective supply of agricultural innovations to smallholder farmers clearly requires the demand and ability of the consumers' (users) willingness to pay (WTP) for efficient supply. According to [9] WTP can help to establish boundaries for information supply price and guide the implementation of private participation. So, the study examines farmers' WTP for the teff threshing services using the contingent valuation method with the specific objectives of the study were, to estimate farmers mean willingness to pay for teff threshing services and to identify the determinant of farmers', mean willingness to pay for threshing services

II. Research Methodology

West Shawa was selected purposively from the Eastern Oromia zone taking in to account the potential of teff production. A three-stage sample technique was used to selecting respondents. In the first stage four potential districts (Ejere, Dndi, Toke Kutaye and Ilu Galan) were purposively selected. In the second stage from each district two potential kebeles were selected. Finally, at the last stage totally 142 households these cultivate teff

were selected using systematic random sampling techniques.

A. Data Sources and Method of Data Collection

Primary data was collected from sample respondents through a structured questionnaire, via face to face interview. Before conducting the final survey, a pilot survey and focus group discussions to come up with starting bids with some randomly selected households' heads was made. To set up the starting point price this finally distributed randomly through structured questionnaires.

B. Elicitation Methods and Questionnaire Design

To design starting bid a plot survey has been conducted with open-ended questions that directly asked the maximum amount they are willing to pay for the threshing services per one quintal of teff grain. These initially open-ended questions were randomly assigned to 20 sampled households through preliminary survey. The range of response varied between 0 and 300 birr per a quintal with high concentration at the middle. The band width for the estimated kernel is determined at 100 birr. The Double Bounded Dichotomous Choice (DBDC) model is more information intensive and asymptotically more efficient than the single bounded method [10]. The DBDC model is a close-ended format consisting of a binary response of a yes or no answer to initial values ($B1$) and follow-up values ($B2$). The follow-up WTP values depend on the respondents' response to the first Willingness to Pay (WTP) value that was proposed; if the first value is accepted, the second value is doubled, whereas if the first value is refused, the second value is half of the value as much. In view of this, three starting bids of 50 100 and 150 were randomly allocated to 142 sampled households in the final survey according to the following table 1

Table1 : Bid design and number of randomly assigned sample households

First round bid	2nd round bid if "yes" in 1st round	2nd round bid if "no" in 1st round	Sample size
50	100	25	52
100	200	50	47
150	300	75	43
Total			142

Source: Own Survey

C. Method of data analysis

Both descriptive and econometric methods of data analysis were used. Descriptive analysis like frequency percentage, mean was used. Additionally, inferential statics t-test and ch2 test also used to compare socio-demographics of households accept and did not accept.

D. Econometric methods of data analysis

When the dependent variable in a regression model is binary, the analysis could be conducted using linear probability or Logit or Probit models [11]. Bivariate Probit models are estimated for the double bounded models, for efficiency and follow-up approach comparison. Bivariate normal density function is appealing to statisticians in the sense that it allows for non-zero correlation, while the logistic distribution does not[12]. When the model was assumed to follow normal distributions with zero mean and variance σ^2,

The system of equations could be estimated as seemingly unrelated Bivariate Probit (SUBVP) Model[11]. It is used to estimate the mean WTP of the respondents and used to determine the factors affecting the WTP of households from the double bounded elicitation method

A Bivariate Probit model was specified as follows

$$y^*_1 = \beta x_1 + \varepsilon_1$$

$$y^*_2 = \beta x_2 + \varepsilon_2 \quad \text{----------} \quad (1)$$

$$E(\varepsilon_1 / x_1, x_2) = E(\varepsilon_2 / x_1, x_2) = 0$$

$$Var(\varepsilon_1 / x_1, x_2) = E(\varepsilon_2 / x_1, x_2) = 1$$

$$Cov(\varepsilon_1, \varepsilon_2 / x_1, x_2) = \rho \quad \text{- - -- -- - -- - - - -- - - -- - -- (2)}$$

Where: y^*_1= i^{th} respondent unobservable true WTP at the time of the first bid offered.

WTP = 1 if $y^*_1 \geq \beta_i^0$ (initial bids), 0 otherwise

y^*_2 = i^{th} respondent implicit underlying point estimate at the time of the second bid offered.

x_1 and x_2 are the first and second bids offered to the respondents, respectively

ε_1, and ε_2 are error terms for the first and second above equations, respectively

β_1 and β_2 are Coefficients of the first and second bids offered , respectively

ρ is correlation coefficient, which is the covariance between the errors for the two WTP function

Mean WTP = α / β - - -- - -- - - - - -- - - - (3)

α is a coefficient for the constant term, and β is a coefficient for offered bids to the respondents.

The mean WTP for threshing services using the coefficients of the Bivariate Probit model is given as the mean (average) WTP from the coefficients of the first bid and and second bid

III. Results and discussion

Descriptive statistics of socio-economic characteristics of the sample households

In this study descriptive statistics was used to explain the different socio-economic characteristics of the sample households

Table 2: Relationship of continuous variables and willingness/non-willingness for threshing services for pre specified bids

Variable	Non willing		Willing		t-test	Total Mean
	Mean	Std.dev	Mean	Std.dev		
Age	45.4	13.6	41.5	12.1	1.67*	42.8
Education	2.9	3.6	5.6	4.3	3.12***	4.5
No. of parcel	4.9	3.0	3.6	2.0	2.33**	4.0
Distance to mkt	8.98	9.6	4.7	3.3	3.69***	6.1
Livestock (TLU)	8.9	9.6	4.7	3.3	.56	6.4
Total family	6.18	2.89	5.97	2.24	-0.45	6.0
No. of cattle for threshing	5.6	4.1	3.4	3.4	1.96*	4.0

*, **, *** represent the significant at 10%, 5%, and 1% level of probability of significance respectively

Source: Own Survey

The educational level of the respondent was one of the important factors for the house hold for the decision of willingness to pay for threshing services. Education influences farmers' decision to adopt technologies by enhancing farmers 'ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers [11].

The mean of years that the household head spent in school for the willing and non-willing households were 5.6 and 2.9 years respectively. It was statistically significant at less than or equal to 1% probability level of significance (Table 2).

Similarly, the average family size of the HH was about 6. Farm HH who have less family size are willing to use threshing services. but there is no statistical association willing and non willing. More than half of the households in Ethiopia currently cultivate less than one hectare of land, while the average household size is approximately five members. According to this survey the mean land size is 2.3 hectares, which sustains an average household size of 6 people.

Table 3; Household experience using a teff threshing machine, frequency of visit by extension worker and off farm activity

No	Variable	Categories of HHs	Frequency	Percentage
1	Sex	Male headed	126	89
		Female headed	16	11
2	Do you have experience using a teff threshing machine?	Yes	36	25
		No	106	75
3	Is there a student left from school for threshing services?	Yes	90	63
		No	52	37
4	Frequency of visit by development workers	Weekly	36	25
		Monthly	30	21
		Peak season	46	32
		No visit	30	22
		No	106	75

Source: Own Survey

Threshing costs of teff using traditional method

Through respondent interviews the cost of threshing the teff harvested from one hectare using traditional method was estimated according to the table below. The cost estimated was depend on the average opportunity costs of human labor estimated as 100 Birr/man/day and 124 Birr/pair of oxen/day for oxen power according farmer's perception during the survey conducted. The cost of teff threshing using traditional method of threshing was estimated 5534 Birr/hectare (table 4). Similarly, [13] indicated that the traditional threshing practice was very expensive when the implicit cost of family owned inputs was included

Table 4, Threshing costs of teff using traditional methods

No	Cost Items	Average amount estimated /ha	Average Cost of activity (in Birr)	Remarks
1	Labor for Preparing threshing floor	4.5	450	Including mudding
2	Human labor for threshing	10.5	1050	100 Birr/man/day
3	Oxen rental payment for threshing	12.6	1562	124 Birr/ oxen/day
4	Labor for winnowing	5	500	
5	Estimated threshing loss	44kg	968	2200birr/qt
6	Meal for laborers		1004 birr	Including drinking alcohol
	Total		5534 birr/ha	

Source: Own Survey

The other drawback of traditional way of threshing reduce the quality or mix with dung, animal urine and soil impurities of produce to not have premium price in the market. In addition, the interviewed farmers because of heaviness most of farmers start threshing at night time to escape from day temperature. The farmers were asked at what hour did you start threshing and their replay was indicated that about 62% of them had started threshing at night time. Another point that is clearly seen was because of lack of their own cattle for threshing and enough labor for threshing more than a half (54%) of the farmer replied as they thresh lately per years and only 46% thresh on time before the crop affected with external factor like rain and animals.

Table 5: Average threshing time per day and per year

No.	Categories	Category	N	%
1	At what hour do start thresh teff/day	8-9 o clock at night	35	25
		10-11 “ “	53	37
		12 o.clock and onward	55	38
2	Threshing time per year	On time	66	46
		Lately	76	54

Source: Own Survey

Household’s willingness to pay for Teff Threshing Services

As indicated in methodology part, based on the pilot survey and group discussion results, the three starting bids of 50 100 and 150 birr per one quintal delivering threshing services were randomly allocated to 142 sampled households in the final survey and the result obtained was indicated in the table below

Table 6. Distribution of household’s willingness to pay for Teff Threshing Services

Type of bid		Birr per quintal	Number of “Yes”	%	Number of “No”	%	Total
Initial bid		50	39	27	13	9	52
		100	31	22	16	11	47
		150	20	14	23	17	43
		Total	90	63	52	37	142
Follow up bid	If the response for initial bid was yes	100	14	16	25	28	39
		200	13	14	18	20	31
		300	7	.07	13	14	20
		Total	*34*	38	*56*	62	90
	If the response for initial bid was no	25	8	15	5	.10	13
		50	8	15	8	15	16
		75	13	25	10	19	23
		Total	*29*	56	*23*	44	52

Source: Own Survey

Hence, given the randomly assigned initial bids, out of the 142 household heads, 90 (63%) of them said "yes" or they were willing to receives the initial bids and the remaining 52 (37%) said "no" or they were not willing to accept the initial bids. Of the 52 surveyed respondents, the percentage of households that did not accept the initial bid but accepted the follow up discounted bid was found to be 56% (Table 6)

Distribution of "yes" and "no" responses

In the double-bounded dichotomous choice model, there are four possible response sequences: these are; both answers are yes (Yes-Yes); both answers are no (No-No); a yes answer followed by a no answer (Yes-No); and a

no answer followed by a yes answer (No-Yes).The distribution of “Yes” and “No” answers to the corresponding initial and follow up bids are given in Table 7. Accordingly, only 23 respondents answered "NN" (No to first and No to the follow up bids) and 29 of them answered "NY" (No to first and Yes to the follow up bids).

Table 7. The distribution of "Yes" and "No" answers vs. initial and follow up bids

WTP Response	Frequency	Percent
No –No	23	16
No –Yes	29	20
Yes –No	56	40
Yes- Yes	34	24
Total	142	100

Source: Own Survey

The Econometric Analysis

Age of households (hhs) head, education level of hhs heads, households whom is student left from school for threshing services and land holdings under teff in 2011/12 were identified to have significant positive influence to willingness to the practices. While no. of male family member with age more than fifteen years engaged on agriculture with full time and distance of hhs residence from main market, first bid and second bid were identified to have significant negative influence on willingness to pay for threshing services. The remaining variables did not show any significant role to influence the decision behavior of the sample households in the study area. The chi-square test showed the overall goodness of fit of the model at less than 1% probability level (prob > chi2 = 000).

Table 8: Seemingly unrelated Bivariate Probit estimates of WTP

Variable	WTP for first bid			WTP for second bid			Marginal effect	
	Coef.	R. Std.Err	p>/z/	Coef.	R.Std.Err	p>/z/	Dy/dx	Std.Err
Age	0.0206*	0.0116	0.08	.00093	.0116	0.93	.00361	.0025
Education	.0823**	.03415	0.02	.062*	.033	0.06	.02198	.007
Malegreater	-.18823	.1574	0.23	.4066**	-.1420	0.01	.0207	.034
Distancemkt	-.098***	.029	0.01	.0116	.0167	0.49	.0153	.0059
Tefhectar	.23690*	.139	0.09	.0485	.1398	0.73	.0339	.029
Student	.50701*	.274	0.07	.391	.259	0.13	0.144	.065
Cons	.955264	.73	0.01	.5383	1.34	0.43		
BID1	-.008***	.004	0.01					
BID2				-.003 ***	.0093	0.00		

Source: Own Survey

From Table 8, education level of the respondents is positively and significantly related to WTP. That is, respondents with more years of schooling likely to be willing to pay for threshing services. The result also revealed that holding other things constant, a unit increase in years of schooling of the respondents, increases the probability of accepting the first bid as well as the follow up bid by about 2 %. The finding of positive association between household head educational status and willingness to pay was consistent with initial assumption and it was also similar to findings by [15] which identified educational status of farmers to have positive influence on encourages tractor hiring services. Labor availability was generally expected to negatively influence farmers’ farmer willingness to pay for teff threshing services because of having labor. Hence, house hold with high number of male families greater than fifteen years these engaging on agriculture with full time was expected to have negative relationship with farmers’ willingness to for threshing service of teff through mechanical ways. Farmers with more access to family labor were found to be statistically different from farmers with less access and the relationship was highly statistically significant ($p<0.004$) in the second bid. Holding other explanatory variables constant, hhs who had more labor were willing to pay less than those with less access to labor

Mean WTP for teff threshing services based on Bivariate Probit model

The mean WTP from bivariate probit model was computed using the formula specified by [11] that is, mean WTP = $- \alpha/ \beta$ where α is a coefficient for the constant term, and β is a coefficient for offered bids to the respondents. Thus, the mean WTP based on the coefficient of the initial bid and the first constant term was calculated as Follows;

Mean $WTP_1 = - \alpha/ \beta = -0.95/-0.01 = 95$ birr

The mean WTP using the coefficients of the second or follow up bid and the second constant term was also calculated as follows;

Mean $WTP_2 = - \alpha/ \beta = -1.233/-0.009 = 137$ birr

Hence, the Mean WTP= - α/ β =(Mean WTP1+ Mean WTP2) /2 = 116 birr was the mean willingness to pay for one quintal of teff threshing services

Welfare Measures and Aggregation benefits by districts

In the previous section, factors affecting household's willingness-to-pay for threshing services have been presented and discussed. Once the mean WTP was obtained, the values were aggregated to get the total WTP for the entire population.

An important issue related to the measurement of welfare using WTP was aggregation of benefit obtained from the sample respondents to the total population

Protest zero responses were excluded from the data set, and households who were expected to have a valid response in the selected districts were used in the estimation of the total aggregate benefit of conservation practices. According to agricultural and natural resource of each district office, the number of households in each districts were indicated in table row (2) of table 12.

Table 12 : Welfare measures and aggregate benefits by each districts

Name of KAs and attributes	Districts of study area				Total
	Ejere	Dandi	T.kutaye	I.Galan	
Total HHs in each district(a)	14540	31037	13523	9608	199578
Number of sampled HHs(b)	57	32	27	26	142
No. HH with protests zeros(c)	11	5	4	3	23
Proportion of protest zeros(d)	19	16	15	12	16.2
Expected protest zero's HH (e)	2763	4966	2028	1153	31932
HHs with valid responses(f)	11777	26071	11495	8455	167646
Mean WTP(g)	116	116	116	116	
Total WTP(f*g)	1366132	3024236	1333420	980780	6704556

Source: Own Survey

The study area of the four districts had 199,578 households. In the Double-bounded Dichotomous choice model from four possible response sequences, both answers no (No-No) of 23 respondent (16.2%) were excluded from the total 142 sampled households. Totally 31932 (16.2%total households) were excluded from further analysis.In Table 12 above, the aggregate WTP was calculated by multiplying the mean WTP by the total number of households who were expected to have a valid response in the selected districts. Following this, the aggregate WTP for threshing services was computed at 6,704,556 birr per one quintal services in the selected four districts based on the mean from the Double bounded Dichotomous choice

IV.CONCLUSION

This study examined households' willingness to pay for teff threshing services in west Shawa zone, Oromia National Regional State, Ethiopia. The main objective of this study was to identify factors affecting smallholder farmers' willingness to teff threshing services. The data used for this study were both from primary and secondary sources.

A designed contingent valuation questionnaire (primary data) was administered to 142 farm households drawn randomly from four districts (Ejere, Dandi, Toke Kutaye and Ilu Galan).The primary data were collected using semi structured questionnaire and the secondary data were obtained from each districts of agriculture and natural resource office. Both descriptive statistics and econometric model were employed to analyze the data.

The t-test was used for the continuous explanatory variables was used to confirm the presence of difference between acceptance of the offered initial bid. Descriptive statistics showed that there were significant differences between willing and non-willing households of teff threshing services with respect to some explanatory variables. Among these variables education level, no. of parcel, distance to market and no. of cattle for threshing were statistically significant at different probability level of significance.

According to respondent interviews the cost of threshing teff harvested from one hectare using traditional method was calculated as 5534 birr/ha Including different drawback like reduce the quality or mix with dung, animal urine and soil impurities of produce to not have premium price in the market. In addition, the interviewed farmers because of heaviness the activity most of farmers start threshing at night from 9:00 o'clock. The results obtained through Bivariate Probit model to examine factors affecting mean willingness to pay showed that age of households (hhs) head, education level of hhs heads, hhs whom is student left from school for threshing services and land holdings under teff in 2011/12 were identified to have significant positive influence to willingness to the practices. While no. of male family member with age more than fifteen years engaged on agriculture with full time and distance of hhs residence from main market, first bid and second bid were identified to have significant negative influence on willingness to pay for threshing services.

Recommendation

Based on the results of the study, the following recommendations were made to accelerate the use of machine threshing services in the study area as follows.

Programs for training to farmers regarding implementation of acceptance of using threshing technologies in successful manner need to be imparted along with emphasis to increase literacy.

From the contingent valuation survey responses of the sample households it was observed that threshing teff with machine has a higher demand in the study area

The majority of people (84%) in the study area accepts threshing one quintal of teff with 116 birr. Hence, any suppliers can be delivering by hiring services according to farmers mean willingness to pay based on the findings of this study

The government and concerned bodies may also provide such information to the suppliers in order to induce them to supply teff threshing machine in this study area

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