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# Households' Willingness to Pay for Improved Teff Seed in Yilmana-Dinsa Woreda of West Gojjam Zone, Amhara Nation

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## Abstract

*The objective of this study was to examine the willingness to pay for improved teff seed in Yilmana-Dinsa woreda, West Gojjam zone. The data were generated from both primary and secondary sources. The primary data were collected from 121 sample respondents in three kebeles. The data were analyzed using descriptive statistics and an econometric model. A contingent valuation method was employed to estimate the parameters in the Tobit model. The result showed 79.3% of them were willing to pay for improved teff, while the remaining 20.6% were non-willing respondents for improved teff seed. Among the socio-economic characteristics of the sample respondents, sex, access to training, level of education, age, on-farm income, extension contact, and credit use were statistically significant. The mean amount of household willingness to pay for improved teff seed had an average price of 35.89, with a minimum and maximum of 0 Birr and 100 Birr per kilogram, respectively. The econometric result of the Tobit model revealed that level of education, farming experience, frequency of extension contacts, credit use, and access to training were factors that positively and significantly affected households' maximum willingness to pay for improved teff seed. Off-farm income and distance from the nearest market were factors that negatively and significantly affected households' maximum willingness to pay for improved teff seed. Based on the findings, government and other stakeholders need to focus on strengthening improved seed access through organized seed systems that encompass all actors and promising cultivars through a well-established national extension system in order to fill the current seed system gaps.*

***Keywords:*** *Improved teff, willingness to pay, Tobit model, households*

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## Introduction

Agriculture is a core driver of the Ethiopian economy. It accounts for 38% of GDP, 80% of export value, and 72% of employment opportunities (NPC, 2016). Diversifying and increasing agricultural production through improved seeds can help to overcome malnutrition and poverty by enhancing household production and productivity and creating new market opportunities for smallholders (Akalu and Jochen, 2016). In developing countries, agricultural innovations are perceived as significant pathways out of poverty (Simtowe et al., 2011; Mwangi and Kariuki, 2015), and therefore, improved new agricultural technology adoption has become an important way of boosting productivity (Mignouna et al., 2011). A new technology is assumed to offer a pathway to substantially increase production and income (Beshir and Wegary, 2014).

For long-term food security and economic growth, it is essential to increase agricultural output utilizing enhanced seed that facilitates the production of sustainable food and fiber (Mwangi and Kariuki, 2015). In the majority of SSA nations, neither the national nor household levels of food security have been adequately guaranteed by the agricultural sector. Despite a rise in production over time, productivity has not kept pace with the growth of the cultivated land. Increasing farmers' income, lowering food prices, and consequently boosting increases in consumption can all help to eliminate poverty in agriculture (Diagne et al., 2009).

Addressing food security and poverty problems in agriculture-based economies demands substantial efforts in improving agricultural production and productivity. Alene et al. (2009) and Kassie et al. (2011) also show the contributions of agricultural technologies to the welfare of smallholder farmers and other poor households, who benefited from the enhanced adoption of technologies and improved agricultural productivity and production over time. Improvement of agricultural productivity provides an important solution to addressing the problems of food insecurity and poverty and enhancing the development of agriculture in Ethiopia. Consequently, attempts are being channeled into ways by which increased agricultural productivity can be achieved through promoting the use of improved agricultural technologies and improving the efficiency of agriculture production in Ethiopia (Sinafikeh et al., 2010; Yu and Nin-Pratt, 2014).

The major cereal crops cultivated in Ethiopia are teff (3.02 million ha), maize (2.11 million ha), sorghum (1.83 million ha), wheat (1.66 million ha), and barley (0.99 million ha) (CSA 2015).

Although agriculture is the foundation of the country's economy, crop productivity has remained low. For instance, the average national yield of important food crops such as teff, maize, sorghum, and wheat is 1.58, 3.43, 2.37, and 2.54 tons per hectare, respectively (CSA, 2015), while the potential of those crops is two- to three-times higher (MoARD, 2008).

Even if the introduction and popularization of improved teff seeds took a long time, the issue of improved seed shortage remains unsolved in Ethiopia, specifically in the study area. The major reason suggested was the low level of improved seed adoption technology due to scarcity of improved seeds and governmental support based on their geographical area (Alemayehu et al., 2012). Understanding the existing seed system for commercialization and innovation, identifying key actors and their respective roles, and understanding policy and strategies for better teff production development are vital. Hence, the Ethiopian government has accordingly paid due attention to improving the productivity of the subsector in both the GTPI and GTPII. Despite the fact that improved teff seed has numerous benefits and has been used in Ethiopia for a long time, updated empirical evidence on the determinants of farmers' willingness to pay for improved teff seed will be scarce. Therefore, this study endeavors to fill the information gap on seed systems and determinants of farmers' WTP for improved teff seed technologies in the Yilmana-Dinsa district.

## Statement of the Problem and Objectives

The agriculture sector in Ethiopia plays important roles in food security, economic growth, foreign exchange earnings, poverty alleviation, and employment creation. Despite the enormous contribution over the past years, its significance is limited because of various factors like the lack of improved seeds and low WTP for households, and hence it is becoming increasingly difficult to meet the food requirements of the growing population (Jon, 2007; UNDP, 2013). In Ethiopia, WTP for improved agricultural technologies has been a long-term concern of agricultural experts, policymakers, agricultural researchers, and many others linked to the sector. However, several area-specific evidences indicate that the adoption rate and WTP for modern agricultural technologies in the country are very low, which leads to increasing poverty and food insecurity in rural farm households (Degnet and Belay, 2001; Alemayehu, 2009; Alemayehu et al., 2012). This low rate of WTP decisions by farmers is usually determined by various factors that may be specific to socio-cultural, geographical, and agro-ecological zones.

Teff is among the most widely grown cereals in Ethiopia and a staple diet for the majority of the population, which is important for national food security. While production and productivity have increased over time, demand has risen faster, and so the price of teff has increased in recent years. However, the national productivity of teff is very low at around 15.75 qt/ha (CSA, 2015), with the highest productivity farmers achieving 25 qt/ha and research field trials of teff reaching 40–50 qt/ha (Bekabil et al., 2011). Hence, the result indicates the possibility of increasing teff production and productivity if farmers use improved management practices and improve their willingness to pay for improved seeds, the optimal amount of fertilizer, good crop husbandry, and effective pest control measures.

In order to increase teff production, various attempts were made by increasing the willingness to pay for improved technologies using both conventional and modern breeding techniques. Using conventional breeding techniques, about 33 improved varieties have been released to teff producer farmers (MoA, 2013). Crop management studies have also been done at many locations representing different agro-ecological zones (Tesfa et al., 2013). In addition, extensive studies have been made on the utilization of teff for human food (Geremew and Melaku, 2013) and livestock feed (Alemu, 2013). Significant progress has also been made in technological change and economic viability (Setotaw, 2013), teff research extension, the teff seed system (Dawit et al., 2012), and teff value chain analysis (Bekabil et al., 2011). However, limited research was conducted in WTP for improved seed analysis of teff in Ethiopia in general, and there was particularly no research done on WTP of teff in the study area. Hence, the research tries to fill this research gap.

According to Aryal et al. (2009), farmers' willingness to pay for specific agricultural technologies is influenced by their knowledge, attitude, and economic characteristics such as age, sex, and income; the other motive for this study would be the absence of empirical studies on the determinants of farmers' WTP for improved forage seeds in Ethiopia in general and in the study area in particular. Based on this, I would investigate the determinants of farmers' WTP for improved teff seed and set the accepted mean amount of willingness of households for improved teff seed in the study Yilmana-Dinsa area shape a consumer's willingness to pay, because those characteristics influence attitudes toward agricultural technologies. In addition, market characteristics such as accessibility and prices affect purchase behavior and ultimately farmers' willingness to pay. Therefore, this study intended to examine households' willingness to pay for improved teff seed in Yilmana-Dinsa woreda, West

Gojjam zone, Amhara regional state, Ethiopia. In this regard, this study attempted to answer the following research questions: Who is involved in the willingness to improve teff seed? What are the factors that affect the WTP for improved teff seed in the study area? And what is the mean amount of WTP for improved teff seeds in the study area?

## Related Literature Review

Cho (2013) defines improved seeds by dividing them into pieces as: "open pollinated seeds," which are those produced from natural, random pollination. Traditionally, farmers saved the best of these seeds for use from year to year. Hybrid seeds result from cross-breeding two parent plants that have desirable traits. The resulting plants realize their potential in the first season but lose effectiveness in subsequent generations, so farmers must buy new seeds each year. Genetically modified seeds are created when one or two genes with the desired traits from any living organism are transferred directly into the plant's genome.

Productivity increases in agriculture can reduce poverty by increasing farmers' income, reducing food prices, and thereby enhancing increments in consumption (Diagne et al., 2009). It is also of considerable significance that when agricultural production increases through the use of improved varieties of crops in a given area, farmers and their communities derive added socioeconomic benefit. Such activities can increase the value of locally produced crops, generate local employment, stimulate local cash flow, and through processing, marketing, and related activities, bring about improvements in socio-economic status and the quality of life (Mwabu et al., 2006). However, several research findings have pointed to the fact that the use of new agricultural technology, such as high-yielding varieties of improved seed, could lead to a significant increase in agricultural productivity in Africa and stimulate the transition from low-productivity subsistence agriculture to a high-productivity agro-industrial economy (World Bank, 2008). Farmers' access to seeds of adapted modern or landrace varieties to their agro-ecologies is critical to increasing production.

Low crop productivity in SSA, including Ethiopia, is mainly due to the limited use of improved seed varieties by smallholder farmers. The supply of certified seeds for grain crops in Ethiopia is estimated to be about 10% of the annual seed planted (Spielman et al., 2010). However, deficiencies have been observed in improved seed supply due to inadequacies in seed varieties demanded and quantity required, prices, and untimely seed delivery (Sahlu et al., 2008).

One of the most important inputs in agriculture is seed. Seeds form the foundation of all agriculture. Without seeds, there is no next season's crop. The genetic traits embodied within seeds reflect and determine the nature of farming systems dependent on them. The genetic and physical characteristics of seed determine the productivity in line with the use of other agricultural inputs and improved cultural practices within the farming system. Improving the genetic and physical properties of seed can trigger yield increases and lead to improvements in agricultural production and food security. In order for seed to act as a catalyst in agricultural transformation, however, improved seed has to be made available to a broad base of farmers on a continuing basis.

The use of good-quality seed from improved varieties is widely recognized as fundamental to ensuring increased crop production and productivity. This is even more important in SSA in light of the increasingly available land, declining soil fertility, and ever-growing population; these facts increase the importance of promotion and the use of good quality seed as a means to intensify crop production. The potential benefits from the distribution of good-quality seed of improved varieties are enormous, and the availability of quality seed of a wide range of varieties and crops to the farmers is the key to achieving food security in SSA. Enhanced productivity, a higher harvest index, reduced risks from pest and disease pressure, and higher incomes are some of the direct benefits potentially accruing to the farmers (FAO, 2004).

Among of the essential elements are the formation of institutions that promote the production and dissemination of better seed (Lipton, 2005). There have only ever been two seed-producing companies in Ethiopia: the global commercial corporation and the Ethiopian Seed Enterprise (ESE), which was founded in 1979. (Pioneer Hi-bred Ethiopia established in 1990). The Ethiopian seed industry was largely ad hoc prior to 1979, and seed distribution and multiplication were handled by a number of small, uncoordinated organizations like agricultural research centers, colleges and universities, and various project-related organizations like the rural development unit. ESE was completely in charge of the distribution of inputs, including seed, fertilizer, and pesticides, up to 1990. (Gemeda et al., 2001).

Ethiopia's economy is still dominated by agriculture, with cereals playing a key role. Studies from the past indicate that cereals make up 65 percent of the agricultural value added, or roughly 30 percent of the country's GDP, making grain production and marketing particularly crucial.

Smallholder farmers (14.16 million farmers) planted 12.57 million hectares of land for grain crops during the 2015 production year. Cereals occupied 80.78% (10.14 million hectares) of the area used for grain crops. Teff, maize, sorghum, and wheat made up 24.02% of the grain crop area, 3.02 million hectares, 16.80% of the grain crop area, 2.11 million hectares, 14.58% of the grain crop area, and 13.25% of the grain crop area, respectively. Of the total grain production, cereals made up around 236.08 million quintals, or 87.31%. Maize, teff, wheat and sorghum made up 26.76% (72.35 million quintals), 17.57% (47.51 million quintals), 15.65% (42.32 million quintals) and 16.05% (43.39 million quintals) of the grain production (CSA, 2015).

Low teff productivity is partly caused by the way farmers sow teff seed and apply and broadcast the seed at a rate of 25–50 kg per hectare. This practice reduces yields because of the uneven distribution of the seeds, higher competition between plants for inputs (water, light, and nutrients), and difficult weeding once the plants have matured (Bekabil et al., 2011). Reducing the seed rate to between 2.5 and 3 kg/hectare allows for reduced competition between seedlings and optimal tilling of the teff plants. By row-planting, land management and especially weeding can also be done more readily, and the incidence of lodging is reduced.

In this study, stated preference using the contingent valuation method (CVM) is used to gauge how households perceive improved teff seed and how much they are willing to pay for improved teff seed. Households were asked to indicate the maximum amount they were willing to pay for improved teff seed. The contingent valuation methods involve directly asking people, in a survey, how much they would be willing to pay for improved teff seed.

Over the past fifteen years, the contingent valuation method (CVM) has become a useful tool in determining willingness to pay (WTP). The main objective of CVM is to stimulate the same kind of ordered preferences that, according to economic theory, would be revealed through market behavior if such a market existed. The contingent valuation method (CVM) may be useful when markets are missing and preferences cannot be revealed through market responses. Markets are more often found to be missing or imperfect in developing countries than in developed countries. This may render the CVM even more relevant in developing countries (less developed countries, LDCs), although its validity and reliability have yet to be clearly established LDC context.

Contingent valuation is probably the most widely used method for placing monetary values on public goods. The contingent valuation (CV) method is based on consumer surveys whose questions elicit consumer preferences for public goods by constructing a hypothetical market for the public goods. According to Mitchell and Carson (1989), this market is created based on either a private goods market or a political market. A CV study is designed to estimate consumers' WTP for public goods by asking them how much they would pay for specific government actions. The contingent valuation (CV) method was developed to directly elicit statements of willingness to pay for changes in the resource allocation of non-market goods such as environmental quality. This single question is easy for respondents to answer, relative to other forms of contingent valuation questions.

There are several advantages to using the CVM. Firstly, this method is simple to understand as it does not have to contemplate the exact values for the resource. This method also minimizes the possibility of starting points, strategic points, and strategic biases. This method only requires respondents to make comparisons between the alternatives rather than try to value them directly. In addition, CVM is relatively information-rich in terms of the characteristics of the data of respondents and does not rely on secondary data, which are frequently collected for different purposes. However, this method has some disadvantages. One of the disadvantages is that it requires sophisticated statistical and estimation methods to analyze qualitative responses. Another disadvantage is that only limited information can be obtained from respondents, and this method also requires appropriate ranges of values. Consequently, it is essential that contingent valuation surveys incorporate a well-designed and sensitive measurement instrument.

Questions have been raised about the reliability of direct methods such as the CVM, dichotomous choice questioning, and experimental markets as the best methods for determining a mean willingness to pay. One issue is that consumers may not have enough information about the risks and therefore may give an inaccurate monetary evaluation based on risk avoidance. Another problem is the extension of WTP results to other foods. Within the CVM, most of the analyses are of hypothetical situations that the consumer may take less seriously than a real one and therefore tend to overestimate or underestimate their true WTP. This creates an unwanted bias that affects the true mean WTP for a product.

The CVM survey uses questions to elicit people's preferences for public goods and services by finding out what their WTP would be for the specified improvement (improved forage seed in this case). According to Haab and McConnell (2002), the final element of a CV scenario is the method of asking questions. This part of the questionnaire confronts the respondent with a given monetary amount and, one way or another, induces a response. Here are the basic approaches to asking questions that lead directly to WTP or provide information to estimate preferences.

Open-ended: A CV question in which the respondent is asked to provide the interviewer with a point estimate of his or her WTP. It is worded as "What is the most you would be willing to pay for...?" Due to respondents' difficulty in answering the payment question and the fact that it results in many missing values, the open-ended CV elicitation approach is these days less frequently used.

Bidding Game: A CV question format in which individuals are iteratively asked whether they would be willing to pay a certain amount or not. The amounts are raised (lowered) depending on whether the respondent was (was not) willing to pay the previously offered amount. The bidding stops when the iterations have converged to a point estimate of WTP. The final amount is interpreted as the respondent's WTP. This approach however, has its own disadvantages. The first disadvantage of the bidding game approach is that it results in a starting point bias as the final value is systematically related to the initial bid value. Annoying or tiring respondents which causes them to answer yes or no to a stated amount in hopes of terminating the interview is another disadvantage of the bidding game approach.

Payment Cards: A CV question format in which individuals are asked to choose a WTP point estimate (or a range of estimates) from a list of values predetermined by the surveyors and shown to the respondent on a card. The final amount chosen by the respondent can be interpreted as the respondent's WTP. This approach is also criticized on the ground that the respondents might limit their announced WTP to the values listed on the card.

Closed-ended approaches (dichotomous choice question): asked respondents whether they would pay a stated amount for the good in question by providing intervals in which the respondents WTP lies. This method is advantageous over the open-ended question format in eliciting WTP because of the simplicity of "yes "or "no" answers for the respondents and thus reduces incentives for strategic responses. It also has the advantage of being much more similar to the choice that individuals are asked to make in real markets when faced with market prices. However, it suffers from starting point bias, a shortage of information, reduced efficiency, and the requirement of a large sample to estimate benefits as maximum WTP is not directly obtained from this format.

In general, the stated preference methods such as CVM are used to estimate both use and non-use values and also used to estimate the values of proposed new policies (Young, 2005), and this indicates that CVM can measure the total economic value of improved Teff seeds. More specifically, in this study, an open-ended question format was applied.

Empirically, there are very few studies that have been conducted on the WTP for improved agricultural technologies. Among them, most of the studies applied CVM. But no one showed a willingness to pay for improved teff seed technologies. Therefore, this section will only provide a related willingness to pay studies and the choice of methodologies for the study.

In research done by Reta (2013) on farmers' willingness to pay for locally produced potato seed tubers and groundnut seed, in the case of Haramaya and Babile districts of eastern Hararghe Zone, Oromia regional state, Ethiopia, the double hurdle model is used to analyze the farmers willingness to pay and factors affecting the intensity of premium willingness to pay for quality seed on top of grain prices. The Tobit model is used to analyze factors determining the quality of seed used by farmers. The results of the double hurdle model revealed that level of education, land holding, and seed quality are factors that significantly affect both farmers' decisions to pay and the intensity of WTP for quality potato seed tubers. The result also shows that farmers' willingness to pay for quality groundnut seed and the intensity of their premium willingness to pay for the seed of the crops are significantly affected by family size, land holding, seed availability, and seed quality. The result of the Tobit model shows that levels of education, land holding, use of irrigation, access to credit, seed quality, and availability significantly affected the level of use of quality potato seed tubers. On other side, smallholder farmers' willingness to pay for improved forage seed revealed that, in the case of the eastern zone of Tigray, age, level of education, livestock holdings, access to credit, the initial bid, and follow-up bids were significantly affecting their willingness to pay.

Some literature also conducted research on the joint estimation of farmers' stated willingness to pay for agricultural services in the case of west and central Africa. In this paper, a multivariate probit approach was used to investigate farmers' stated willingness to pay for different agricultural services, including soil fertility management, crop protection, farm management, improved produce quality and varieties, on-farm storage (post-harvest), improved individual and group marketing, and disease control.

It is also common to employee a contingent valuation technique to estimate respondents' willingness to pay (WTP) for improved rural water supply. The analysis was done based on data collected from 132 households. The data were collected through double bounded dichotomous question to elicit respondent's WTP. Both binary and ordered probit model were used to examine the determinants of WTP. The regression results indicate that households who earns better annual income, who participated during the early phase of project implementation, who are using unreliable water sources and who are spending more time in collecting water are more likely to pay. Whereas those households with large family members and those collecting water from convenient water points are less likely to pay.

## Materials and Research Methods

The study was conducted based on both primary and secondary data. The primary data were collected using a formal survey from a sample of farmers in the study area through a semi-structured questionnaire and face-to-face interviews. Before the data collection, the questionnaires were pre-tested on eight farmers to evaluate the appropriateness of the design, the clarity and interpretation of the questions, and the relevance of the questions. Subsequently, appropriate modifications and corrections were made to the questionnaire based on their answers. Enumerators who have a college diploma and are working in the district were hired and trained about the objectives of the study and the techniques of data collection. In addition to the questionnaire, focus group discussion and key informants' interviews were employed using checklists to obtain additional supporting information for the study.

A two-stage sampling procedure was used for the selection of sample household heads. At the first stage, three teff-producing kebeles were selected randomly. In the second stage, from the selected kebeles, about 121 households' heads were selected randomly from each kebele using probability proportionate to size sampling techniques. The sample size was determined following a simplified formula provided by Yamane (1967). Accordingly, the required sample size at a 95% confidence level with a level of precision equal to 9% was used to determine the sample size required to represent the population.

$n = \frac{N}{1+N(e)^2} n = \frac{5893}{1+5893(0.09)^2}$ = 121

Where: n = sample size N = population size e = level of precision (9%)

This is accomplished through proportionate sampling, which determines sample size from each kebele in a proportional manner. Descriptive statistics and Tobit analysis were used for analyzing the collected data.

In this study, the Tobit model was used to identify both factors affecting the WTP of households for using improved teff seed and to estimate the parametric MWTP of farmers for teff seed. To analyze survey responses, two different econometric models are specified: one for single-bound and the other for open-ended survey responses, depending on the nature of the response. The main objective of estimating an econometric model in a willingness to pay survey is to calculate the mean willingness to pay and to allow inclusion of respondents' socio-economic factors in the willingness to pay functions, which supports the researcher in obtaining information on the validity and reliability of contingent valuation results and hence increasing confidence in the application of results obtained from the contingent valuation empirical analysis (Haab and McConnel, 2002).

There are two approaches to modeling the single-bounded, closed-ended survey responses. These are modeled as dichotomous variables, as in the random utility framework in the utility differential model. The households' willingness to pay survey responses from the open-ended format are using a censored model such as the Tobit model if the dependent variable takes nonnegative values with some study. In this study, we used the Tobit model for the open-ended responses to analyze survey responses. Tobit is an extension of the probit model, and it is really one approach to dealing with the problem of censored data. Some authors call such a model a limited dependent variable model because of the restriction it puts on the value taken by the regressed. In this study, the Tobit model was employed to identify the factor affecting households' maximum willingness to pay for improved teff seed. The Tobit model allows us to estimate the effect of the independent variables on the zero and positive values of the dependent variable separately. The relationship between the censored and independent variables can be expressed by a general Tobit model.

$y_i = 1$ If $y^*>0$

$y_i= 0$ If $y^* \leq 0$

$y*$ is observed if $y_i>0$ and is not observed if $y_i* \leq 0$. Then the observed $y_i$ will be defined as

$y=y*=\beta x + U_i$ If $y*>0$

$y_i= 0$ If $y* \leq 0$

Where $y_i$=The observed maximum willingness to pay of individual I; $y_i*$= The latent variable and it is observed if it is greater than one and not as well as observed if it is less than or equal one; $x_i$= The independent variable and $\beta$= Vector of slope parameter

It is noticeable that most Ethiopian households are not using improved seed for their agricultural production; hence, there are a large number of 0 values associated with the maximum value willing to use the improved teff seed. An attempt to use ordinary least squares estimates to model the maximum value willing to improve teff seed with a large proportion of zero observations would result in biased estimates. Therefore, Tobit models were estimated to generate both zero and non-zero values of the dependent variable to account for a non-trivial number of zero observations. This method has been widely used in applied econometric studies. The Tobit model allows us to estimate the effect of the independent variables on the zero and positive values of the dependent variable separately. The observed maximum value willing to pay for improved teff seed (y) of households takes "0" or a positive value in our model. The relationship between the censored and independent variables can be expressed by a general Tobit model. The Tobit model, originally developed by Tobin, may be expressed in the following way

$$y = \max(0, y^*)$$

$$y^* = \beta_{xi} + \mu_{i,} \mu_i \overset{0,\delta_2}{N})$$

Where $\beta$ a vector of unknown coefficients is, x is a vector of independent variables. The Tobit model supposes that there is a latent unobservable variable $y*$. This variable depends linearly on $x_i$ via a parameter vector$\beta$. In addition, there is a normally distributed error term $\upsilon_i$ to capture random influence on this relationship.

From the standard likelihood function for the censored normal distribution, we can derive the log-likelihood function for the Tobit model:

$$y_i - x_{i\beta^2}$$
$$\frac{x_{i\beta}}{\delta}$$
$$1 - \emptyset$$
$$LnL_T = (2) + \delta^2 + + \sum_{y_i}$$
$$\frac{-1}{2}$$
$$\sum_{yi=yi}$$

After running regression of dependent variable (yes/no indicator), on a constant and on independent variable, the mean WTP value is determined as follows depending on the normality assumption of WTP distributions (Haab and McConnell, 2002):

$$mean\ \text{WTP} = \mu = \sum \text{Mx}/\text{n}$$

Where Mean WTP = the mean willingness to pay for improved teff seed; ∑Mx = Total sum of sampled household maximum pay amount of ETH birr and n = total sampled households. In this study the dependent variable is maximum willingness to pay for improved teff seed. Which is the amount of money (birr) that households agree to pay for improved teff seed?

**Table 1**

*Summary of Independent Variables and Their Effect of Maximum Willingness to Pay*

| Variables | Data type | Measurement | Hypothesis |
|---|---|---|---|
| Sex of the household heads | Dummy | 1 if male, 0 if female | +/-ve |
| Family size of household heads | Continuous | Number | +ve |
| Education level of household heads | Continuous | Years | +ve |
| Farming experience | Continuous | Years | +ve |
| Amount of credit taken | Continuous | Birr | +ve |
| Frequency of extension contact | Continuous | Number | +ve |
| Distance to nearest market | Continuous | Kilometers | -ve |
| Off/non-farm income | Continuous | Birr | +/-ve |
| Land allocated for *teff* production | Continuous | Hectares | +ve |
| Access to training | Dummy | 1 if yes, 0 if No | +ve |

**Source: Own computation**

## Result and Discussion

This chapter presents the findings of households' willingness to pay for improved teff seed and how demographic and socio-economic factors affect the maximum willingness of households to pay for improved teff seed. The results are analyzed and discussed in two ways. These are descriptive and econometric methods. In the descriptive analyses, we analyze and discuss the general characteristics of households, including demographic, socio-economic, and institutional characteristics. Their relation to the willing and non-willing respondents to the improved teff seed is described as follows: using the mean, standard deviation (SD), percentage, frequency, t-test, and chi-square test.

**Table 2**

*Socio-Demographic Characteristics of Sample Households*

| Variables | Willing (N=96) | Non-willing (N=25) | Total (N=121) | Min. | Max. | Test statistic (t, $chi^2$) |
|---|---|---|---|---|---|---|
| Sex | 87.5 | 66.7 | 78.04 | 0 | 1 | 18.37** |
| Access to training | 82.6 | 23.3 | 53.71 | 0 | 1 | 27.65*** |
| Age | 42.67 | 40.13 | 41.1 | 23 | 65 | 6.26** |
| Level of education | 3.72 | 1.02 | 2.37 | 0 | 10 | -10.72*** |
| Farming experience | 22.46 | 26.04 | 24.25 | 3 | 29 | 5.94 |
| Family size | 6.75 | 5.89 | 6.32 | 2 | 11 | 0.97 |

***, ** implies statistically significant at 1% and 5% significance level.

NB: The t-test is for continuous variables and $chi^2$-test is for categorical variables in the test Statistics

It is also important to see whether or not those who were willing to pay for the improved teff seed were different from those who were not willing to pay with regard to their socio-economic characteristics (Table 3).

**Table 3**

*Socio-Economic Characteristics of Sample Households*

| Variables | Willing (N=96) | Non-willing (N=25) | Total (N=121) | Min. | Max. | Test statistic (t, $chi^2$) |
|---|---|---|---|---|---|---|
| Farm size | 2.89 | 3.45 | 3.17 | 0.75 | 5.37 | -1.68 |
| On-farm income | 43,267 | 18,523 | 30,895 | 4,500 | 78,000 | -12.74*** |
| Off-farm income | 2,382 | 4,576 | 3,479 | 800 | 11,500 | -2.08 |
| Extension contacts | 2.56 | 1.02 | 1.79 | 0 | 4 | -8.86*** |
| Credit use/taken | 5,685.4 | 456.8 | 3071.1 | 0 | 11,500 | -13.08** |
| Distance to market | 3.78 | 4.84 | 4.31 | 0.32 | 6.5 | 0.96 |

***, ** implies statistically significant at 1% and 5% significance level.

Source: Own Computation

According to the data collected from the sample households, 62% of the total respondents obtained improved teff seed from their own savings, while the remaining 33%, 9%, 14.6%, and 5.7% obtained seed from purchased, gifted by others, exchanged seed, and not used improved seed. It was reported that households usually bought improved teff seed from other farmers or from markets or exchanged it with other relatives when they wanted to replace their stock with fresh seed or change their varieties. When households purchased seed from other farmers, the price they paid was lower than the price of the seed they bought from markets, even if the quality of the seed was not as good.

**Table 4**

*Source of Teff Seed*

| Source of seed | Frequency | Percentage |
|---|---|---|
| Own seed | 76 | 61.79 |
| Through purchase | 40 | 33.06 |
| Through gift | 11 | 8.94 |
| Through exchange | 18 | 14.63 |
| Not use else where | 27 | 21.95 |

Source: Own survey, 2021

According to the results obtained from the focus group discussion and key informant responses, the lack of involvement of the private sector in improving teff seed production and supply is the prevailing constraint that caused the absence of improved teff seed marketing to directly affect teff production and productivity in the study area. Even households do not have enough skill and knowledge to improve the teff seed production system through market-oriented activities. So, the responsible stockholders share of input supply, technical advice, and training delivered to the smallholder households on the improved seed system creates a suitable field for establishing improved teff seed marketing through integrating producer households or groups with the user households, traders, and other stockholders who aim to disseminate the seeds. The existing demand for upgrading teff production and productivity and increasing the number of populations also calls for the timely improvement of teff seed to be established as a business so that seeds would be available at any time and in close proximity.

Regarding the determinants of farmers WTP for improved teff seed, all diagnostic tests are satisfactory. Six of the hypothesized 12 variables in the regression model were found to significantly influence farmers' willingness to pay for improved teff seed. These are: level of education, farming experience, frequency of extension contacts, distance to nearest market, off-farm or non-farm income, access to training, and credit access.

**Table 5**

*The Results of The Tobit Model in Maximum WTP For Improved Teff Seed*

| Explanatory Variables | Coefficients | dy/dx | Std. error | Z | P-value |
|---|---|---|---|---|---|
| Sex | .012 | .038 | .103 | .116 | .736 |
| Family size | .008 | .027 | .019 | 0.421 | .362 |
| Education level | .102*** | .156 | .016 | 6.375 | .005 |
| Farming experience | .107*** | .208 | .018 | 5.944 | .001 |
| Frequency of extension contact | .025*** | .062 | .016 | 1.562 | .008 |
| Distance to nearest market | -.135** | -.282 | -.078 | -1.731 | .016 |
| Off/non-farm income | -.048* | -.014 | -.014 | -3.428 | .046 |
| On-farm income | .008 | .013 | .013 | 0.615 | .427 |
| Land allocated | .124 | .098 | .069 | 1.797 | .152 |
| Access to training | .072** | .009 | .015 | 4.800 | .015 |
| Credit access | .008* | .015 | .011 | 0.727 | .091 |
| Livestock holding | -.017 | -.015 | -.006 | -2.833 | .274 |
| Constant | .174 | | .028 | 6.214 | .182 |
| No. Observations | 121 | | | | |
| Log likelihood | -112.069 | | | | |
| Pseudo $R^2$ | 0.548 | | | | |
| Prob> $chi^2$ | 0.0000*** | | | | |

***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Source: Stata Output

Education level of household head: education level had a positive effect on farmers' maximum willingness to pay for improved teff seed, positively and significantly at the 1% level of significance. By keeping the other factor constant, each additional school year makes households 15.6% more likely to pay for improved teff seed. This may indicate that the education level of the respondents increased because they tended to pay more money. This could be due to the capacity to analyze the cost-benefit of improved teff seed. This result was also supported by research on assessing farmers' willingness to pay for improved common bean seed, potato seed tubers, groundnut seed, and improved forage seed, respectively. They reasoned out that education provides knowledge and makes the household get information, and the information creates awareness about the benefits obtained from improved technologies.

Farming experience: farming experience had a positive effect on farmers' willingness to pay for improved teff seed, positively and significantly at the 1% level of significance. The results revealed that for each additional year of household head farming experience, the individual becomes 20.8% more likely to be willing to pay the maximum amount for improved teff seed. This result indicated that more experienced households in farming activities were more likely and willing to use improved technology. This implies that experienced farmers have good knowledge about the benefit they earned and the cost they incurred by allocating their limited resources through the use of improved seed varieties.

Frequency of extension contact: The result of extension contacts had a positive effect on households' maximum willingness to pay for improved teff seed, and it was statistically significant at the 1% level of significance. The marginal effect result showed that for each additional contact day, taking other factors into account, the household would be 6.2% more likely to be willing to pay for improved teff seed. This implies that households with better and more frequent contact with extension agents would have an opportunity to understand about improved teff seed. In line with this extension, the contact provides information regarding the use of agricultural inputs (fertilizers, seedling raising, and harvesting) at the right time and in the right amount to improve production and productivity. Hence, the more they are willing to use improved seed, the more they produce in the final output. However, delivery of improved teff seeds at the right time is still a major challenge for a number of smallholder producers in the study area.

Off-farm income: off-farm income was also an important factor that affected households' maximum willingness to pay for improved teff seed significantly and positively at the 10% level of significance. The marginal effect result indicates that households that generate income from off-farm sources decrease the willingness of farmers to pay for improved teff seed by 1.4 percent. This is due to households that had received more income from off-farm income; farmers mostly shift towards non-farm income activities rather than employing for non-farming activities.

Distance to nearest market: The estimated coefficients of distance to nearest market and household's maximum willingness to pay for improved teff seed were positive and significant at the 5%

significance level. This is in line with the hypothesis. The marginal effect of the result indicates that, other explanatory variables being constant, as the distance of the producers' residence from the nearest market increased by one kilometer, the willingness of farmers to pay for improved teff seed decreased by 28.2%. The main reason behind this is that producers who reside far from the nearest market have an increased marketing cost and cannot get improved inputs as easily as producers who are closer to the market, who can easily get required agricultural inputs at a substantial cost.

Access to training: Access to training had a positive effect on households' maximum willingness to pay for improved teff seed, positively and significantly at the 5% level of significance. If farmers were more informed on the use of improved seeds, it would be the most important input that promotes production and productivity and increases farm income. Training, competitiveness of credit and labor markets, and access to credit extensions were some of the determinants of households' willingness to pay for improved teff seed.

Access to credit: As hypothesized before, credit use had a positive effect on households' maximum willingness to pay for improved teff seed, both statistically and significantly at the 10% significant level. The marginal effect result indicated that as farmers could get more access to credit, the probability of households' willingness to pay for improved teff seed also increased by 1.5%. This finding was in line with other studies on smallholder farmers' willingness to pay for improved forage seed in the case of Tigray, Ethiopia. With his justification, households that have access to credit can minimize their financial constraints and buy more improved seed than households without access to credit.

The mean willingness to pay for the open-ended contingent valuation questions is computed by taking the average of the households' maximum willingness to pay amount. In the open-ended question, respondents were asked to state the maximum amount in cash they would like to pay for improved teff seed. The amount of money that households would contribute to the improved teff seed per year ranged from 0 to 100 ETH Birr.

i.e., $mean\ \mathrm{WTP} = \mu = \sum \mathrm{Mx}/\mathrm{n}$

Where, Mx is the maximum willingness to pay amount by served households

n is the sample size

$Mean\ \mathrm{WTP} = \mu = \sum \mathrm{Mx}/\mathrm{n} = 4342.6/121 = 35.89$

**Table 6**

*Sampled Households' Pay Demand*

| Amount of cash | Number of respondents | Percent |
|---|---|---|
| 0 | 25 | 20.66 |
| 1-15 | 8 | 6.5 |
| 16-30 | 22 | 17.9 |
| 31-45 | 31 | 25.2 |
| 46-60 | 23 | 18.7 |
| 61-75 | 9 | 7.3 |
| 76-100 | 3 | 2.4 |
| Total No of Obs. | 121 | 100.0 |
| Mean = 35.8941 | Std. err = 18.5972 | |

Source: Own survey results, 2021

From the total of 121 sampled respondents, 25 sampled households were not willing to contribute cash for improved teff seed. On the other hand, the remaining 96 sampled households were willing to contribute some amount of money that they already stated during the survey, despite the fact that the amount of money they were willing to contribute varied from one respondent to the next. The average amount of money that farmers were willing to contribute for improved teff seed practices was 35.89 ETH per year.

## Conclusion and Recommendations

Based on the study results found, it is possible to conclude that the willingness of sampled households to pay for improved teff seed was low due to a lack of standardized inputs, a lack of market access, a lack of awareness and training, the high price of inputs, and a lack of money and credit access. This shows that providing more attention to research and extension linkages and organizing frequent training for development agents, supervisors, and other stockholders about existing and newly developed improved agricultural technologies and new methods of agricultural practices are necessary to raise production and productivity.

From the findings of this study, the following points are suggested to be considered by policymakers, government organizations, and other stakeholders as important lessons to be learned for strategies to move in the right direction and for implementing the service for better seed sector development. The education level of the household head was found to be an important variable affecting the probability of willingness to pay for improved teff seed. This implies that placing emphasis on upgrading households' levels of formal education can increase their willingness to pay. The results of the study also show that those farmers who perceived themselves as more educated were more willing to participate in improved seed use than those who did not have that perception. So, increasing education level is important for readiness to accept new ideas, innovations, and market information and enhances farmers' willingness to pay for improved seeds and produce more product and income.

The frequency of extension contact was found to have a positive and significant relationship with the willingness of households to pay for improved seed as it enhanced their ability to acquire an optimal number of seeds. This indicates that extension coverage should be widened by establishing additional development centers and increasing the number of extension workers. Therefore, the government and other stakeholders should encourage extension agents to enhance the dissemination of improved teff varieties among farmers through long- and short-term trainings, workshops, seminars, and demonstration activities.

It can also be clearly seen from the result that the annual non-farm income of households has a statistically significant and negative impact on households' willingness to pay for improved teff seed. This is because, as the annual income of households that get it from non-farm activities increases, most farmers' shift toward non-farm income activities rather than buying improved agricultural seeds. So, the concerned bodies would be raising their farm production and decreasing their off-farm income activities by delivering the required number of agricultural inputs and other consultation activities.

Farmers' willingness to pay for better teff seed kinds was found to be strongly positively correlated with their level of agricultural expertise. This suggests that the government and other interested parties should organize and carry out practical and ongoing training for farmers, extension agents, and other agricultural specialists during each cropping season. In order to maximize their agricultural outputs, farmers will be more inclined to spend top dollar for improved teff seed as a result of this.

It was apparent from the study that if farmers got easier access to credit, they would use improved varieties for teff cultivation, and their willingness to pay would increase. Making credit services available for seed purchase on a need-based basis increases the probability of farmers increasing their willingness to pay for improved teff seed. Thus, the credit facility should be accessible and targeted at poor farmers, particularly those who were unable to pay for improved seeds due to a lack of operating capital, by assuring them of loans at reasonable interest rates that they can afford. Therefore, it is recommended that the government and non-governmental organizations work together to provide credit services to farmers at an affordable rate of interest to increase the willingness of farmers to pay for improved teff seed.

The final factor that significantly affected families' maximum willingness to pay for enhanced teff seed was distance to the market. In order to increase agricultural productivity and production, it is crucial that households are close to the market. This can be achieved through expanding market access and the availability of the necessary inputs.

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