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Willingness to Pay for Sustainable Agricultural Extension Services among Smallholder Farmers in Raya Azebo Woreda, Ethiopia

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Abstract

In Ethiopia, where agriculture continues to be the dominant economic sector, agricultural extension services (AESs) are essential for raising agricultural production and fostering rural development. This study examined farm households' perceptions and Factors influencing farm households' willingness to pay (WTP) for agricultural extension services in Raya Azebo Woreda, northern Ethiopia. Focus groups, key informant interviews, and household surveys were used in a mixed-methods approach. A binary logistic regression model, narrative analysis, and descriptive statistics were used to evaluate data gathered from 230 farm households chosen from three kebeles. The findings showed that farmers thought extension services were crucial for improving market connections, employment possibilities, value addition, agricultural production, and environmental sustainability. According to the regression analysis, households' willingness to pay for extension services was positively and significantly impacted by age, education level, landholding size, credit availability, and radio access. This implies that farmers with more access to financial and information services, as well as those with higher levels of education and resources, are better able to invest in advisory services and are more aware of the advantages of agricultural extension. Distance from Farmers Training Centers (FTCs), on the other hand, had a substantial negative impact, suggesting that farmers are less motivated to request and pay for extension services when they have limited physical access. The results emphasize the significance of enhancing rural financial services, increasing information sharing, and making extension services more accessible. Additionally, encouraging private agricultural consulting and advisory firms run by agricultural graduates may improve service delivery. Targeted subsidies or lower service fees should be taken into consideration for resource-poor and female-headed households, whose willingness and ability to pay are comparatively lower, in order to provide fair and sustainable access.

Keywords: Agricultural extension services; willingness to pay; binary logistic regression; sustainability; Ethiopia.

1. Introduction

In Ethiopia, 95% of agricultural production and 85% of jobs are produced by smallholder farmer households, of which there are an estimated 13 million in (2007/08) [1]. Agriculture continues to be the main economic pillar in many developing nations. For example, improvements in agricultural productivity have played a major role in Ethiopia's recent economic growth and the country's efforts to reduce poverty [2]. Producing more food is essential to raising farmers' standard of living and lowering poverty, but smallholder farmers face a number of challenges, including access to agricultural extension services, inadequate infrastructure, issues with education, and unequal access to marketing information [3, 4]. It is commonly known that Agricultural Extension Services (AESs) are essential to rural and agricultural development, especially in developing nations like Ethiopia. Many sub-Saharan African nations, including Ethiopia, are modernizing their agricultural practices through the use of agricultural extension [5] and It is also recognized as a lawful tool and policy to implement desired changes in the environmental and socioeconomic spheres [5, 6]. In most developing nations, the main mechanism for disseminating agricultural innovations and information is the general-based agricultural extension approach. Large teams of extension agents oversee the system and communicate directly with farmers who are spread out geographically. However, these systems are not financially sustainable due to the high cost of extension staff, supply-driven, top-down methodology, restricted geographic reach, limited-service outreach, and lack of demand-driven elements without farmer participation [7-9]. Consequently, by adapting and comprehending the cost-sharing agricultural extension approach, we can change the priorities and interests of marginalized smallholder farmers. Historically, the public sector has provided the majority of funding for agricultural extension, which has been seen as a public good in both developed and developing nations. Nonetheless, a paradigm shift toward decentralization, privatization, and greater participation of other actors in the provision of agricultural extension has been adopted by many developed nations [10-12].

The paradigm change has also resulted in the fee-for-service model, commonly referred to as cost-sharing extension, in which customers share or pay in full for services and hold service providers responsible for the caliber of work. Here, it is assumed that if a portion of the cost of agricultural extension is covered locally, the program will be more likely to fit local circumstances and the

staff will be more likely to serve the interests of the local population [13, 14]. Additionally, since it is assumed that farmers are too impoverished to cover the entire expense, central and regional governments usually cover the majority of it. The goal is to assist farmers in acquiring the knowledge they need to improve themselves and become more productive. Since the formal establishment of the Ethiopian agricultural extension system in the early 1950s, the public sector has provided the majority of funding and delivery for the program [11, 15]. However, it is essential to take into account alternative arrangements in providing and financing extension services in the nation due to budgetary constraints, the large number of people who depend on agriculture for their livelihoods, observed inefficiencies in public extension provision, and the specific needs of market-oriented producers. The perception, capacity, and willingness of farmers to co-finance the provision of agricultural extension must also be investigated in this era of weak partnerships among public, private, and other stakeholders in the delivery of extension services. Regarding this, there is a dearth of empirical data that can be used to inform policy regarding how to pluralize the provision of extension services across the nation. Thus, the purpose of this study is to evaluate how smallholder farmers in Raya Azebo Woreda, Ethiopia perceive and the determinants of willingness to pay the provision of agricultural extension services.

1.2 Empirical review

For better and more extensive extension activities, agricultural technology transfer needs to be stabilized. This has been the main focus of most development initiatives in both developed and developing nations worldwide [16]. Farmers in Central America, particularly in Honduras, have noticed that since the cost-sharing option was introduced, they have come to understand the advantages of the new approach in terms of training and advisory services. As a result, between 65% and 85% of the recommended practices have been adopted [17]. They added that the service providers no longer provide the same clients with training services, or ones very similar to them, year after year. In order to acquire more customers, they will either need to grow their business into new regions or find new extension contents and create new service offerings. Because services are now demand-driven, this makes the offering very appealing to the customers because it meets their perceived needs. In Nigeria a finding by [16] show that both Farmers and Extension Professionals regarding cost-sharing were favorable. Major points made include the following: cost-sharing will help to improve and extend extension services to farmers; it will make

agricultural technology delivery more relevant and responsive to farmers' information needs; and it is desirable and necessary for the achievement of increased productivity and income. A study by [18] in Ethiopia revealed that, It is evident that farmers are willing to pay for better extension services that offer timely and pertinent weather and price information, even in spite of the declining trend. Moreover, it is pertinent given the volatility of agricultural input and output prices, the perishable nature of many agricultural products, and the severe consequences of climate variability and change.

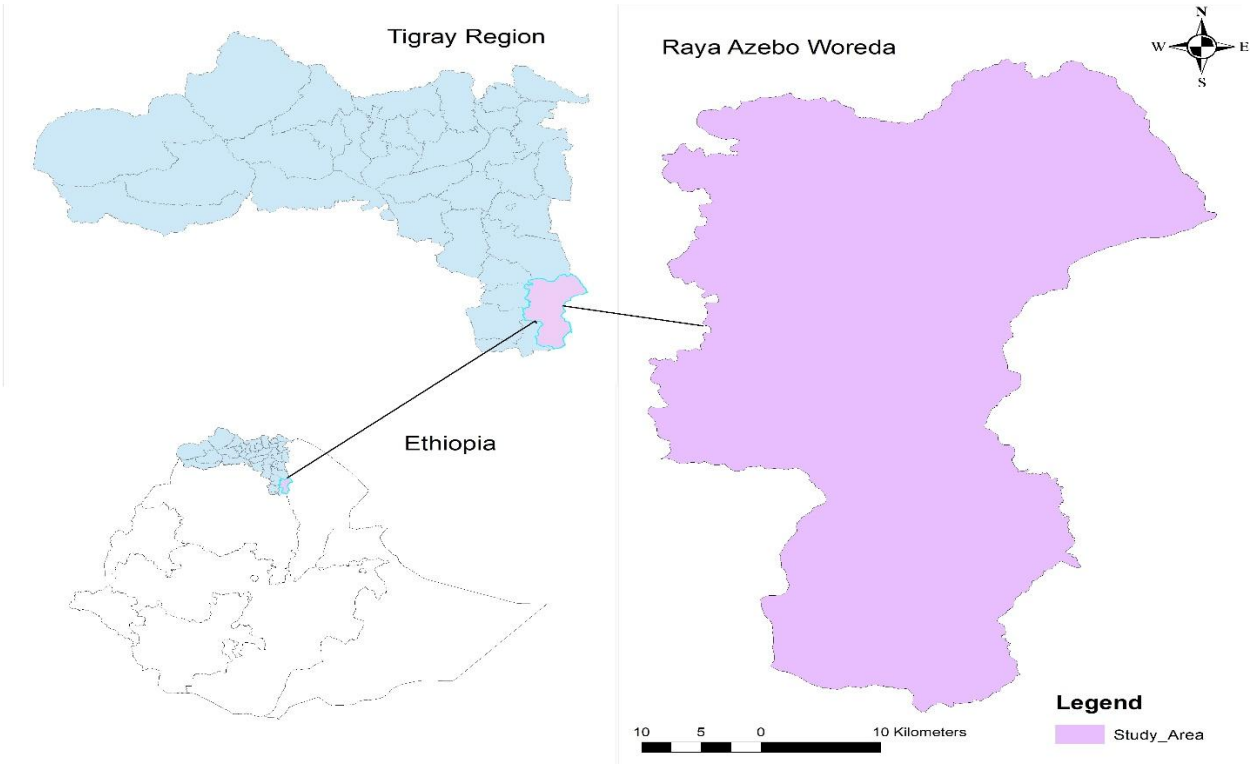
2. Materials and Methods

2.1 Description of the study area

Raya Azebo is a woreda (district) in Ethiopia's Tigray Regional State, located in the Southern Zone. Administratively, it is composed of 23 kebeles, which are the smallest local government administrative units in the country. Geographically, Raya Azebo is bordered by Alamata to the south, Endamehoni to the west, Ofla to the northwest, Wajrat to north and the Afar Regional State to the east and southeast as figure 1 indicated below. Its strategic location within the lowland and midland agro-ecological zones strongly influences local livelihood systems, agricultural practices, and climate vulnerability patterns.

The woreda lies at an average elevation of approximately 1,500 to 2,300 meters above sea level, with variations across kebeles. The mean annual temperature is relatively high, generally ranging between 18°C and 28°C, reflecting the warm semi-arid environment of southern Tigray. Annual rainfall is low and erratic, averaging between 400 and 700 mm, with most precipitation concentrated during the main rainy season. This rainfall variability highlights the district's location within a moisture-stressed agro-ecological zone, where water availability remains a critical determinant of agricultural productivity, food security, and household resilience

Figure 1: Map of study area



Source: Own Computation based on recent Ethiopia's Administration Boundaries shape files 2024

2.2. Sampling Method and Sample Size Determination

The sample size was determined using Yamane's (1967) formula cited by [19] with a 7% margin of error at the 95% confidence level. Accordingly, with 95% confidence, the calculated values should be within ±7% of the actual population parameters. Larger samples typically yield more accurate estimates since the margin of error varies inversely with sample size. Proportional sampling, in which kebeles with greater household populations received proportionally larger sample allocations, was used to guarantee representativeness and reduce sampling bias. By using this method, the sample was guaranteed to fairly represent the distribution of households within the research region. Given this, the formula can be written as follows:

$n = \frac{N}{1+N(e)^2}$ Where ※n⋯› sample size

※N⋯› Total population

※e⋯› level of precision

$$n = \frac{N}{1+N(e)^2} \quad = n = \frac{4600}{1+4600(0.07)^2} = 230$$

Based on data gathered from the Raya Azebo Woreda Agriculture Office, Woreda Administration, and the Central Statistical Agency (CSA), the chosen kebeles included Gerarsa (1,500 households), Kukufto (1,300 households), and Hade Alga (1,800 households), as shown in Table 1. Proportional random sampling was then used to pick 230 households in total, with the number of sampled households from each kebele chosen based on the size of the household population.

Table 1: Sample *Kebeles*, total households, and the sample size to be taken from each *Kebeles.*

Kebeles	**Total population**	**Total sample**
Gerarsa	1,500 HH	75
Kukufto	1,300 HH	65
Hade Alga	1,800 HH	90
Total	4,600 HH	230

Source: authors' survey computation, 2024

2.3. Data Collection Methods

The study employed a mixed-methods approach, combining quantitative and qualitative data collection techniques. Primary data were obtained through household surveys, focus group discussions, and key informant interviews. A structured questionnaire was used to gather household-level information relevant to the study objectives, including farmers' perceptions of agricultural extension services and their willingness to pay for these services.

For respondents who could read and complete the questionnaire, the instrument was administered directly. For respondents who could not read or write, trained interviewers presented the questions orally and documented their answers. This approach enabled the inclusion of respondents with different literacy levels. The questionnaire was organized according to the study's specific objectives to ensure systematic collection of the required information.

Focus group discussions and key informant interviews complemented the household survey by providing qualitative insights into farmers' experiences, perceptions, and views concerning the provision and financing of agricultural extension services.

2.4. Method of Data Analysis

Quantitative and qualitative data were analyzed using complementary approaches. Descriptive statistics were used to summarize household characteristics, farmers' perceptions, and responses concerning willingness to pay for agricultural extension services. The econometric analysis was used to examine the factors associated with households' willingness to pay for these services among crop-producing farmers in Raya Azebo Woreda.

The qualitative information obtained from focus group discussions and key informant interviews was used to provide additional context for interpreting the quantitative findings. Integrating the two forms of evidence helped provide a broader understanding of farmers' willingness to contribute financially to agricultural extension services and the factors influencing their decisions.

2.5. Econometrics Model Specification

The researchers measured the willingness to pay agricultural extension services dependent variable in binary response (willing=1 and not-willing=0 response type) in order to investigate factors that influence households' decisions willing to pay agricultural extension services. In this study, a farm household was considered as willing to pay if they are willing to pay the services. Willingness to pay agricultural extension services, the dependent variable, is binary, with a value of 1 for willing and 0 for not-willing. When a person is given the option to select between two options in this case, willing or not willing to pay agricultural extension services a binary logistic regression econometric model is utilized to analyze the likelihood that farm households willing this payment of agricultural extension services. Furthermore, due to two key presumptions, the model can be used to determine the variables influencing a household's decision willing to pay agricultural extension services.

The first assumption is that, as x_i increases, $pi = E(Y = {}^{1}/_{X})$ increases/decreases but the value lies between 0 and1. The second assumption is that, the relationship between p_i and x_i is nonlinear; thus, one can easily use cumulative distribution function [20]. Despite the lack of support in

statistical theory for a preference between the two, the logit model was chosen for this investigation due to its ease of use and interpretability. The logistic distribution function for examining decision of willing and not-willing to pay agricultural extension services can be defined as

$In\ (odds) = Zi\ where\ Zi\ is\ given\ as$

$$Zi = \beta 0 + \beta 1X1 + \beta 2X2 + - - - - - - + \beta mXm - (1)$$

$$In\ (odds) = \beta 0 + \beta iXi \dashrightarrow \ln\left(\frac{Pi}{1-Pi}\right) = \ln\left(e^{Zi}\right) \dashrightarrow Pi = \frac{e^{ZI}}{1+e^{Zi}} \dashrightarrow Pi = \frac{1}{1+e^{-zi}} - - - - - - (2)$$

$$Pi = \frac{1}{1+e^{-zi}} - (3)$$

P_i is probability of willing to pay and 'X_i' is a vector factors affecting willing to pay and the betas/βm are parameters to be estimated from the model. This equation 2 represents the (cumulative) logistic distribution function [20].

And the probability not willing to pay is given by $1 - Pi = \frac{1}{e^{zi}} - - - - - - - - - - - - - - - - (4)$

The odds are given by odds $= \frac{Pi}{1-Pi} = \frac{\frac{1}{1+e^{-zi}}}{\frac{1}{e^{zi}}} = \frac{e^{zi}}{1+e^{-zi}} = e^{zi} - - - - - - - - - - - - - - - - - - (5)$

Where $Zi = \beta 0 + \sum_{i=1}^{m} \beta iXi + Ui - (6)$

Where 'e' is random error term

To get the marginal effect on probability we have to use the following equations

$$Pi = \Phi(\beta' x) - (7)$$

$$\frac{\partial Pi}{\partial x} = \frac{\partial \Phi(u)}{\partial u} * \frac{\partial u}{\partial x} = \beta\phi(\beta' x)\ given\ \frac{\partial \Phi(u)}{\partial u} = \beta\phi(\beta' x)\ \&\ \beta' x = u - - - - - - - - - - - (8)$$

This study included variables that affect willingness to pay agricultural extension services in the study area. The interpretation of marginal effect coefficients is more direct compared to log odds ratio coefficients. We select the independent variables included in the model based on review prior literatures on willingness to pay agricultural extension services. The balance of theoretical

relevance, connection of variables to willingness to pay decision and with empirical significance enable us to enhance the model's accuracy and interpretability.

While the binary logistic regression model provides a robust framework for analyzing willingness to pay decisions, the risk of omitting unobserved factors (e.g., cultural attitudes, government incentives) and the violation of the linearity and independence of errors assumption could influence the willingness to pay decision results and its robustness. To address such limitations, we incorporated control variables for factors like location and socioeconomic status, which helped reduce omitted variable bias. The other limitation is that the marginal effects are calculated at the mean values of the independent variables while the average values may not represent the typical or most relevant scenarios for certain variables. Since interpreting the marginal effects only at the mean may lead to misleading conclusions, the study also examined the average marginal effects in addition to the marginal effects at the mean. This is implemented by calculating the marginal effect for each observation and then averages these across all.

2.6. Definitions of Variables and Hypothesis

Dependent variable: willingness to pay for the agricultural extension services. Respondents may choose any payment methods using available to them. This results in an index score that can be in binary response (willing=1 and not willing=0 response type).

Independent variables: Based on current theories and empirical research, the independent variables were chosen. Table 2 below lists the explanatory variables that were thought to have an impact on the dependent variable. There was no set procedure for selecting which independent variables to include in the econometric model [21, 22]. Numerous socioeconomic, demographic, and institutional factors were included in the model to explain the variation in the willingness to pay for the agricultural extension services.

*Age of Household Head***:** Farmers' decisions about productivity and technology adoption are anticipated to be influenced by the age of the head of the family. Age reflects acquired experience and expertise that may improve farm management abilities and decision-making capacity, according to the Human Capital Theory [23]. Agricultural productivity may be positively impacted by older farmers' stronger indigenous knowledge and farming experience. However, research on the acceptance of agricultural innovation such as Rogers' Diffusion of Innovation Theory indicates

that younger farmers might be more open to embracing contemporary farming methods and new technologies [24]. Therefore, depending on the situation, age may have a favorable or negative association with the adoption of agricultural technology and farm productivity.

Education: The number of years the head of the family has attended formal schooling is used to quantify education. Education improves people's capacity to get, analyze, and apply information effectively, according to Human Capital Theory [25]. Farmers with higher levels of education are more likely to comprehend market prospects, extension communications, and improved agricultural technologies [26]. Higher education is therefore anticipated to have a positive impact on market involvement, technology uptake, and farm output.

Family Size: The total number of people residing in a household is referred to as the family size. The Household Labor Supply Theory states that more family labor is available for agricultural tasks like planting, harvesting, and land preparation in larger households [27]. Farm productivity and the ability to oversee bigger land areas may both rise as a result. Large families, however, may also have higher household consumption demands, which could limit the funds available for farm technology investments. Therefore, depending on how labor availability and consumer pressure are balanced, family size may have both good and negative effects on agricultural production and technological adoption.

Farm Experience: The length of time the head of the household has been engaged in farming operations is represented by farm experience. The Learning-by-Doing Theory states that throughout time, farmers gain knowledge and useful abilities that enhance their capacity to control agricultural hazards and maximize production methods[28]. Experienced farmers are more likely to apply suitable farm management techniques and comprehend the agro-ecological conditions in the area. According to empirical research, farming experience has a favorable impact on farmers' capacity to embrace appropriate technology and make well-informed production decisions[29, 30]. Therefore, it is anticipated that farm experience will have a good impact on agricultural output and effective resource use.

Land Size: The entire agricultural area that a household owns or cultivates, expressed in hectares, is referred to as land size. The Theory of Farm Size and Productivity states that larger landholdings

may offer more chances for economies of scale, investment in agricultural technologies, and diversification [31]. Because they can spread the cost of investment over a broader region, farmers with larger land sizes are frequently better positioned to embrace improved seeds, irrigation systems, and machinery. Farm size appears to have a favorable impact on market involvement and production capacity, according to empirical research in agricultural economics[32]. Thus, it is anticipated that agricultural production and technological adoption will positively correlate with land size.

Farm Income: The overall revenue from farming operations, expressed in Ethiopian Birr, is referred to as farm income. Higher income allows farmers to invest in better agricultural inputs including fertilizers, new seeds, irrigation technologies, and farm equipment, according to the Investment Theory of Agricultural Development[33]. Higher farm income farmers are better equipped to handle the risks involved in implementing new technology because they are less financially constrained [34]. Farm revenue has a favorable impact on farmers' ability to participate in markets and embrace contemporary agricultural practices, according to empirical data from research on rural development.

Distance to Farmers Training Center (FTC): From the home to the closest agricultural extension center, the distance to the Farmers Training Center (FTC) is expressed in kilometers. The Agricultural Extension and Information Access Theory states that farmers have better access to technical expertise, training, and advisory services when they are close to extension services[35]. The likelihood of receiving timely information on improved agricultural techniques and technologies is higher for farmers who live closer to extension facilities. Research on rural advising services reveals that farmers' adoption of technology and involvement in training are adversely impacted by their distance from extension services[36]. Thus, it is anticipated that access to agricultural information and technology adoption will be adversely affected by distance to the FTC.

Distance to Market: The physical distance between a farmer's home and the closest agricultural market is measured by distance to the market. The Transaction Cost Theory states that being farther away from markets raises transportation costs, limits access to market information, and deters farmers from engaging in commercial agriculture[37]. Farmers that are closer to markets typically

have easier access to buyers, prices, and agricultural inputs. Shorter market distances encourage the development and uptake of market-oriented innovations [38]. Therefore, it is anticipated that market participation and the adoption of agricultural technology will be negatively correlated with market distance.

Sex of Household Head: The sex of the head of the home a dummy variable, with 0 being female and 1 denoting male. Gender disparities affect access to productive resources like land, financing, information, and extension services, according to the Gender and Agricultural Development Theory[39]. Male-headed households frequently have better access to institutional support and agricultural resources than female-headed households in many rural environments[40]. As a result, households headed by men may adopt better agricultural technologies more frequently and have higher production capacities. Gender is therefore anticipated to have an impact on technology adoption and farm output.

Credit Access: The household's access to formal or informal credit services is referred to as credit access (1 = yes, 0 = no). The Rural Finance and Credit Constraint Theory states that credit availability lessens the financial barriers that prevent farmers from investing in agricultural inputs and technologies[41]. Farmers can use credit to buy fertilizer, better seeds, irrigation equipment, and other productivity-boosting farm inputs. Access to financing dramatically boosts farm investment and technology uptake[42]. Credit availability is therefore anticipated to have a favorable impact on technology adoption and agricultural productivity.

Irrigation Access: A farmer's use of irrigation for agricultural production is indicated by their irrigation access (1 = yes, 0 = no). The Agricultural Intensification Theory states that irrigation helps farmers grow crops all year round and lessen their reliance on rainfall[43]. Crop yields are increased, production is stabilized, and farmers are better able to implement better farming methods when they have access to irrigation[44]. Access to irrigation is therefore anticipated to have a favorable impact on both technology adoption and farm productivity.

Radio Access: The presence of a radio in the home is indicated by radio access (1 = yes, 0 = no). The knowledge Diffusion Theory states that rural farmers receive a lot of agricultural advances and knowledge from the media [45]. Weather forecasts, market information, and agricultural

extension programs are frequently carried on radios. Farmers who have access to radio are more likely to get timely information that helps them make better decisions on their farms[46]. Radio access has a favorable impact on agricultural technology uptake and awareness, according to empirical research in rural communication[47].

Table 2. Definitions and Descriptive statistics of explanatory variables and their expected effect on willingness to pay.

Variable Name	**Definition of variables**		**Willing, n = 163**		**Not willing, n = 67**	
		Descriptive statistics (Mean, Std.Dvt.), Total, n = 230	Mean	Std.Dvt.	Mean	Std.Dvt.
Age	Age of household head in years	43.63043 13.7786	41.0597	12.25843	44.68712	14.25799
Education	Number of years of formal schooling	.7391304 .9584099	.7791411	.9559724	.641791	.9645456
Family Size	Total number of households	8.204348 6.074284	7.907975	5.649003	4.925373	6.996348
Farm experience	Farm experience of Household head in years	16.74783 10.60266	19.15337	10.54537	15.76119	10.75638
Land size	Farm size in hectares	2.417391 1.178279	2.570552	1.180967	2.044776	1.093131
Farm income	Income from farm in Ethiopian Birr	11249.26 8544.76	11327.3	8585.431	11059.4	8506.319
Distance _FTC	Distance in KM home to FTC	1.982609 1.121311	1.865031	1.03944	2.268657	1.262298
Distance_ Market	Distance in KM home to market	2.895652 1.15122	2.889571	1.154733	2.910448	1.15117
Gender	Sex of household head, 0 = female, 1 = male	.7521739 .432692	.7607362	.4279488	.7313433	.4466064
Credit access	Credit use, 0= no, 1= yes +	.6478261 .4786896	.7607362	.4650962	.5522388	.5010166
Irrigation ~access	Whether a farmer use irrigation or not 0= no, 1= yes	.273913 .4469376	.2638037	.4420522	.2985075	.4610569

Radio ~access	Own radio, 0= no, 1= yes +	.6695652 .4713956	.6695652	.4837745	.6319018	.4295717

Source: Own survey 2024

The explanatory variables utilized in the analysis are defined and their descriptive statistics are shown in Table 2. Means and standard deviations are used to summarize continuous variables, while dummy variables are coded as 1 if the household has the given attribute and 0 otherwise. Both the total sample (n = 230) and the families willing to pay (n = 163) and unwilling to pay (n = 67) for agricultural extension services are included in the statistics.

3. Results and Discussions

3.1. Perception of Households toward Agricultural Extension Services

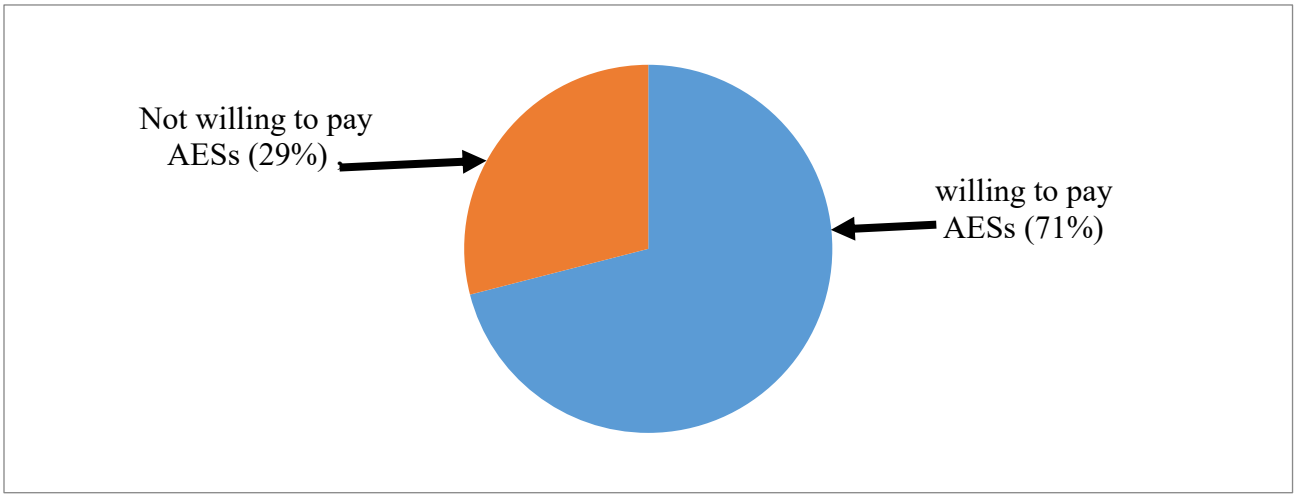
Designing demand-driven and sustainable agricultural extension interventions requires an understanding of farmers' perspectives. Figure 2 shows that 71% of the sample's households were willing to pay for agricultural extension services linked to crops, whereas 29% were not. The willingness-to-pay variable's mean of 0.71 and standard deviation of 0.45 showed that most families had a favorable desire to pay for extension services.

This finding suggests that farmers recognize the value of extension services in increasing agricultural output, improve farming knowledge and skills, market access, help farmers manage pests, diseases, and crop-production risks, help farmers respond to drought and climate variability and farm revenue. The relatively high number of willing households also raises the option of using cost-sharing or private extension models, even though affordability concerns among households with limited resources should be addressed to enable equitable access to extension services. These findings are consistent with previous studies conducted in various countries. For instance, studies found that 81.1%, 88.0%, and 64.2% of farmers in Bangladesh, Tanzania, and eastern Ethiopia were willing to pay for agricultural extension services [48] [49], [50]. The similarities between these findings suggest that farmers are generally aware of the financial benefits of extension services and are willing to contribute money when these services are deemed relevant, accessible, and capable of raising farm income and productivity.

Farmers' demand for better extension services was favorably correlated with their willingness to pay for both short-term and long-term agricultural training, according to [18]. In a similar vein, 81.07% of farmers in Raya Azebo Woreda indicated interest in utilizing mobile-based agricultural extension services, according to,[51] reported that 81.07% of farmers in Raya Azebo Woreda

expressed interest in using mobile-based agricultural extension services These results show that local farmers are open to new and better extension strategies and understand how they might improve livelihoods and agricultural productivity.

Figure 2. Distribution of farm households by willingness to pay for agricultural extension services in Raya Azebo Woreda, Ethiopia.



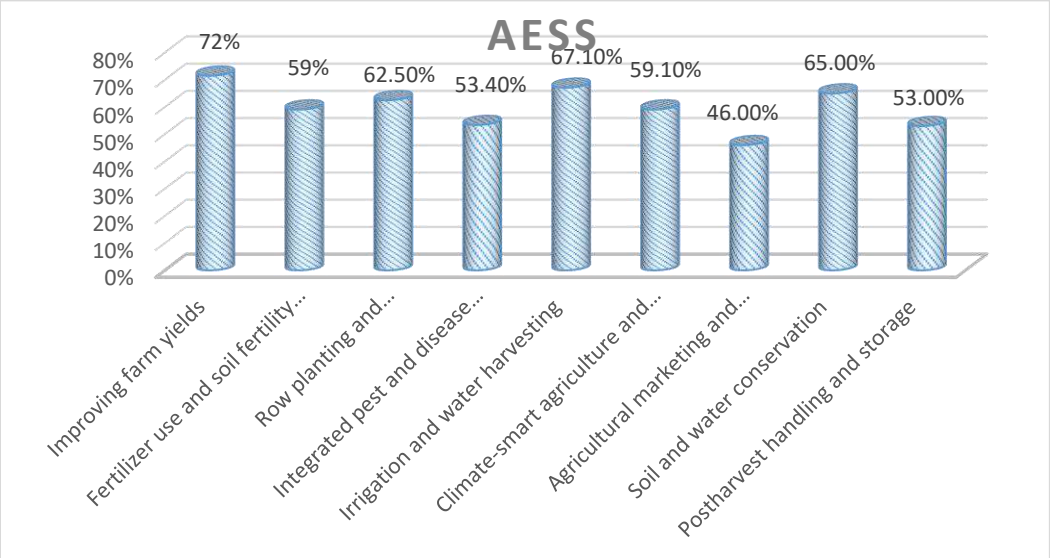
Source: authors' commutation 2024

The qualitative findings demonstrated that the adoption of agricultural technology and willingness to pay for extension services varied among wealth categories. Households with relatively higher incomes were more likely to purchase better agricultural technologies, actively seek out assistance from extension agents, and participate in cost-sharing arrangements. Conversely, low-income households were unable to purchase complete technology packages and pay for consulting services. A low-income farmer from Hade Alga kebele mentioned during the focus group talks that while better technologies are necessary, it can be difficult to finance both new technologies and paid advisory services without access to credit or other financial support mechanisms.

This result implies that poorer households' willingness to pay for extension services and their adoption of technology are still significantly hampered by their low financial resources. According to focus group participants, funding agricultural extension services and institutionalizing them as a community practice is essential for boosting household food security, creating jobs, increasing the quantity and quality of agricultural output, and increasing competitiveness in regional and global markets. Participants perceived modern agricultural technology as a means of boosting social status and promoting local economic development.

However, some significant informants and discussants asserted that these prospective benefits have not been fully realized because of a lack of extension agents and limited access to full technical packages. These findings suggest that maximizing the advantages of agricultural extension services requires expanding farmers' access to complementary technology and strengthening extension capabilities.

Figure 3. Distribution of respondents' assessment of the importance and efficiency of agricultural extension services in Raya Azebo Woreda.



Source: Authors' survey data 2024

Farmers' perceptions of the importance and effectiveness of agricultural extension services were assessed using a five-point Likert scale. As shown in Figure 3, 72% of respondents strongly agreed that agricultural extension services are important, potentially reflecting their contribution to improving farm productivity and crop yields. Furthermore, 67%, 65%, and 62% of respondents recognized the importance of extension services in irrigation and water harvesting, soil and water conservation, and row planting, respectively. These findings are consistent with previous studies [52, 53].

Approximately 59.1% of respondents strongly agreed that extension services support fertilizer application & soil fertility management and climate-smart agriculture & drought preparedness. These findings highlight the role of extension services in promoting sustainable agricultural

practices through improved knowledge, efficient resource use, and the adoption of environmentally friendly technologies.

Regarding pest and disease management, 53% of respondents strongly agreed that extension services improve integrated pest and disease management. This finding aligns with previous Ethiopian research [54], which highlighted the contribution of extension services to farm productivity through technology adoption and knowledge dissemination. Although the high cost, operational complexity, and maintenance requirements of agricultural mechanization may constrain adoption among smallholder farmers, access to improved agricultural technologies and inputs can enhance operational efficiency and reduce labor requirements.

In terms of postharvest and market-related benefits, 53% of respondents strongly agreed that extension services improve postharvest handling and storage, while 46% indicated that these services contribute to agricultural marketing and value addition. This suggests that extension services can support farmers beyond production by improving market information, strengthening linkages with buyers and input suppliers, and promoting value-adding activities. These findings are consistent with a Tanzanian study [48], which highlighted the contribution of extension services to postharvest management and market integration.

Finally, respondents also recognized the potential contribution of agricultural extension services to employment creation. By encouraging agricultural diversification, improved production technologies, and participation in agribusiness and value chains, extension services can generate employment opportunities, strengthen rural livelihoods, and contribute to local economic development.

3.2. Preferred Types of Agricultural Extension Services (AESs)

Farmers' willingness to pay (WTP) varied across the different agricultural extension services (table 3). Access to improved crop varieties received the highest preference (65%), followed by row planting technique (55.52%). This indicates that farmers showed the greatest willingness to pay for services related to improved crop varieties and crop production practices.

Access to irrigation facilities (35%), agricultural tools and inputs (37%), and Crop and animal production advisory services (33%) received moderate preferences. In contrast, Advice on crop and animal production Agricultural market linkage services, and animal veterinary services received lower preferences. Overall, the findings indicate that farmers preferred improved crop varieties and row planting more than the other agricultural extension services examined.

Table 3. Farmers' Willingness to Pay for Different Agricultural Extension Services

No.	Type of agricultural extension service	Farmers' WTP (%)	Level of preference
1	Access to improved crop varieties	65	High
2	Row planting techniques	55.5	High
3	Access to irrigation services	35	Moderate
4	Agricultural tools and inputs	37	Moderate
5	Crop and animal production advisory services	32.8	Moderate
6	Advice on crop and animal production	28	low
7	Agricultural market linkage and valued addition services	26	low
8	Animal health and veterinary services	18	low

Source: Authors' own survey data 2024

3.3 Econometric Results

Table 4 displays the binary logistic regression findings that identify the variables affecting smallholder farmers' willingness to pay for agricultural extension services. The results demonstrate that age, education, landholding size, loan availability, radio access, and proximity to Farmers Training Centers (FTCs) all had a substantial impact on farmers' willingness to pay. Landholding size ($\beta = 0.518$, $p < 0.01$), radio access ($\beta = 0.960$, $p < 0.01$), age ($\beta = 0.031$, $p < 0.05$), education ($\beta = 0.360$, $p < 0.10$), and credit availability ($\beta = 0.648$, $p < 0.10$) all had a favorable effect on willingness to pay. On the other hand, distance to FTC had a negative effect on willingness to pay ($\beta = -0.353$, $p < 0.05$).

On the other hand, willingness to pay was not statistically significantly influenced by sex, family size, farming experience, irrigation availability, farm income, or market distance. The likelihood ratio test (LR $\chi^2 = 36.12$, $p < 0.01$) shows that the model is jointly significant, indicating the overall explanatory power of the included variables. The model's moderate fit is further indicated by the pseudo R2 score of 0.1301.

Table 4. Binary logistic regression results on determinants of smallholder farmers' willingness to pay for agricultural extension services

wtp	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]
Gender	.2050933	.3715959	0.55	0.581	-.5232213 .9334079
Age	0307904	.0123646	2.49	0.013 *	.0065562 .0550245
education	.3604947	.1920954	1.88	0.061*	-.0160053 .7369947
familysize	-.0307735	.026559	-1.16	0.247	-.0828281 .0212812
Farmexperince	.0066614	.0156912	0.42	0.671	-.0240927 .0374156
land_size	.518287	.1517932	3.41	0.001**	.2207778 .8157961
creditaccess	.6483419	.3324269	1.95	0.051*	-.0032029 1.299887
Irrigationaccess	.0089685	.3781077	0.02	0.981	-.7321091 .7500461
Radioaccess	.9596399	.3679722	2.61	0.000***	1.680852 -.2384277
farmincome	-8.93e-08	.000019	-0.00	0.996	-.0000373 .0000371
dist_ftc	-.3531406	.1474444	-2.40	0.017 *	-.6421263 -.064155
dis_mkt	-.0836411	.1455998	-0.57	0.566	-.3690115 .2017294
_cons	-.6454073	.9922284	-0.65	0.515	-2.590139 1.299325

Logistic regression	Number of obs = 230
	LR chi2(12) = 36.12
	Prob > chi2 = 0.0003
Log likelihood = -120.70403	Pseudo R2 = 0.1301

***, **, and * indicate the significance level of 1%, 5%, and 10%, respectively (*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001). The numbers written in brackets indicate t-statistics.

3.4 Econometric Discussions

Twelve factors that were believed to influence the study area's willingness to pay (WTP) for agricultural extension services were included in the model. At various significance levels, six of these factors were shown to be statistically significant. According to the binary logit model results (Table 4), the majority of respondents (71%) were willing to pay for agricultural extension services, particularly if the services are good and generate better profits than their existing returns. The findings demonstrate a positive correlation between age and willingness to pay for agricultural extension services, with a marginal effect of 0.0307 and statistical significance at the 5% level (p = 0.013).

According to this research, older household heads are more likely to be willing to pay for extension services than younger ones. The findings are consistent with a study conducted in Uganda that

suggests older farmers may be more likely to invest in agricultural services due to their established farming knowledge and financial resources. This result, however, is at odds with research from Tanzania and Nigeria [48] [55], [56], which found a negative correlation between willingness to pay and age. According to these research, younger farmers are generally more willing to pay because they are more flexible and open to innovation, whereas older farmers are often more risk conservative and less likely to invest in new services. Younger household heads are more inclined to participate in paying for agricultural extension services, according to [57], which also found a negative correlation between age and willingness to pay.

The finding demonstrates that education has a positive effect on willingness to pay for agricultural extension services, which is consistent with the a priori expectation. The variable is statistically significant at the 10% level ($p = 0.061$). According to the marginal effect, the likelihood of wishing to pay increases by around 36% for every unit increase in educational attainment. This implies that more educated farmers are more likely to be willing to pay for extension services, maybe because they have a better understanding of the benefits of scientific agricultural practices and their potential impact on output and environmental sustainability. The results support the study's hypothesis and are similar with other research [56] [50] [49], which likewise found a positive correlation between education and willingness to pay for agricultural extension services. The results support the study's hypothesis and are similar with other research [55] [49] [48], which likewise found a positive correlation between education and willingness to pay for agricultural extension services.

Table 4 shows a positive correlation between land size and willingness to pay for agricultural extension services, which is statistically significant at the 5% level. The regression results show that for every hectare of added farmland, a household's willingness to pay increases by about 51%. This implies that, in comparison to smallholders, farmers with bigger landholdings are more likely to invest in agricultural extension services, probably because of their higher production capacity and comparatively higher farm income. The result is in line with earlier research [56], which similarly found a positive correlation between landholding size and willingness to pay for agricultural services, and therefore supports the study hypothesis.

Access to credit services was found to have a beneficial impact on farmers' willingness to pay for agricultural extension services; this effect is statistically significant at the 10% level. The marginal

effect indicates that families with credit availability are around 64% more likely to be willing to pay for extension services than those without. This suggests that the availability of funding makes it easier for farmers to employ improved agricultural technologies and pay for consultancy services. The results are in line with [57], which highlights that loan availability is a crucial institutional component that promotes rural and agricultural development by helping farmers get beyond financial obstacles associated with input purchases and service payments.

The results of the binary regression show that willingness to pay for agricultural extension services in the study area is positively and statistically significantly impacted by radio access. The variable is significant at the 1% level ($p = 0.000$). Households with radios are around 95% more likely to be willing to pay for agricultural extension services, according to the marginal impact. This suggests that having access to radio information increases farmers' understanding of new agricultural technologies, market information, and weather-related forecasts, increasing their desire for extension services. Similar results were reported by [51] [55], who also found that farmers' willingness to pay for agricultural extension services and agricultural productivity was significantly impacted by limited information access.

Distance from the Farmers Training Center (FTC) has a negative correlation with the intention to pay for agricultural extension services; this correlation is statistically significant at the 10% level. The findings show that for every kilometer that a household is farther away from the FTC, the likelihood that they will be willing to pay for agricultural extension services decreases by about 35%. This suggests that households farther away from FTCs are less likely to pay for extension services because they have less access to timely information, modern agricultural technologies, and extension contact. The result is in line with previous research [50], which also found that farmers' access to and demand for agricultural extension services are adversely affected by greater distance to service centers.

4. Conclusion and Recommendations

The binary logistic regression results showed that age, education level, land size, access to credit, and access to radio significantly and positively influenced willingness to pay, while distance to Farmers Training Centers (FTC) had a significant negative effect. These findings highlight that socioeconomic status, access to information, financial capacity, and physical accessibility are key determinants of demand for agricultural extension services. Based on these findings, the study

recommends strengthening rural financial systems by expanding access to credit through microfinance institutions, rural banks, and agricultural insurance schemes to enhance farmers' ability to pay for extension services. Investment in agricultural information systems, particularly radio-based and other low-cost communication channels, is also essential to improve awareness and adoption of improved technologies. Furthermore, improving the accessibility and outreach of Farmers Training Centers is necessary to reduce distance-related barriers. Policy attention should also focus on ensuring inclusive extension service delivery by targeting resource-poor, smallholder, and female-headed households through subsidies or differentiated service fees. Finally, promoting private agricultural advisory and consultancy services led by agricultural science graduates is encouraged to complement public extension systems and improve service quality and responsiveness.

Declarations

Ethical Approval and Consent to Participate

The Institutional Review Board (IRB) of Mekelle University, Ethiopia, reviewed and approved the research protocol. The study was conducted in accordance with Ethiopia's National Research Ethics Review Guidelines, Mekelle University's ethical and research standards, and relevant ethical guidelines and regulations. Written informed consent was obtained from all participants before data collection. Participation was entirely voluntary, and the confidentiality and anonymity of participants were maintained throughout the research process.

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Clinical Trial

There are no clinical trials involved in this investigation.

Conflicts of Interest

The authors state that none of the work described in this study could have been influenced by any known competing interests.

Consent for Publication

Not applicable.

Availability of Data

The original data generated during the study and used in this paper are available with the corresponding author and can be provided on reasonable request.

Authors' Contributions

AT and SD conceived and designed the study. AT conducted the data analysis and drafted the manuscript, while SD contributed to the methodological development and interpretation of the results. Both authors discussed the findings, provided critical revisions, and approved the final version of the manuscript.

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