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ARE AGRICULTURAL EXTENSION SERVICES ACCESSIBLE TO GHANAIAN FARMERS? PROBABILITIES AND EXPECTATIONS FROM CORNER SOLUTION RESPONSES

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Abstract: *Agricultural extension services play a vital role in Ghana's vegetable sector modernization and growth agenda. The Government of Ghana has made efforts to enhance extension delivery by improving the Agricultural Extension Agent (AEA)-farmer ratio from 1:1,906 in 2016 to 1:709 in 2020. However, access to extension services remains limited, raising concerns about their reach and effectiveness. This study examines the socio-economic factors influencing farmers' access to extension services in Ghana, focusing on the role of credit, farmer-based organizations (FBOs), and experience. Specifically, it analyzes the determinants of access using the Tobit model to predict probabilities and expectations associated with corner solution responses. Cross-sectional data were collected from 400 vegetable farmers across selected regions of Ghana. Findings revealed that, on average, a randomly selected vegetable farmer had about a 33% probability of accessing extension services. Key socio-economic factors influencing access included credit availability, FBO membership, household size, and farming experience. The study recommends strengthening and expanding FBOs to improve access, enhancing collaboration between government and financial institutions to facilitate credit, and providing adequate logistical and operational support to district extension directorates to ensure timely and effective service delivery across Ghana.*

Keywords: *Agricultural extension, Corner solution, Tobit, Conditional expectation, Unconditional expectation, Extension delivery*
(JEL code:B41, C01, C25, Q16, Q18)

INTRODUCTION

Vegetable cultivation remains a key source of livelihood and nutrition for many households. However, productivity is increasingly constrained by erratic rainfall, declining soil fertility, and farmers' limited knowledge of climate-resilient production technologies (Duku, Gu & Hagan, 2011; Forkuor et al., 2022). Continuous cultivation on the same land, compounded by the adverse impacts of climate change, has further degraded production systems (Mabe, Sienso & Donkor, 2014; Lassoued & Smyth, 2023). These challenges highlight the need to strengthen farmers' technical knowledge and adaptive capacity, which are often limited due to inadequate access to agricultural extension services. Extension systems play a crucial role in bridging the knowledge gap by training farmers in climate-smart practices, soil fertility management, and efficient production technologies. Strengthening these services can therefore enhance farmers' resilience, improve productivity, and ensure the sustainability of Ghana's vegetable sector.

The primary objective of extension services is to enhance productivity, promote sustainable agricultural methods, and improve the livelihoods of farming communities through education, training, and advisory support (Priya et al., 2025). The agricultural extension system remains an important knowledge and information dissemination mechanism in developing countries because of the crucial role it plays in agricultural growth and modernization (Kaur & Kaur, 2018). Agriculture is the mainstay of most of these economies (Habineza et al., 2020), driving overall economic growth (Msuya et al., 2017). Public extension delivery services in developing countries have evolved over the years, making it imperative to focus on timely and evidence-based guidance in addressing the needs of poor and marginalized farmers. In the face of the devastating effects of climate change on agriculture, coupled with low productivity and declining soil fertility, farmers' expectations of extension programs have become increasingly high (Danjumah et al., 2024). Agricultural extension primarily supports farmers to produce crops productively and profitably through educational interventions (Antwi-Agyei & Stringer, 2021). It bridges the gap between farm-level productivity and research station-level productivity. In developing regions like Africa, agricultural extension covers critical aspects such as agricultural production, gender inclusion, agricultural marketing, youth development, natural resource management, rural development, and leadership development (Agomoh Chisom, 2021). A key principle underlying the practice of agricultural extension in developing countries is its ability to leverage local leadership to generate a multiplier effect on the efforts of extension agents. It is inherently farmer-centered, designed to address the specific needs of farmers within their catchment areas (Agomoh Chisom, 2021). A well-functioning agricultural extension delivery system offers significant benefits to the agricultural sector. Agricultural Extension Agents (AEAs) assist farmers in accessing improved agricultural technologies for crop production (Altalb et al., 2015) and train them on how to use these technologies effectively to increase productivity. Farmers benefit more from extension delivery systems when they have frequent contact with extension officers, as this enhances their access to information on good agronomic practices that positively impact their farm businesses (Gebrehiwot et al., 2017; Acevedo et al., 2020). Various approaches employed in developing countries include demonstrations, training activities, farm visits, group discussions, farmer field schools, and plant clinics. Another important approach involves the use of media such as television and radio to deliver agricultural messages to target farmers (Jha & Singh, 2021).

LITERATURE REVIEW

Ghana's agricultural extension strategy

Agricultural extension remains a key driver of Ghana's agricultural sector modernization and growth agenda (MoFA, 2023). In Ghana, agricultural extension delivery services were initially started by private individuals engaged in the cocoa, coffee, and rubber value chains. After independence, the service became nationalized, leading to the establishment of the Extension Directorate in 1987 to harmonize all related services under one umbrella. The flagship extension system has been the Training and Visit (T&V) system, which has been adopted since the 1990s (MoFA, 2005). This system was largely funded by the Government of Ghana (GoG) with donor support from the World Bank. Other extension systems, such as Participatory Technology Development and Extension and the Farmer Field School approach, have also been tested in the country. The key role of Agricultural Extension Agents (AEAs) is the transfer of knowledge, which is often complemented by the facilitation of learning among farmers. In recent years, there has been increasing participation of the private sector across the entire agricultural value chain in the delivery of extension services to farmers (MoFA, 2005). The Government of Ghana has attempted to enhance extension service delivery by bridging the AEA-farmer ratio from 1:1,906 in 2016 to 1:709 in 2020 (MoFA, 2022). This improvement was achieved through the recruitment of about 2,700 extension agents in 2018 (MoFA, 2023). The initiative is expected to increase the availability of and access to technical assistance for farmers across the country so that they can achieve the highest utility from promoted agricultural programmes. However, the government's target of achieving an ideal ratio of 1:1,500 by 2025 (MoFA, 2022) remains quite large. The question, therefore, is whether farmers truly have adequate access to extension services.

Abdallah et al. (2016) recommended that the capacity of farmer-based organisations (FBOs) be strengthened to facilitate the delivery of agricultural extension services to their members, since membership in such organisations is a key determinant of access to extension services. Several other studies (Stockbridge et al., 2003; Abokyi, 2013) have also reiterated the important role FBOs play in promoting effective extension service delivery. However, since Abdallah et al. (2016) conducted their study in Northern Ghana, it is necessary to examine whether these findings can be generalised using data from Southern Ghana, where agricultural dynamics and socio-economic contexts may differ. Farmer-based organisations serve as business models that can support the adoption of climate-resilient technologies. For instance, farmers' cooperatives, a form of FBO, enable members to pool their resources for production and marketing. These cooperatives have been instrumental in helping vegetable farmers adopt irrigation systems in Ghana (Owusu, 2021). In rural parts of the north, where vegetable production has been severely affected by erratic rainfall, cooperative societies have allowed farmers to mobilize resources to establish irrigation systems. This has enabled them to produce vegetables all year round, thereby building resilience to the adverse impacts of climate change (Owusu, 2021).

Socio-economic characteristics also influence both access to and receipt of extension services. Age and education, for example, affect the extent to which farmers receive such services (Atsan et al., 2009). Older farmers tend to receive fewer extension visits because they are often conservative and less receptive to new innovations. Conversely, higher education levels positively affect access to extension services, as education enhances understanding of the importance and benefits of adopting new technologies. With respect to access to extension services, Abdallah et al. (2016) further identified age and farm size as factors that affect access to credit, which indirectly influences participation in extension activities. Understanding how socio-economic characteristics shape farmers' participation in extension services is therefore critical for designing inclusive and effective agricultural support systems. This present study examines the factors affecting access to agricultural extension services in Ghana. Specifically, it seeks to measure the response probabilities and expectations associated with the number of extension visits farmers receive. The study contributes to existing literature in two key ways. Firstly, it predicts the average response probabilities of accessing extension services. Secondly, it measures partial effects under both conditional and unconditional expectations and compares these effects at the levels of Average Partial Effect (APE) and Partial Effect on the Average (PEA).

MATERIALS AND METHODS

Theoretical and empirical models

Crop farmer's access to agricultural extension services can be roughly described as a corner solution response if it is measured as the number of extension visits received during the production season. In a population of farmers, the dependent variable (number of extension visits received during the production season) takes on a wide range of values which is zero for some significant fraction. Corner solution responses can be analyzed using the tobit model (Wooldridge, 2016). Other limited dependent variable models like logit and probit cannot be used to model the number of extension visits because they take on only binary responses. The tobit model is defined by the latent variable y* :

$$y^* = x\beta + e, \quad e \sim N(0,\sigma^2)$$

$$y = y^* .1[y^* > 0]$$

Where 1[ ] is the indicator function which returns a 1 if the expression in [ ] is true, and 0 otherwise. In the tobit model, we assume that the error term follows a standard normal distribution with mean and standard deviation equal to 0 and σ^2 respectively. The values of interest in the tobit model include: (1) Probability of extension service access (2) Conditional expectation, (3) Unconditional expectation and (4)Partial effect for the respective values of interest(Smed et al., 2017;Wooldridge, 2016).

Probability of receiving extension service and associated average partial effect (APE)

Given that the prob ability of observing a zero,

$$P(y = 0) = 1 - \Phi\left(\frac{x\beta}{\sigma}\right) \qquad (1)$$

in the case of number of extension visits received by farmers (i.e. not receiving extension services).

The probability of having a positive value (number of extension visits) is therefore presented as:

$$P(y > 0) = \Phi\left(\frac{x\beta}{\sigma}\right)$$

, Where

Φ is the standard normal cdf

For a discrete variable, the average partial effect is given as:

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\Delta P(y>0)}{\Delta x_k} = \frac{1}{N}\sum_{i=1}^{N}\left(\phi\left(\frac{X_{c+1,i}\beta}{\sigma}\right) - \phi\left(\frac{X_{c+1,i}\beta}{\sigma}\right)\right) \qquad (2)$$

For a continuous variable, the average partial effect is given as :

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\partial P(y>0)_i}{\partial x_k} = \frac{1}{N}\sum_{i=1}^{N}\left(\phi\left(\frac{X_i\beta}{\sigma}\right)\left(\frac{\beta_k}{\sigma}\right)\right) \qquad (3)$$

Conditional expectation E(y|y>0) and associated average partial effect (APE)

In the tobit model, (Ey|y>0) is the expected value for those having a positive value (Wooldridge, 2016). In this study the expected value is the number of extension visits received by a farmer who had positive extension visits from AEAs (i.e. ... n can be

$$E(y|y > 0) = \mathbf{x\beta} + \sigma\lambda\left(\frac{x\beta}{\sigma}\right) \qquad (4)$$

For a discrete variable, the average partial effect is given as:

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\Delta E(y|y>0)_i}{\Delta x_k} = \frac{1}{N}\sum_{i=1}^{N}\left(\left(X_{c+1,i}\beta + \sigma\lambda\left(\frac{X_{c+1,i}\beta}{\sigma}\right)\right) - \left(X_{c,i}\beta + \sigma\lambda\left(\frac{X_{c,i}\beta}{\sigma}\right)\right)\right) \qquad (5)$$

For a continuous variable, the average partial effect is given as :

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\partial E(y|y>0)}{\partial x_k} = \frac{1}{N}\sum_{i=1}^{N}\beta_j\left\{1 - \lambda\left(\frac{x\beta}{\sigma}\right)\left[\frac{x_i\beta}{\sigma} + \lambda\left(\frac{x\beta}{\sigma}\right)\right]\right\} \qquad (6)$$

Unconditional expectation E(y) and associated average partial effect (APE)

In the tobit model, unconditional expectation E(y) refers to the expected value of y for both those with zero and positive values. In the case of this article average number of extension visits that a farmer in the population received from AEAs in the whole season. This is equal to the probability of having a positive value times the expected value given the farmer has positive values. In this case the probability of being visited time the number of visits, given a farmer was visited by an AEA. Unconditional expectation can be expressed as:

$$E(y) = P(y >).E(y|y > 0|x) = \Phi\left(\frac{x\beta}{\sigma}\right)\boldsymbol{x\beta} + \boldsymbol{\sigma\phi}\left(\frac{x\beta}{\sigma}\right) \qquad (7)$$

For a discrete variable, the partial effect is given as:

$$\frac{\Delta E(y)}{\Delta x_k} = E(y|x_1, \ldots . x_k = c+1) - E(y|x_1, \ldots . x_k = c) \qquad (8)$$

$$= \left[\Phi\left(\frac{x_{c+1}\beta}{\sigma}\right)x_{c+1}\beta + \sigma\phi\left(\frac{x_{c+1}\beta}{\sigma}\right)\right] - \left[\Phi\left(\frac{x_c\beta}{\sigma}\right)\boldsymbol{x_c\beta} + \sigma\phi\left(\frac{x_c\beta}{\sigma}\right)\right] \qquad (9)$$

We calculate the partial effect for every farmer and take the average (Smed et al., 2017). For a continuous variable, the partial effect is also given as :

$$\frac{\partial E(y)}{\partial x_k} = \beta_k\Phi\left(\frac{X\beta}{\sigma}\right) = \frac{\partial p(y>0)}{\partial x_k}E(y|y>0) + p(y>0)\frac{\partial E(y>0)}{\partial x_k} \qquad (10)$$

Here we also calculate the partial effect for every farmer and take the average for the APE (Smed et al., 2017).

A formal representation of the tobit model with number of extension visits explained by the independent variables is

$$y^* = \beta_0 + \beta_1 gender + \beta_2 education + \beta_3 off_{farm} + \beta_4 credit + \beta_5 fbo + \beta_6 household\ size + \beta_7 age + \beta_8 age_{squared} + \beta_9 experience + \beta_{10} farmsize + e \qquad (11)$$

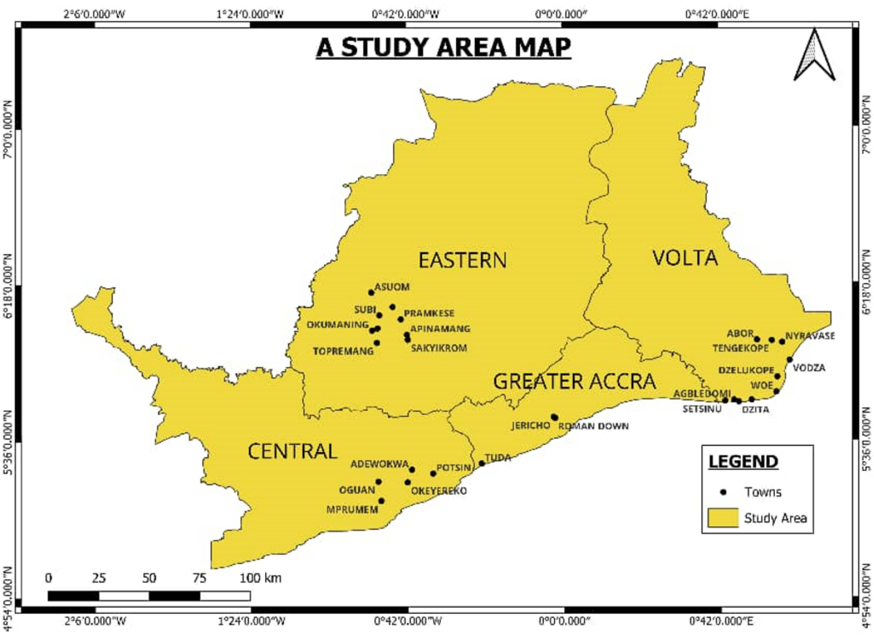
$$e \sim N(0,\sigma^2)$$

$$extension\ visits = y^*.1[y^* > 0]$$

Data collection and analysis

A cross sectional data collected from vegetable farmers was employed for this study. The dataset is from a 2023 survey that was carried out in the Central, Eastern, Volta and Greater Accra regions of Ghana. A two-stage sampling technique was employed in the selection of respondents across different ecological and socio-economic zones. In the first stage, four regions—Central, Eastern, Volta, and Greater Accra—were purposively selected based on their significance in vegetable production, diversity in agro-ecological conditions, and varying levels of access to extension services. These regions also reflect a mix of coastal, forest, and transitional zones, which provide a broader understanding of the dynamics influencing agricultural extension service delivery in southern Ghana. In addition, eight districts were also selected purposively within the four regions namely: Gomoa East, Gomoa West, Kwaebibirem, Denkyembour, Weija, Kpone-Katamanso, Anloga and Keta. The second stage was a random selection of 50 vegetable farmers from each

Figure 1. Map of Study Area



Source: Own editing

Table 1. Sample size distribution

Region	District	Sample frequency
Central	Gomoa West	50
	Gomoa East	50
Eastern	Kwaebibirem	50
	Denkyembour	50
Greater Accra	Weija	50
	Ashaiman	50
Volta region	Anloga	50
	Keta	50
Total		400

Source: Own editing

district, yielding a sample size of 400 farmers.

The dataset comprises information on the number of times farmers were visited by agricultural extension agents in the last vegetable production season for 2022/23 crop season. Other information collected include socio-demographic status of farmers and their off-farm work information. The dependent and independent variables that were used in the tobit model are presented in Table 2. The independent variables were classified as discrete and roughly continuous variables. The discrete variables included gender, education, off-farm income and credit. Household size, age, age squared, experience and farm size were also classified as roughly continuous variables. Questionnaires for data collection were administered to the study respondents from July 2023 to September 2023. KoboCollect mobile application, a computer-assisted personal interviewing software, was employed for data collection. The Excel software was employed for data-cleaning and descriptive analysis. The

Table 2. Description of the variables in the dataset

Variable	Variable name	Description
Dependent		
Extension access	Extension visits	A corner solution response variable. It is the number of times AEAs visited the farmer's farm during the crop production season.
Independent		
Gender	Gender	= 1 if respondent is male, 0 otherwise
Educational level	Education	= 1 if respondent received JHS education, 0 otherwise
Credit	Credit	=1 if respondent received credit, 0 otherwise
FBO	FBO	=1 if respondent was a member of an FBO, 0 otherwise
Age	Age	Continuous variable: age
Household size	Household size	Continuous variable: Number of people in household of the respondent
Experience	Experience	Continuous variable measured in years of farming
Farm size	Farm size	Continuous variable measured in hectares

Source: Own editing

study employed R software for the regression analysis.

RESULTS AND DISCUSSION

Personal characteristics of the respondents

In Table 3, the distribution in terms of age, farm size, years of farming and household size of farmers is presented. The total number of respondents was 400. The average age of the farmers was approximately 45 years, indicating that most of them are economically active, an assertion supported by the findings of Gelgo et al. (2016). The average number of years farming was about 13, indicating that on the average vegetable farmers have been in the farming business for more than a decade as a means of livelihood. Farmers who have spent more years in farming usually have a better understanding of how the various technologies can be applied for better outcomes. They have more technical knowledge in the application of the climate-resilient technologies (Donkoh et al., 2019). Similar findings are also reported in a study by Jordan et al.(2021), where majority of smallholders had acquired more than a decade of experience in the farming business. The average household size of the farmers was approximately six members. This is very important in providing family labor for vegetable farming where the supply of hired labor is low (Beshir et al., 2022).

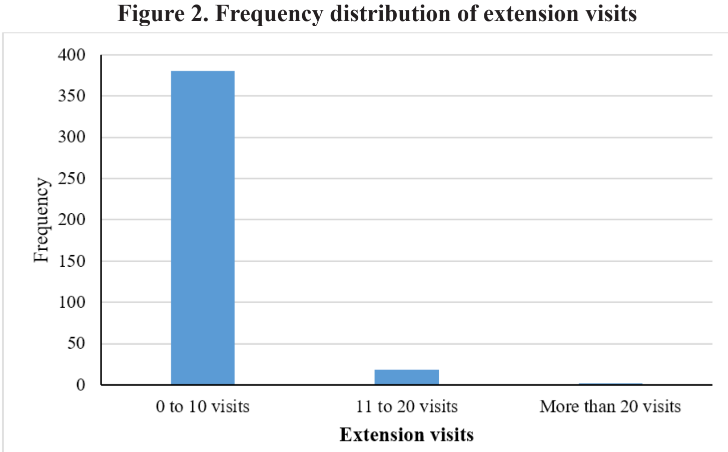
Figure 2 presents the distribution of the number of extension visits received by farmers within the study area. The results reveal that a vast majority of farmers (95%) received between 0 to 10 visits from Agricultural Extension Agents (AEAs) during the crop production season. This indicates limited interaction between farmers and extension officers, which could negatively affect the timely dissemination of agricultural information and

Table 3. Socio-economic characteristics of the respondents by mean

Category	Mean	Standard deviation
Age	45.46	12.90
Farm size	0.63	0.53
Years of farming	13.23	11.28
Household size	6.04	2.92

Source: computation from survey data, 2023

Figure 2. Frequency distribution of extension visits



Source: Own editing

adoption of improved practices.

A small proportion of respondents (4.7%) reported receiving 11 to 20 visits, while only 0.25% had more than 20 visits during the production season. The low number of farmers receiving frequent visits suggests that extension delivery remains constrained, possibly due to an inadequate extension-to-farmer ratio, logistical challenges, or resource limitations within the extension system. Overall, the findings highlight a significant gap in extension contact frequency, underscoring the need for strengthening extension service delivery to ensure farmers receive adequate technical support and advisory services necessary for improving productivity and resilience in agricultural production.

Probabilities of receiving extension services, Conditional and Unconditional expectations

A distribution of the predicted probabilities of receiving extension and expected values from the tobit estimation is presented in Table 4. The β coefficients from the tobit estimation are presented with p-values in Table 5. Finally results for both average partial effects (APEs) and partial effect on the averages (PEAs) are reported for the three values of interest (probability, conditional and unconditional expectations), also in Table 5. Results from table 4 indicates that mean probability of receiving extension services P(y>0) was approximately 33%. The minimum and maximum probabilities were 6% and 80% respectively for the farmers in the study area. The table indicates that mean conditional expectation E (y|y>0) was approximately six. Conditional expectation is the expected value for those who had positive number of extension visits from the AEAs. The minimum and maximum values were approximately four and ten respectively.

Table 4. Probabilities, Conditional and Unconditional expectations

	Minimum	Maximum	Mean
P(y>0)	0.0574	0.7967	0.3285
E(y|y>0)	3.735	10.355	5.787
E(y)	0.2142	8.2491	2.0634

Source: Own editing

Table 4 also indicates that mean unconditional expectation E(y) was approximately two. Unconditional expectation is the expected value of extension services for both farmers with zero and positive values. The minimum and maximum values were approximately 0.2 and eight respectively.

Partial effects: APEs and PEAs

Table 5 shows both APEs and PEAs for the tobit model. Partial effect is the estimated change in the three values of interest when the value of one of the explanatory variables changes by one unit. The tobit regression results shows that the effect of

Table 5. Regression results from the tobit model

Variable	Estimate	Pr(>|Z|)	APE			PEA		
			P(y>0)	E(y|y>0)	E(y)	P(y>0)	E(y|y>0)	E(y)
(Intercept)	-7.3733	0.0064**						
Gender	2.0154	0.1369	0.0747	0.5451	0.6192	0.0794	0.5286	0.5947
Education	0.7058	0.5519	0.0269	0.2002	0.2352	0.0289	0.1936	0.2267
Credit	4.2314	0.0008***	0.1713	1.2809	1.5799	0.1805	1.2534	1.5519
FBO	4.3907	0.0001***	0.1757	1.2740	1.5350	0.1828	1.2515	1.5072
Household size	-0.5056	0.0135*	-0.0209	-0.1721	-0.2224	-0.0228	-0.1670	-0.2210
Age	-0.0043	0.9385	-0.0002	-0.0012	-0.0014	-0.0002	-0.0012	-0.0013
Experience	0.1014	0.0823.	0.0038	0.0285	0.0333	0.0041	0.0276	0.0320
Farm size	1.3233	0.1997	0.0501	0.3721	0.4347	0.0538	0.3597	0.4179

Scale: 8.74 ; Wald-statistic: 42.01 on 8 Df, and p-value: 1.3473e-06

Log-likelihood: -627.1 on 10 Df

*Notes: "***" means p-values in the range of 0%- 0.1%; "**" means p-values in the range of 0.1% - 1%;*
"" means p-values in the range of 1% - 5% and "." means p-values in the range of 5% - 10% [n =400]*
Source: Own editing

credit, FBO membership, household size and experience were the only significant variables in the model.

The squared correlation, a goodness of fit measure for the tobit, was estimated to be approximately 0.0624. This smaller value is normally the case for Limited dependent variables which in this case is a tobit model, employed to model cross-sectional data. This is because tobit estimates are selected to maximize the log-likelihood function and not the R-squared. The wald test, also an overall fit measure of the model, was statistically significant with a test statistics of 42.01. This means the independent variables were jointly significant in explaining the variance in extension visits compared to reduced form models. A limitation of the study is that we did not analyze other dependent variables like distance to extension offices, infrastructure availability or road quality which also predict extension access. The focus of the study was to analyze socio-economic characteristics of the farmers that predict access to extension services.

Credit

The Average Partial Effect (APE) represents the estimated change in the outcome variable based on each respondent's characteristics, averaged across all observations. In this study, the APE of credit on the probability of receiving extension services, P(y>0), was 0.1713, implying that farmers who received credit were approximately 17 percentage points more likely to access extension services—a relationship that was highly significant at the 0.1% level. Similarly, the APE of credit on the conditional expectation, E(y|y>0), was 1.2809, indicating that among farmers who had at least one extension contact, access to credit was associated with about 1.28 additional visits per year. The APE on the unconditional expectation, E(y), was 1.5799, suggesting that farmers with access to credit were expected to receive, on average, nearly two more visits annually, regardless of whether they initially had extension contact.

The Partial Effect at the Average (PEA) is the partial effect calculated using the values of the average "respondent" in the dataset (Wooldridge, 2016). The PEA of credit on the probability of receiving extension services was 0.1805. The PEA on the conditional expectation was 1.2534, while that on the unconditional expectation was 1.5519. These results indicate that farmers were about 18% more likely to be visited by extension officers if they received credit, given that the partial effect was calculated at mean values. The change in the conditional expectation when farmers had access to credit was 1.2534, whereas the change in the unconditional expectation was 1.5519.

Access to credit plays a crucial role in enhancing farmers' engagement with extension services. Credit enables farmers to afford inputs, technologies, and logistics that attract the attention of extension officers. Such farmers are often perceived as more productive and capable of effectively implementing new practices. Consequently, those who obtain credit are more likely to receive follow-up visits and technical assistance from extension officers, as they represent promising beneficiaries for agricultural development programs. These results highlight the vital role of credit in enhancing both access to and frequency of extension services. Access to financial resources enables farmers to invest in recommended technologies and inputs, making them more receptive to and engaged with extension activities (Moahid et al., 2021; Owusu, 2017).

FBO membership

The Average Partial Effect (APE) of FBO membership on the probability of receiving extension services was 0.1757. The effect of FBO membership was significant at the 0.1% level, implying that the probability of receiving extension services increased by approximately 18% if a farmer was an FBO member. The APEs of FBO membership on the conditional and unconditional expectations were 1.2740 and 1.5350, respectively. This indicates that farmers who were members of an FBO were expected to receive about one additional visit if they had access to extension services during the crop season. Furthermore, a farmer who was a member of an FBO was also expected to receive approximately two more visits, irrespective of whether he or she was initially visited during the season.

The Partial Effect at the Average (PEA) provides a complementary perspective, as it measures the partial effect evaluated at the mean values of the explanatory variables. The PEA of FBO membership on the probability of receiving extension services was 0.1828, while the PEAs on the conditional and unconditional expectations were 1.2515 and 1.5072, respectively. These results suggest that, on average, farmers who were members of an FBO were about 18% more likely to be visited by extension agents compared to non-members. Similarly, access to FBO membership was associated with an expected increase of 1.25 extension visits among those already receiving services and about 1.51 additional visits overall.

FBOs facilitate access to agricultural extension services through lobbying, advocacy, and the provision of resources that enhance the effectiveness of extension officers (Akomaning et al., 2017). As collective organizations, they serve as vital platforms connecting farmers to extension systems by coordinating training, mobilizing members, and facilitating communication between farmers and extension officers (Abdallah et al., 2016). FBOs have a mandate to ensure that their members are adequately informed about good agricultural practices and often act as intermediaries for extension delivery. Through these functions, members benefit from group-based extension visits, demonstrations, and capacity-building activities organized through their associations. Consequently, farmers who belong to FBOs are more likely to receive follow-up visits and technical support from extension agents, as such membership strengthens their linkages with agricultural service providers (Ahmed, 2019; Ibrahim et al., 2025). Since being in an FBO can increase the on the probability of receiving extension services, FBOs' capacity can be built to facilitate the delivery of agricultural extension services to their members as mentioned by Stockbridge et al. (2003), Abokyi (2013) and Abdallah et al. (2016).

Household size

The Average Partial Effect (APE) of household size on the probability of receiving extension services was -0.0209. This indicates that the probability of receiving extension services decreased by approximately 2.1% if the number of members in a respondent's household increased by one. The effect of household size was significant at the 5% level. The APE on the conditional expectation was -0.1721, while the APE on the unconditional expectation was -0.2224. This suggests that farmers from larger households were expected to receive almost no additional extension visits if only they were visited during the crop season. Similarly, a farmer with a larger household was expected to receive approximately no extra visits, regardless of whether they initially had access to extension services.

The Partial Effect at the Average (PEA) provides an additional perspective, measuring the effect at the mean values of the explanatory variables. For an increase in household size by one member, the PEA on the probability of receiving extension services was -0.0228, while the PEAs on the conditional and unconditional expectations were -0.1670 and -0.2210, respectively. These results indicate that as household size increases by one member, the likelihood of receiving extension services decreases by roughly 2.3%, and the expected number of extension visits declines correspondingly, whether or not the farmer already receives such services.

This negative relationship may be attributed to the increased financial and logistical responsibilities associated with larger households. Farmers with many dependents often face competing demands that limit their ability to afford costs associated with extension visits or to provide the inputs and logistics necessary for effective engagement with extension officers (Daniel & Teferi, 2015). As a result, extension officers may be less inclined to visit these farmers, given the perception that they have limited capacity to implement recommended technologies or adopt advisory guidance. Consequently, larger household size appears to reduce both the likelihood and frequency of extension service delivery to farmers.

Years of farming

The probability of receiving extension services increased by approximately 0.4% for each additional year of a farmer's experience. The Average Partial Effect (APE) on the conditional and unconditional expectations was approximately 0.03, indicating that as farmers gain more experience, they are slightly more likely to receive extension visits. Experienced farmers often adopt improved agricultural technologies that require technical knowledge and assistance from district extension directorates. Consequently, they are more likely to request and benefit from additional visits from extension officers (Anang & Asante, 2020).

The Partial Effect at the Average (PEA) further supports this finding. For a one-year increase in farming experience, the PEA on the likelihood of receiving extension services was estimated at 0.0041, while the PEAs on the conditional and unconditional expectations were 0.0276 and 0.0320, respectively. These values, calculated at the means of the covariates, suggest that each additional year of experience slightly increases the probability of receiving extension services and the expected number of visits, whether or not farmers already have access to such services (Wooldridge, 2016).

This positive association may be explained by the greater awareness and proactivity of experienced farmers in seeking technical advice. They are often engaged in innovative farming practices and more willing to adopt improved technologies, which require guidance from extension officers. As a result, extension agents may prioritize these farmers for visits, recognizing their commitment to improving productivity and effectively implementing new agricultural practices.

CONCLUSION

Previous studies in agricultural extension access in Ghana have not highlighted the different ways by which the partial effects associated with probabilities and expectations can be evaluated. The present study predicts response probabilities and includes a broad range of assessing partial effects for the conditional and unconditional expectations. The findings of the study imply that on average, a randomly selected farmer had about 33% chance to access extension services in the study area. The average visits received by the farmers, given extension access, was estimated to be approximately six in the season. The findings also imply that the average visits received unconditionally were estimated to be two in the season. The socio-economic factors that were found to influence farmers' access to extension services were credit, FBO membership, household size and experience. Farmers were more likely to receive extension support if partial effects were measured using the average value of an individual in the dataset. The study also demonstrated that the average number of visits received by farmers was larger when partial effects for both expectations of interest are calculated using the APE method. The study recommends the intensification of the formation of farmer-based organisations to improve extension access in Ghana. Also, capacity building of FBO to facilitate the delivery of agricultural extension services to members can fill the gap created by low extension access. Also, the government of Ghana should team up with credit institutions to improve the intermediation among farmers. Lastly, stakeholders in the agriculture sector should assist the district extension directorates with the needed logistics to make their work effective.

Disclosure Statement

The authors report there are no competing interests to declare

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