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Research Article

Examining the Influence of Rice Farmers' Characteristics on Extension Service Sources: Insights from Northwestern Ethiopia

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Abstract

This study aimed to investigate the relationship between farmers' characteristics and their access to agricultural extension services from multiple sources. The researchers collected cross-sectional data from a sample of 384 rice-farming households and analyzed the data using descriptive statistics and a binary Probit regression model. The result showed that age of the household, rice farming experience, plot number, cultivated rice land, dependency ratio, and crop diversification are drivers of receiving agricultural extension service. The study also explored the factors that drive farmers' choice of service providers for agricultural extension at the household level. The findings indicate that factors such as sex, education level, household size, dependency ratio, oxen number, crop income, and cultivated rice land are the main drivers of farmers' selection of service providers. This implies that farmers' socio-economic characteristics influence their choice of extension service providers. Given the current emphasis on demand-driven agricultural extension services, the findings of this study are particularly relevant. It is suggested that for better effectiveness of agricultural extension, it would be practical for providers of extension services to target a certain type of farmer that they can best serve.

Keywords

Extension Service Providers, Farmers Characteristics, Probit Regression Rice

1. Introduction

The provision of extension services in sub-Saharan countries is an important component of agricultural development to ensure food security and eradicate poverty [1]. Achieving food security requires a holistic and multi-sectoral approach that considers social, economic, and environmental dimensions. In this regard, a pluralistic agricultural extension system stimulates the involvement of many actors in serving smallholder farmers [2]. Within the framework of a pluralistic agricultural extension system, extension services play a crucial role in providing farmers with relevant production skills to facilitate the adoption of farming technologies [3].

However, access to agricultural extension services is characterized by inequity among different farmer categories [4]. The ability to access these services is derived from production orientation (subsistence, semi-commercial, or commercial), the gender category of the farmer (men and women),

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and the priorities of extension service providers [5]. Women make up almost 50 percent of the agricultural labor force in sub-Saharan Africa, an increase from about 45 percent in 1980 [6]. By encouraging women's participation in agriculture, the Ethiopian government recognizes the important role women play in the sector and aims to harness their potential for individual empowerment, food security, economic growth, and sustainable development [7]. It is generally true that commercially oriented farmers often have better opportunities to access extension services compared to subsistence farmers, as commercial farmers have better economic viability, market orientation, and political and policy priorities [8].

One of the drawbacks of a centralized extension service is that it can lead to weak linkages between smallholder farmers' needs and the extension service itself. This can result in a lack of responsiveness to the specific challenges and context faced by smallholder farmers [9]. The shift towards a pluralistic agricultural extension system, as noted in [2] and other literature, is driven by the recognition that no single actor or approach can effectively address the diverse needs and complexities of agricultural systems. The Ethiopian government has indeed adopted a pluralistic extension approach in its agricultural extension system [10]. In a pluralistic extension system, farmers have the opportunity to access services and support from various providers, such as government agencies, NGOs, research institutions, farmer organizations, private sector entities, and community-based organizations. Each provider may bring different expertise and resources. Consequently, understanding these differences is important for designing effective extension messages and interventions.

Many studies on the determinants of access to agricultural extension services have focused on specific providers, often examining the factors that influence access to services from a single provider. However, the reality is that farmers often receive services from multiple providers in a pluralistic extension system. While there may be a gap in the literature regarding access to extension services from multiple providers, it is important to recognize that the determinants of access can vary depending on the specific context and the combination of providers involved [11, 12]. Absolutely, understanding the relationships between farmers' characteristics and different extension service providers is crucial for improving the effectiveness and impact of agricultural extension programs on smallholder farmers' livelihoods and food security. Bridging the knowledge gap in this area can lead to more targeted and tailored extension interventions that address the specific needs, preferences, and circumstances of farmers. The objective of this study, therefore, is examining the relationship between rice farmers' characteristics and extension service providers.

2. Literature Review

2.1. Concepts and Definitions of Agricultural Extension Service

The use of agricultural extension varies between developed and developing countries. For instance, the agricultural advisory service is an alternative to agricultural extension in the United Kingdom, Germany, and Scandinavian countries [13, 14]. Politics and other traditions are tied to agricultural extension services. As a result, the operationalization of agricultural extension—that is, its methodology, the specific approach used, and implementation—varies from country to country [15]. Because of these differences, various scholars have given different definitions to agricultural extension. Traditionally, it can be defined as the delivery of information and technologies to farmers. It means that technologies are directly transferred to clients, whether they like it or not. [16] defined agricultural extension as extending relevant agricultural information to the people. This is the essence of the technology transfer model, which considers farmers as recipients of the technologies [17]. Purcell DL and Anderson JR. [18] defined extension as 'the process of helping farmers become aware of and adopt improved technology from any source to enhance their production efficiency, income, and welfare'. The above definitions of agricultural extension have limitations in incorporating farmers' lives and needs. Recently, agricultural extension has been defined as "systems that facilitate the access of farmers, their organizations, and other market actors to knowledge, information, and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions" [14]. Based on the Ethiopian context, it can be defined as "an approach to rural development and agricultural transformation where knowledge, teaching, and learning play key roles to ensure food security, reduce rural poverty, and sustainably manage the natural resource basis" [2].

2.2. Public, Pluralistic and Public/Private Agricultural Extension Systems

The type of agricultural extension system varies from country to country. Because the policy frameworks among countries are different, in this regard, there are three main agricultural extension systems. These are public agricultural extension, pluralistic agricultural extension, and private/public agricultural extension systems. [19, 20] reported that the public agricultural extension system has been the main agricultural extension system, in which the government is the main development actor in providing agricultural extension services to smallholder farmers. Because the system is inadequately funded, has wide area coverage, and has high extension costs, there are no sustainable budget sources to provide agricultural advisory services [21, 22]. As a result, the extension service effectiveness is very low [21]. On the

other hand, the public extension system has the advantage of dealing with issues of natural resource management, which may not be in the interest of the private sector [23]. Hence, technology transfer through public agricultural extension is considered advisable for developing countries in which the rehabilitation of natural resources is an issue [22].

To take advantage of sustainable budget sources for agricultural advisory services, the transition to a pluralistic agricultural extension system is emerging. It is a flexible system to consider different production systems, farm and farmers' conditions, and other factors. A set of stakeholders and institutions engage with and support farmers in solving their development goals through pluralistic extension services [3]. It means a mix of public, private, and NGO sector extensions, with varying services, missions, and goals, is available [24, 21]. Since several actors are involved, services are likely to better meet the diversity of rural needs. The practical use of pluralistic extension services can increase the popularity of countries such as China and India [24]. This orientation is somewhat a movement away from the top-down models of technology transfer [3, 19] As stated in the agricultural extension strategy of Ethiopia, a pluralistic agricultural extension system is recommended to transform the agriculture sector [10]. But practically, top-down technology transfer continues to be an operational approach [22].

The third extension system is a combination of the public and private agricultural extension systems. The public sector extension was criticized for not doing enough, not doing it well, and for not being relevant [25]. This failure was attributed to bureaucratic inefficiencies and the poor formulation and implementation of extension programs. As a result, many extension programs lacked a coherent link between smallholder farmers and other actors [22]. In another way, the private sector is interest- and profit-oriented, and smallholder farmers can't pay for important areas of extension service with the minimum number of farmers who can pay for it [26]. The paid private extension system is focused on reducing public outlays on agricultural extension by motivating farmers to pay some costs of knowledge and technology. However, most farmers in Ethiopia are small-scale, and sharing some knowledge is impractical [27]. In this case, looking for a public-private partnership to make the facilitation of extension services efficient and effective is salutary [26]. Its modality can be consolidated by subcontracting some roles of the public to the nonprofit or profit-based private sector [28]. In this case, agricultural advisory services are both public and private goods. Along with the public sector, involving the private sector and NGOs can help accelerate improvements in agricultural extension services to increase the efficiency of providing agricultural inputs, information, and training [29].

2.3. Perspectives on Agricultural Extension System

In Ethiopia, the use of agricultural extension evolves alongside the regime changes. As a result, its concept is complex and confusing. Practically, it involves multiple actors such as universities, research systems, the public agriculture and rural development sectors and the farmers. These actors play leading roles in knowledge production and management, teaching, learning and defining the knowledge needed for specific developmental goals. Based on the current developmental scenario in Ethiopia, agricultural extension mainly involves introducing, adapting and disseminating new knowledge and technologies through training and community mobilization. As identified by [30], scientific knowledge is the key driver of Ethiopian agricultural extension and rural development. It is an indication that there is high level government investment in agricultural extension system. It is more of top down approach, though the approach being used is called as participatory. This condition has resulted in path dependency syndrome, which is a dynamic process whose evolution is governed by its own history. It means that path dependency describes a situation in which the current goal of the actors is dictated by the past. These patterns of path dependency have appeared under modified names and structures (such as transition from peasant association to kebele administration), allowing the state to play a key role in the socio-political and economic decisions at the grassroot level. Thus, the same extension system has repeatedly manifested itself over regimes with little room for plurality, practicability, and participation [30]. This may be one of the reasons for the persistence of top-down planning and implementation.

In Ethiopian agriculture extension system, farming community has divided into two unequal groups, which are model farmers and followers. The main aim of the division is for ease of technology transfer, with special roles of development agents [2]. Model farmers are considered the frontline farmers and have access to training and newly introduced technology packages [2, 30]. So, they are expected to provide technologies (improved varieties and associated knowledge) transfer services to followers farmers. However, the agricultural extension system is constrained by knowledge and skill gaps among model farmers and development agents due to ambitious top down allocation of plans and actors involvement in non-extension activities. These limit farmers' participation in technology promotion and adoption [31, 2]. Based on the report by [31], the model farmer approach has increased extension coverage, improved the possibility for information and technology dissemination. Simultaneously, the approach has become a mechanism for the top-down control of farmers in identifying and favoring farmers with political commitments. Agricultural extension service provision over the different periods has generally been characterized by top-down, unimodal and public sector-dominated development approaches [32]. The demonstration of technologies using model farmers has been a key strategy for introducing and disseminating extension packages [31]. The same pattern is occurring for rice extension system. Specific to rice, the private sectors involvement in rice produc-

tion and extension service in rice production hubs (Fogera, Pawe, Chewaka, Abobo, May Tsebri, Gura Ferda and Gode) is boldly indicated in the national rice flagship program of Ethiopia [33].

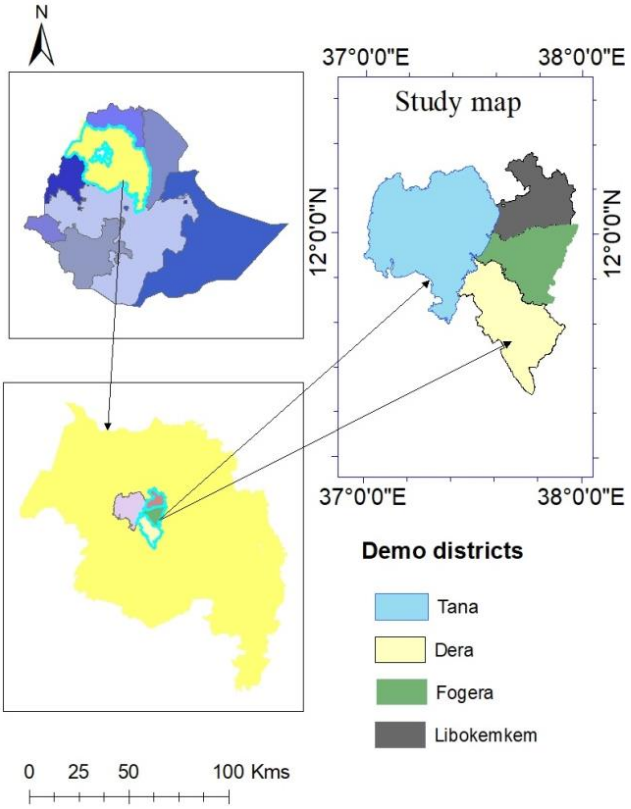
Smallholder farmers characteristics are also another concern that determines the performance of agricultural extension service. Smallholder farmers are characterized by farm and farmers specific characteristics. Farm specific characteristics includes their small plots of land, low utilization of fertilizer, their use of family labor and/or may hire labor and produce low output. [34] reported that more than 95% of crop output comes from subsistence smallholder farmers in Ethiopia. The same author reported that 29% of crop producers cultivated less than 0.5 hectares of land per household [35]. The report by [36] showed that the number of cattle determines access to agricultural extension service at 5% significance level. Furthermore, 52% of smallholder rice farmers use hired labor to meet their demand of rice production [33]. Farmers specific characteristics used by different authors includes age, farming experience, sex, education level, group membership [36-38]. The gender issue is a big development agenda in developing countries and several authors confirmed the difficulties in accessing women with agricultural advisory services [39, 40]. [36] showed that age and education level of farmers determines access to agricultural extension service at 1 % significance level. The probability of participating in the agricultural extension service is significantly influenced by the age of the household head, farming experience, access to agricultural credit, membership of a farmer-based organization and the size of plots allocated to maize production [36]. The aim of this study, therefore, is examining the association between farmers' socio economic characteristics and receiving agricultural extension service by multiple sources. As stated in the extension strategy and national rice flagship program, the extension approach is pluralistic and understanding the status of actors role in participating agricultural extension service in relation to farmers' characteristics is paramount importance [10].

3. Methodology

3.1. Study Area Description

This study was carried out in Fogera, Libokemkem and Dera districts of Northwest Ethiopia. The description of each district below are taken from respective district agriculture and rural development office in 2022.

Fogera: It is located in Northwestern Ethiopia, bordered by Farta to the east, Dera to the south, Lake Tana to the west, and Libokemkem to the north. The area's altitude ranges from 1774 to 2410 meters above sea level (m.a.s.l). It experiences a moderate climate with a mean annual rainfall of 1216 mm and an average temperature of 19 ℃. The agricultural landscape of Fogera is primarily focused on the cultivation of three major crops: rice, maize, and finger millet. Of the total cultivated land in the region, which spans 57535 hectares, rice cultivation accounts for approximately 43% of the area. This indicates the significance of rice farming within the agricultural practices of Fogera.



Source: Ethiopian Geospatial data

Figure 1. *Location map of the study area.*

Libokemkem: It is located in Northwestern Ethiopia, sharing its borders with Fogera to the south, Gonder Zuria to the north, Lake Tana to the west, and Ebinat to the east. The altitude of the area varies from 1800 to 2850 meters above sea level (m.a.s.l). It experiences an annual rainfall ranging from 900 mm to 1200 mm, with an average annual temperature ranging from 12 ℃ to 26 ℃. The agricultural activities in Libokemkem primarily revolve around the cultivation of three major crops: maize, rice, and tef. Among these crops, rice cultivation occupies approximately 34% of the total cultivated land, which amounts to 39509 hectares. This highlights the significant contribution of rice farming to the agricultural landscape of Libokemkem.

Dera: It is surrounded by the Abay River to the south, Lake Tana to the west, Fogera to the north, and Este to the east. The altitude in Dera ranges from 1500 to 2600 meters above sea level (m.a.s.l). The region experiences a mean annual rainfall ranging from 1000 mm to 1500 mm, with an annual temperature varying between 15 ℃ and 32 ℃. Maize, tef, and finger millet are the primary crops in Dera, occupying the majority of the cultivated land, which spans 56,882 hectares. Rice cultivation, on the other hand, represents a

smaller portion, accounting for 7.8% of the total area.

3.2. Sampling Design and Data Collection

The study employed a cross-sectional survey research design and targeted smallholder rice producers as the study population. A multistage sampling technique was utilized for sampling. Firstly, districts known for significant rice production in Ethiopia were purposefully selected. Secondly, kebeles (local administrative units) were randomly chosen from a list of potential rice-producing kebeles. Lastly, 384 rice-producing households were systematically selected using a random sampling technique. The sample size was determined using Yamane's formula. A sampling frame of rice-producing households was obtained from the agricultural and rural development offices of the selected kebeles. Data collection involved face-to-face interviews using a questionnaire designed with Cspro software. Enumerators received training, and the questionnaire was pretested to ensure data quality. The sample size determination followed Yamane's formula [41].

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

where n represents the sample size, and N and e denote population size and precision level, respectively. Hence, with a precision level of 0.05, from 9,600 rice producing farm households, 384 sample households were selected.

3.3. Econometric Model Specification

This study utilized the probit model to examine the correlation between agricultural extension providers and the socioeconomic characteristics of farmers. Firstly, the analysis focused on determining the factors that influence smallholder farmers' access to agricultural extension services. The dependent variable in this analysis was whether or not farmers received agricultural extension services, represented as a binary response variable. Secondly, the study explored the connection between farmers' characteristics and the sources of agricultural extension services they received. Since farmers often receive services from multiple sources, the dependent variable in this analysis indicated whether a given farmer received agricultural extension visits from a specific source. Thus, there were four binary response variables in the second analysis. The models are specified below:

The model for determinants of overall receiving extension service on rice was specified as:

$$y_i = 1, \text{ if } y_i>0, \text{ for those who have received agricultural extension} \quad (2)$$

$$y_i = 0, \text{ if } y_i<=0, \text{ for those who didn't received extension service} \quad (3)$$

$$Y_i = b_i x_i + e_i, \text{ the model to estimate the determinants of receiving extension service} \quad (4)$$

Where y_i is receiving extension service or not, x_i, the explanatory variables included in the model, and e_i, the error term, which is normally distributed with (0,1). Accordingly, the four models to investigate the relationship between farmers socioeconomic characteristics and receiving agricultural extension services on rice from multiple sources (government, NGO (non-governmental organization), farmer cooperatives, and research centers) were specified as follows:

$$y_i = b_i x_i + e_i, \text{ government} \quad (5)$$

$$y_i = b_i x_i + e_i, \text{ NGO (nongovernmental organizations)} \quad (6)$$

$$y_i = b_i x_i + e_i, \text{ Farmers cooperatives} \quad (7)$$

$$y_i = b_i x_i + e_i, \text{ research centers} \quad (8)$$

Table 1. *Operational definition of variables.*

Variables	Descriptions	Expected sign
Dependent variable		
Receiving agriculture extension service	Households that received agricultural extension service by multiple sources (1=yes, 0=no)	
Independent variables		
Sex (male)	Dummy: male headed household (1=male, 0=female)	+/−
Age	Age of the household head in completed years	−
Education	Number of years of formal education	+
Rice farming experience	Rice farming experience of the household head in completed years	−

Variables	Descriptions	Expected sign
Household size	Number of household members	+
Dependency ratio	The ratio of household members not involved in any economic activity to total household size.	–
Plot number	Number of rice plots	+
Oxen number	Number of oxen in the household	+
Crop income	Income of household obtained from crop sale	+
Total land owned	Size of land owned by the household in hectare	+
Rice cultivated	Size of land covered with rice in hectare	+/–
Credit received	Dummy: the farmer has received agricultural extension service (1=yes, 0=no)	+
Crop diversification	Dummy: weather the household cultivates rice or rice and others (1=yes, 0=no)	+/–

4. Results and Discussion

4.1. Socio Economic Characteristics of Sampled Households

Table 2 provides a summary of the characteristics of the population under study. The findings reveal that 81.3% of the interviewed farming households were male. Additionally, 16.9% of the households received credit, while 79.4% engaged in crop diversification. The average household size was five members, with an average formal education duration of 1.3 years. The household dependency ratio was calculated at 42.4%, indicating a predominantly active labor force capable of contributing to agricultural productivity. The average age of the interviewed households was 42, signifying a productive workforce. The average rice farming experience was 21 years, and households owned an average of 5.23 plots of land, suggesting fragmented rice farmland. The average crop income for the households was 33,279.576 Ethiopian Birr (ETB). Furthermore, the average total land owned was 0.858 hectares, with an average rice cultivated land size of 0.653 hectares.

Table 2. *Summary statistics of population characteristics.*

Variable	Mean	Std. Dev.	Min	Max
Sex	.813	.391	0	1
Age	41.714	11.932	19	77
Education	1.313	2.08	0	10
Rice farm experience	20.922	11.504	1	54
Household size	5.323	1.966	1	10
Dependency ratio	.424	.209	0	1
Plot number	5.63	2.158	1	11
Oxen number	1.682	.746	0	3
Crop income	33279.576	25604.796	350	131900
Total land owned	.858	.333	.13	2
Rice cultivated	.653	.342	.06	2
Credit received	.169	.375	0	1
Crop diversification	.794	.405	0	1

Note: for dummies, the mean refers to mean proportions that are converted to percentages in the description.

4.2. Drivers of Receiving Agricultural Extension Service

Table 3 presents the results of the probit model analysis examining the factors associated with receiving agricultural extension services. The coefficients in the model indicate the strength and direction of the relationship between each independent variable and the likelihood of receiving agricultural extension services. Additionally, the marginal effects provide insights into the change in the probability or expected value of the dependent variable resulting from a unit change in an independent variable while keeping other variables constant.

The analysis from Table 3 reveals that both plot number and crop diversification have a positive and statistically significant influence on the likelihood of receiving agricultural extension services, with a significant level of 1%. The findings indicate that farmers with larger plots can increase their probability of receiving extension services by approximately 3.5%. This suggests that farmers who have larger land holdings are more likely to seek and benefit from technical advice and support provided through agricultural extension services. This finding is consistent with a study conducted by [42] in Ethiopia, which also found a positive effect of plot number on participating in extension programs. Similarly, the analysis indicates that farmers engaged in diverse cropping practices have an increased probability of receiving extension services by approximately 16.8%. This implies that farmers who practice crop diversification are more likely to access and benefit from extension services. The results align with a study by [43], which also found a positive and significant influence of crop diversification on the provision of extension services. Furthermore, the study by [44] on small-scale farmers in southern Zambia reported that farmers with medium-sized farms have better access to extension services compared to those with small or large farm sizes.

Both rice farming experience and credit received have a positive and significant influence on the source of extension services at a 5% significance level. Receiving credit services is found to increase the probability of obtaining extension services by approximately 11.9%. This implies that farmers who have access to credit are more likely to receive extension services, possibly due to their enhanced investment capacity or ability to implement recommended agricultural practices with the financial support they receive. Furthermore, the results suggest that for every one-year increase in rice farming experience, the probability of receiving extension services increases by approximately 1%. This finding suggests that farmers with more experience in rice farming are more likely to seek out and benefit from extension services. This could be attributed to their familiarity with farming practices and their recognition of the value that technical support can provide to enhance their farming operations.

However, rice-cultivated land size has a negative and significant effect on the probability of receiving extension services at the 10% significance level. This implies that as the size of rice-cultivated land increases by one hectare, the likelihood of receiving extension services decreases by approximately 11.8%. This finding contradicts the results reported by [9], which demonstrated a significant and positive influence of cultivated land size on receiving extension services at the 10% significance level. These conflicting results suggest that the relationship between cultivated land size and the receipt of extension services may vary across different studies or contexts, as mentioned in the work of [45]. Furthermore, the analysis indicates that age has a significant and negative impact on the likelihood of receiving extension services at the 10% significance level. Specifically, as age increases by one year, the probability of receiving extension services decreases by approximately 0.8%. This result aligns with the theory proposed by [46] that younger smallholder farmers are more likely to seek out and engage with extension services.

Table 3. *Drivers of receiving agricultural extension service.*

Variables	Coef.	SE	Marginal effects	SE
Sex	-.106	.253	-0.030	0.069
Age	-.026*	.016	-0.008	0.005
Marital status	-.077	.109	-0.022	0.031
Education	.007	.04	0.002	0.012
Rice farm experience	.036**	.017	0.010	0.005
Household size	-.009	.053	-0.003	0.015
Dependency ratio	.031	.398	0.009	0.115
Plot number	.12***	.042	0.035	0.012

Variables	Coef.	SE	Marginal effects	SE
Oxen number	-.054	.121	-0.015	0.035
Crop income	0.00	0	0.000	0.000
Total land owned	.223	.25	0.065	0.072
Cultivated rice	-.408*	.221	-0.118	0.064
Credit received	.471**	.24	0.119	0.051
Crop diversification	.524***	.195	0.168	0.068
Constant	.311	.642		
N	384			
Log likelihood	-186.23696			
Chi-square (14)	50.39			
Pro>chi2	0.0000			

*** p<.01, ** p<.05, * p<.1

4.3. Farmers Characteristics and Sources of Agricultural Extension Services

According to the information provided, over 37% of the interviewed households received extension services from multiple sources of service providers. The government was the largest provider, reaching over 72% of the surveyed farmers, as shown in Figure 2. This finding aligns with a report by [45] on smallholder farmers' perspectives on advisory extension services in southern Ethiopia, which stated that 68.3% of 347 respondents received agricultural extension services from the government. These results confirm that the government plays a dominant role in providing extension services to smallholder farmers.

The results presented in Table 4 provide probit regression estimates and marginal effects on the relationship between farmers' characteristics and access to agricultural extension services from different sources.

Regarding the government extension service, the age of the household head was found to have a negative influence at the 10% significance level. For each one-year increase in age, the probability of receiving extension service from the government decreased by approximately 0.9%. This finding aligns with previous studies by [46], which suggest that older smallholder farmers may be more conservative and less inclined to adopt new technologies or engage with extension services. As usual, the extension services are gender-biassed, and hence they are dominated by men's outlooks [47]. The household size was found to have a negative and significant impact on the government extension service at the 10% significance level. As the number of household members increased by one, the probability of receiving extension service from the government decreased by approximately 3%. This finding indicates that larger households may face challenges in accessing government extension services, potentially due to resource constraints or limited outreach capacity. On the other hand, the number of oxen owned by the household had a positive and significant influence on the government extension service at the 1% significance level. With each additional oxen, the probability of receiving extension service from the government increased by approximately 9.7%. This suggests that farmers with more oxen may be more likely to receive government extension services, possibly due to their increased investment capacity or agricultural productivity. The income obtained from crop sales had a positive and significant effect on the government extension service at the 1% significance level. For every one birr increase in crop income, the probability of receiving agricultural extension services from the government increased by approximately 0.1%. This finding implies that farmers with higher crop income may have a greater likelihood of receiving government extension services, potentially due to their ability to invest in agricultural practices and technologies. This result is consistent with [42] Crop diversification was found to have a significant and positive influence on the government agricultural extension service at the 10% significance level. Farmers who practiced crop diversification had an increased probability of receiving extension service from the government by approximately 11.9%. This result is consistent with the findings of [48-51], suggesting that crop diversification may contribute to increased access to government extension services, possibly due to its alignment with profitability-oriented extension systems.

According to the results, sex has a negative and significant influence on the provision of agricultural extension services by NGOs at a 1% significance level. Female-

headed households have a higher probability of receiving extension services from NGOs, with an increase of approximately 67.2%. This finding suggests that NGOs in Ethiopia may have gender-oriented plans that prioritize providing extension services to female-headed households. This result is consistent with the findings reported by [51]. However, it is worth noting that the results reported by [52] indicate that male-headed households had better access to agricultural extension services from farmer organizations and the government, respectively. These contrasting findings may reflect variations in the focus and strategies of different service providers. The education level of the household head positively and significantly influences the provision of extension services by NGOs at a 5% significance level. For each additional year of education, the likelihood of receiving extension services from NGOs increases by approximately 2.8%. This suggests that higher education levels of household heads may contribute to better access to extension services provided by NGOs. Furthermore, crop income is positively associated with the provision of extension services by NGOs at a significant level of 1%. As crop income increases by one birr, the probability of receiving extension services from NGOs increases by approximately 0.1%. This finding implies that farmers with higher crop incomes are more likely to access extension services provided by NGOs, potentially due to their ability to invest in agricultural practices and technologies.

Sex and crop income positively and significantly influence the cooperative extension service provision at a 1% significant level. Male-headed households would increase the probability of receiving extension service by 23.3%, while as crop income increases by one birr, the probability of receiving extension service from cooperatives would increase by 0.1%. As the number of household members increases by one, the probability of receiving extension service from cooperatives increases by 3.1%. This is consistent with results reported by [53], who found that households with a large number of members are more likely to get extension service than households with a small number of members. However, as dependency ratio increases by one, the probability of getting extension service from cooperatives decreases by 24.4%. Furthermore, as oxen number is increased by one, the probability of receiving extension service from cooperatives decreases by 7.5%.

Crop income and size of cultivated rice land are positively associated with research centers' extension service provision at 1% and 10% significant level, respectively. As crop income is increased by one birr, the probability of receiving extension service from research centers would be increased by 0.1%. The report by [54] on effect of farmer socio-economic characteristics on extension services demand and its intensity of use in post-conflict Liberia showed, there is a positive association between extension service and crop income. As size of cultivated rice land is increases by one hectare, the probability of receiving extension service from research centers increases by 13.7%. This result is consistent with [55].

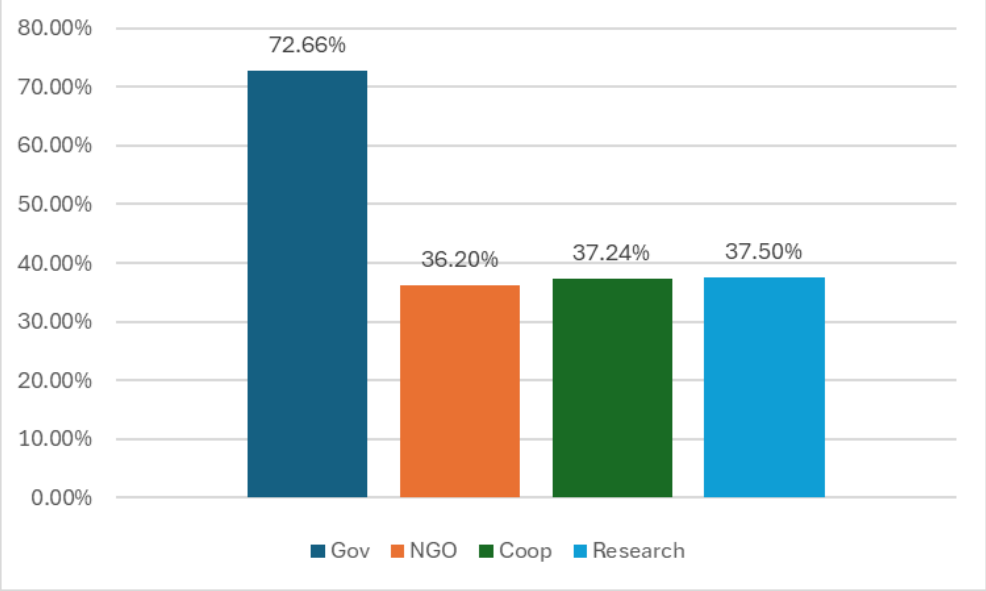


Figure 2. *Providers of agricultural extension services.*

Table 4. *The relationship between socio economic characteristics and receiving agricultural extension from different sources.*

Variables	Government			NGO			Cooperatives			Research centers		
	Coef	SE	Marginal effect	Coef	SE	Marginal effect	Coef	SE	Marginal effect	Coef	SE	Marginal effect
Sex	.201	.232	0.065	-1.996***	.284	-0.672	.697***	.233	0.233	-.32	.22	-0.124
Age	-.03*	.016	-0.009	-.023	.016	-0.008	.007	.014	0.003	.001	.014	0.000
Marital status	.142	.11	0.044	-.171	.118	-0.062	.099	.105	0.037	.099	.098	0.037
Education	-.024	.038	-0.007	.076**	.038	0.028	.037	.034	0.014	.026	.033	0.010
Rice farm experience	.018	.016	0.006	.01	.016	0.004	0.00	.014	0.000	.002	.014	0.001
Household size	-.096*	.052	-0.030	.01	.057	0.004	.084*	.048	0.031	-.055	.048	-0.021
Dependency ratio	.199	.413	0.062	.018	.445	0.007	-.652*	.383	-0.244	.111	.374	0.042
Plot number	.01	.039	0.003	-.033	.042	-0.012	.03	.036	0.011	.022	.036	0.008
Oxen number	.313***	.12	0.097	.012	.124	0.004	-.199*	.111	-0.075	-.05	.11	-0.019
Crop income	0.00***	0.00	0.001	0.00***	0.00	0.001	0.00***	0.00	0.001	0.00***	0.00	0.001
Total land owned	.028	.254	0.009	.258	.262	0.094	.184	.236	0.069	.12	.232	0.045
Cultivated rice	.185	.236	0.058	-.25	.244	-0.091	-.128	.211	-0.048	.363*	.208	0.137
Credit received	.316	.219	0.091	-.043	.217	-0.015	.286	.186	0.110	-.09	.188	-0.033
Crop diversification	.359*	.196	0.119	-.03	.229	-0.011	.065	.2	0.024	.069	.201	0.026
Constant	.117	.638		1.267	.695		-2.008	.615		-.974	.594	
N	384	384		384			384			384		
Log likelihood	-192.83			-175.61			-225.76			-232.42		
Chi2 (14)	64.895			151.479			55.522			43.236		
Pro>ch2	0.000			0.000			0.000			0.000		

*** p<.01, ** p<.05, * p<.1

5. Conclusion and Recommendations

The study described factors associated with the provision of agricultural extension services and the providers of such services. It provides insights into the various factors that influence the provision of agricultural extension services and emphasizes the need to improve the pluralistic nature of extension systems. The findings of the study suggest that different factors have varying effects on different aspects of agricultural extension service provision. To enhance the provision of extension services, there is a need to leverage the benefits of factors that contribute to improved extension provision. This may involve measures such as promoting crop diversification to enhance farm income, providing extension services to women from multiple sources, and promoting smallholder commercialization, which can stimulate greater demand for agricultural extension services. By identifying context-specific farmer characteristics related to access to extension services, the study provides insights that can assist designers of demand-driven approaches in creating strategies to generate demand for specific agricultural extension approaches. Overall, the study underscores the importance of understanding the factors influencing the provision of agricultural extension services and tailoring extension efforts to the needs and characteristics of different farmers. It is suggested that for better effectiveness of agricultural extension services, it would be practical for providers of extension services to target a certain type of farmer that they can best

serve.

Abbreviations

NGO	Non-Governmental Organization
UN	United Nations

Author Contributions

Ayele Tesfahun Gashu: Conceptualization, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing

Adane Melak Beyene: Conceptualization, Data curation, Methodology, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

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