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REGULAR ARTICLE

MODELLING RICE FARMERS' SUBSCRIPTION TO AGRICULTURAL EXTENSION METHODS IN GHANA

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ABSTRACT

Agricultural extension programmes are the main pathways to transfer improved innovations or information from extension agents to farmers in rural and peri-urban areas. Agricultural extension methods have been perceived by many to have significant influence on the adoption of improved production techniques by farmers. This study modelled the factors influencing farmers' subscription to various agricultural extension methods using data from 543 rice farm households in northern Ghana. A generalised Poisson regression (GPR) model was estimated to account for errors in the dispersion of the data. The results reveal farmer-to-farmer extension method, the use of demonstration farms, and household extension method as the most significant mechanisms to communicate information to farmers in the study area. Farm size, membership of farmer association, number of years spent as an irrigation farmer, research and location (upper east region) were found to be significant in influencing farmers' subscription to various agricultural extension methods, and should be considered by extension agents who extend knowledge on improved production techniques to farmers. Governments and actors in the agricultural space must recognise the importance of farmer-to-farmer extension method, as well as the use of field demonstrations to train farmers on improved practices. Radio, as a mass media mechanism should be used to support the other conventional extension methods, to deploy information on improved production techniques to rice farmers.

Keywords: Extension methods; Generalised Poisson; Farmers
JEL: R52, R58, H41

INTRODUCTION

High poverty and food insecurity are threat to global security, especially in sub-Sahara Africa. To fight poverty and food security, enhancing farmers' capacity for higher agricultural productivity through effective agricultural technology transfer mechanism is significant. Technological change and research, coupled with adoption of agricultural enhancing production practices are important steps in building farmers capacity to increase production and income in a sustainable way **(Azumah *et al.*, 2018).** The significance of rice to fight poverty and food insecurity cannot be downplayed in Africa as it is considered to be one of the food security crops to achieve the African Green Revolution **(Tsusaka & Otsuka, 2013).** In Ghana, the domestic demand for rice exceeds total production necessitating government to import over 40 percent of the commodity to meet the domestic demand **(MoFA, 2016).**

To revamp and enhance the performance of the rice industry, farmers' subscription to agricultural extension methods which will enhance technology adoption is relevant. Agricultural extension methods are the main pathways of transferring agricultural innovations or information from extension agents to farmers in rural and peri urban areas. Agriculture extension simply refers to the application of scientific research and improved/new knowledge to agriculture practices via farmers' education (**FAO, 2011**). It is a research and development tool for transferring research-based findings to farmers with the aim of farmers adapting leading to adoption of improved technologies to enhance productivity. Thus, agriculture extension is the act of communicating with farmers and stakeholders involved in agricultural value chains through extension agents. Agricultural extension methods are communication channels or medium through which extension agents pass research base-solutions to farmers. Research, education and extension are key in the agricultural system **(Deneke and Gulti, 2016; Lemma and Tesfaye, 2016)** as they are responsible for transferring information to farmers. Hence, extension methods play a vital role in the agricultural technology transfer model of agricultural extension **(Azumah *et al.*, 2018).**

The performance and capability of researchers and extension agents in ensuring rural food security depends on the continuous flow of agricultural knowledge and information to farmers. In the field of agricultural development, delivering quality information to farmers is one of the primary ingredients to enhance agricultural productivity (**Pandey, 2017).** Extension methods are necessary for better exchange of information between extension agents and farmers to foster adoption of technologies. Successful adoption and efficient use of improved agricultural innovations depend on the effective communication and the utility of the innovation as well as, the enablement of the skills efficacy of the end user **(Gathecha *et al.*, 2012)**. Extension methods are agricultural technology transfer approaches (ATTA) and techniques used by an extension agent, which include field demonstration led by farmers, and farmer-to-farmer extension to enhance farmers' capacity to adopt improved innovations.

In this study, the extension methods are categorized into four: household extension method, farmer-to-farmer method, school methods (lectures/discussions and field demonstration) and mass media methods (radio, television, video show, mobile phone, drama, posters and newspapers). All these extension methods have their merits and demerits depending on the situations. Meaning that one method cannot be described as superior to the other **(Azumah *et al.*, 2018).** The choice of a particular method is influenced by several factors which include the tenure system, education, farmers' belongingness to association and resource availability **(Anandajayasekeram *et al.*, 2008)**.

Despite the role of agricultural extension methods in technology adoption, there is no empirical studies on modelling farmers' subscription to agricultural extension methods. For instance, **Folorunsho (2019)** employed descriptive statistics to examine rice farmers most preferred extension teaching methods for capacity building in Nigeria using a three-stage sampling technique. The study concluded that the most common extension teaching method was management training plots. The study further recommended that extension organisations should put premium on managing training plots to promote technology adoption. In Kenya, a study was conducted to appraise the access and use of extension approaches in promoting uptake of improved sorghum technologies using descriptive statistics and Pearson correlation of moment **(Chimoita *et al.*, 2017)**. The researchers concluded that extension methods such as mobile phones technology and radio services perform better in promoting uptake of improved sorghum varieties and gender, age and household position of the farmer contribute to promoting uptake of improved sorghum technologies.

Lugman *et al.* (2019) used 150 farmers to investigate the determinants of the application of Information and Communication Technologies (ICTs) among farmers in the Punjab province of Pakistan. By using descriptive statistics, the researchers concluded that there is a significant association of the extent of ICTs use for agricultural information with age, landholding and educational level of farmers. The recommendation made was that government and development agencies should initiate different agricultural technology transfer programmes in liaison with national and multi-national private telecommunication firms to enhance availability of ICTs to farmers.

Other researchers who employed descriptive statistics to explore agricultural extension methods and the effectiveness of agricultural technology transfer approaches are **Lamontagne-Godwin *et al.* (2017); Azumah *et al.* (2018); and Gathecha *et al.* (2012)**. This study builds on the previous works by applying a quantitative approach in modelling the determinants of farmers' subscription to agricultural extension methods. Northern Ghana has a unique situation given the high poverty levels and lower productivity relative to other parts of the country. Therefore, knowing the factors that influence the subscription of farmers to particular extension methods may guide development practitioners and government in the dissemination of improved agricultural technologies.

In the context of this study, farmers' subscription implies the usage of an extension method to acquire information on improved production techniques – which could be paid for or accessed free of charge depending on the medium.

DATA AND METHODS

Sampling and data type

The study was conducted using rice farmers from the Upper East, Savannah, and Northern regions of Ghana. A three-stage sampling approach was employed to select the rice farmers. In the first stage, the three regions in Northern Ghana were purposively selected based on their rice production potentials. In the second stage, ten (10) districts were randomly selected from the three regions using simple random sampling approach. Within each district, 5 communities were randomly selected. Based on **Slovin's (1960)** sample size determination formula, a total of 543 rice farmers were sampled from ten (10) administrative districts using systematic sampling technique in the three regions of Northern Ghana: Upper East Region (Kasena-Nankana, Bolgatanga, Bongo, Bulsa-North), Northern Region (Karaga, Savelugu, Gusheigu Tolon and Kumbungu), and Savanna Region (Central Gonja). Sampled farmers were visited at their homes to explain the purpose of the study, and to seek for their consent to administer questionnaires to them at their convenience after the pre-test of the questionnaire.

Analytical framework

Several models could be used to estimate count data. The commonest of them is the Poisson regression (PR) model which is appropriate when a researcher' aim is to investigate factors influencing the intensity of adoption without accounting for excess zeros. PR model is supported by some assumptions **(Sharma *et al.*, 2011)**. The first assumption is that if a farmer derives an optimum utility from the last technology adopted (in this case, subscription to extension methods), then there is no limit to the number of methods to subscribe to. For instance, subscribing to many extension methods is seen to be better where the marginal value of subscription is at least, equal to the marginal cost.

The second assumption is that a farmer's decision to subscribe to anyone of the extension methods does not rule out the subscription to the other available methods. The subscription to a given method may not be independent of another as the effects of certain methods might be complementary **(Isgin *et al.*, 2008)**. **Co**mplementary subscription decision gives room to measure the intensity of subscription to extension methods using PR model. In this study, count modelling is applied to investigate the drivers of intensity of subscription to extension methods by rice farmers in northern Ghana. In all, 11 agricultural extension methods were identified and considered (Table 3). Given y_i which represents the extension methods, is an integer count variable and assumes a Poisson normal distribution, the standardize PR model can be expressed as Eq. 1 **(Greene, 2008; Winkelmann, 2008).**

$$Pr\,o\,b(\pi_i = y_i|x_i) = \frac{\pi^{-\lambda_i}\lambda^{y_i}}{y_i!}, \lambda_i \in K^+, y_i = 0,1,2,\ldots n \qquad (1)$$

Where: $\lambda_i = E(y_i|x_i) = Var(y_i|x_i)$ and the mean is mostly well-defined as$y_i = exp(x_i\beta)$ where x_i is a vector of socioeconomic characteristics of farmer i, and β is a vector of unknown parameters to be estimated. The marginal effect in the PR model is specified as Eq. 2.

$$\frac{\partial E(y_i|x_i)}{\partial x_i} = \lambda_i\beta \qquad (2)$$

This marginal effect is mostly translated as the unit change in the intensity of subscription variable resulting from a change in the explanatory variable in the count data model **(Cameron and Trivedi, 1998).**

Standardize PR model has been widely used for empirical studies, but some scholars have criticised the PR model because of the assumption of equality between the variance of the count-dependent variable and its conditional mean, known as the equi-dispersion condition **(Winkelmann, 2008)**. According to **Nkegbe and Shankar (2014)**, the count-dependent variable can be witnessed to display over-dispersion, suggesting the variance is greater than the conditional mean, due largely to the multitude of zero observations of the dependent variable in a data set. In some instances, too, there could be the reverse (under-dispersion). There is the need therefore, to use appropriate model to account for this problem. In this study, the count dependent variable (subscription intensity) is shown to have variance less than the mean resulting in under-dispersion (Table 4). The Generalized Poisson Regression (GPR) model has been suggested as it is a flexible count data approach in handling count data of any nature to cover dispersion errors **(Famoye *et al.*, 2004)**.

If the generalized Poisson distribution function is normalize given a random variable Y then its probability mass distribution function can be express mathematically as Eq. 3.

$$f(y_i, \pi_i, \delta) = \frac{\pi_i(\pi_i + \delta y_i)^{\lambda_i^{-1}}\lambda^{-\pi_i - \delta y_i}}{y_i!}, y_i = 1,2 \ldots\ldots n \qquad (3)$$

Where $\pi_i > 0\ and\ max(-1, \pi_i) < \delta, 1.$ y_i denotes the various practices adopted by farmers. The variance and mean of the random variable y_i can be computed as Eq. 4.

$$u_i = E(y_i) = \frac{\pi_i}{1-\delta}, var(y_i) = \frac{\pi_i}{(1-\delta)^3} = \frac{1}{(1-\delta)^2}E(y_i) = \alpha E(y_i) \qquad (4)$$

Table 1: Description and measurement of variables as well as its expectation

Variable	Description	Measurement	A prior expectation extension methods
Dependent variables			
Extension methods (total)	Extent of subscription to extension methods	Number of extension methods a farmer subscribes to.	N/A
Independent variables			
Sex	Gender of respondent	Dummy: 1 = male, 0 = female	+/-
Experience	Years in rice farming	Years	+/-
Education	Farmers years of education	Years	+
Off-farm business	Farmers' engagement in off-farm activities	Dummy: 1 = yes, 0 = no	+/-
Farm size	Rice farm size	Acres	+/-
Credit	Access to credit/loan	Dummy: 1 = yes, 0 = no	+
Irrigation	Farmers years in irrigation	Years	+
Extension	Extension visits of MoFA extension officers	Number of visits per annum	+/-
Land tenure	Land ownership for farming	Dummy: 1 = own 0 = otherwise	+
Road network	Access to good roads	Dummy: 1 = yes, 0 = otherwise	+
Farmer association	Farmer belong to any famer association	Dummy: 1= yes 0= otherwise	+
Research	Farmer had direct contact with research scientist	Dummy: 1= yes, 0= otherwise	+
Region	Location of respondent	Dummy: 1= Upper East 0= otherwise	+/-

The $\alpha = \frac{1}{(1-\delta)^2}$ represents the dispersion factor in the GPR model. So, if we have $\delta = 0$ then there is evidence of equi-dispersion and standardized PR model is preferred. Conversely, if it is found that $\delta > 0$ then over-dispersion is presence. Conversely, if $\delta < 0$ it indicates under-dispersion which support the use of GPR model as in this study. The log likelihood estimation of the GPR model is given by the Eq. 5.

$$L = \sum_{i=1}^{n} L(\pi_i, \delta; y_i) = \sum_{i=1}^{n} InL(\pi_i, \delta; y_i) = \sum_{i=1}^{n} \{In\pi_i + (y_i - 1)In(\pi_i + \delta y_i) - (\pi_i + \delta y_i) - Iny_i!\} \quad (5)$$

Description of the variables used in the Poisson regression models, the measurement and likely directions (a priori expectations) of each variable are been presented in Table 1.

RESULTS AND DISCUSSION

Profile of sampled farmers

Descriptive statistics of sampled rice farmers give a picture and behaviour of the variables used in the model. Table 2 illustrates the profile of rice farmer considered for the study. About 83 percent of the respondents were male rice farmers. The mean years in formal education was approximately 4 years among the respondents with about 12 years in rice cultivation experience. About 27 percent of the respondents were into off-farm businesses to supplement their rice production. The average farm plot size in the study area was 2.42 acres.

Table 2: Summary statistics of variables

Variable (continuous)	Mean	Std. Dev.	Min	Max
Education	4.05	5.13	0	27
Experience	11.72	7.66	1	40
Farm size (acres)	2.42	3.62	0.25	60
Extension visits	3.4	5.34	0	35
Irrigation (years)	5.29	6.36	0	30
Variable (dummy)	*Freq.*	*Percent*		
Sex	451	83		
Off farm business	147	27		
Farmers association	348	64		
Land tenure	478	88		
Road network	223	41		
Research	424	78		
Region (location)	174	32		
Credit	65	12		
Obs.	543	100		

Source: computed from field data, 2017/2018

Majority (64%) of the respondents belonged to farmers associations (Table 2). This builds farmers' capacity to access loans to purchase inputs in order to increase production as well as minimize cost in terms of labour. The results revealed that averagely, a farmer received at least 3 times extension visit from extension officers per year. In terms of land tenure system, about 88 percent of the farmers used their own land for rice cultivation. Meaning that about 12 percent of the rice farmers had leased their land for rice cultivation. The study also shows that about 41 percent of the respondents had access to good road network linking to market centres. In addition, about 78 percent of the rice farmers had direct contact with research scientists. In terms of location, about 32 percent of the farmers were from Upper East region of Ghana. About 12 percent of the rice farmers had access to production credit/loan and the average years a farmer spent in irrigation in the study area is 5 years.

Level of Subscription to Agricultural Extension Methods by Farmers

This section focusses on farmers' subscription to agricultural extension methods as identified by **Azumah *et al.* (2018)** by using frequencies, and Kendall's coefficient of concordance to test the agreement among the ranked methods. These extension methods include household, lectures/discussions, demonstration plots, radio television (TV), video, mobile phone, drama, posters, newspapers and farmer-to-farmer extension methods (Table 3). These are grouped into four extension methods as discussed in section 1. For household extension method, about 42.2 percent of the farmers subscribed to this method. In terms of school extension method, about 32.0 percent of the rice farmers subscribed to lecture/discussions method while about 72.7 percent subscribed to technology plot demonstrations (i.e. field training). Similarly, for the mass media extension method, 71.8 percent, 28.4 percent, 35.4 percent, 63.0 percent, 19.7 percent, 21.6 percent and 18.6 percent of the rice farmers subscribed to radio, TV, video, mobile phone, drama, posters and newspaper respectively. About 64.3 percent of the rice farmers subscribed to farmer-to-farmer extension method. Despite the less subscription to mobile phones by farmers, it is still considered as a powerful extension tool that farmers use to explore information for agricultural marketing, micro-credit disbursement and crop management practices (Butt, et al., 2017). It has reported in literature that farmers have minimal practical exposure in accessing agricultural information from mass media mechanisms **(Shankaraiah and Swamy, 2012)**. Generally, the first five extension methods the farmers subscribed to were plot demonstration, radio, farmer-to-farmer, mobile phone and household extension methods.

Kendall's coefficient of concordance (*W*) was used to assess the level of agreement in responses among rice farmers (Table 3). The test statistic (*W*) was significant at 1 percent and estimated to be 0.45, giving more evidence to reject the null hypothesis that there was no agreement in the responses among the farmers. In the order of relevance, farmer-to-farmer extension method was ranked first by the farmers as the most effective extension method among the identified methods (Table 3). This finding corroborates with **Nakano *et al.* (2018)**. According to **Kiptot and Franzel (2015),** farmer-to-farmer extension plays a complementary role to formal extension services by facilitating the spread of improved agricultural production techniques and improving farmers' capacities. However, the effectiveness and sustainability of the farmer-to-farmer extension method depend largely on volunteer farmer trainers' technical abilities to overcome process-related challenges that hinder them from achieving the desired technology transfer outcomes.

Practical field demonstration led by farmers was ranked second with the mean value of 3.04. Household extension method was ranked third ranked fifth with the mean value of 3.95. This means that field demonstration led by farmers is more effective compare to lectures/discussions. According to **Pangborn *et al.* (2011),** demonstration farm with clearly defined extension messages is necessary to enhance farmer adoption of improved agricultural technologies.

Among the mass media extension methods, radio had the highest subscription and ranked fourth with a mean value of 4.32; mobile phone ranked sixth with a mean value of 6.43; video ranked seventh with a mean value of 6.88; TV ranked eighth with a mean value of 7.03; drama ranked ninth with a mean value of 7.68; posters ranked tenth with a mean value of 8.59 and newspapers ranked eleventh with a mean value of 9.1. Even though radio ranked fourth, it is still considered as one of the most powerful extension methods to disseminate agricultural technologies to majority of farmer in the rural area of Ghana because of issues of cost and coverage of wider audience. Radio has been found by **Aremu *et al.* (2015)** to be a faster method in disseminating agricultural technologies, inputs and output process to the masses of the rural folks. Radio is a powerful instrument to circulate information to farmers as it aides in the announcement of meetings, and disseminating improved skills, production techniques, and enhanced methods of agricultural production that will eventually improve crop productivity and household income, hence farmers welfare.

Extent Subscription to Extension Method by Farmers

Farmers could subscribe to different extension methods to have access to information and new skills. Table 4 presents the distribution of subscription intensity by farmers to the various extension methods identified. From the results, the mean subscription was found to be about 4.7 – meaning a farmer subscribed averagely to about 5 extension methods at a time. About 26 percent and 19.52 percent of the farmers subscribed to four (4) and three (3) extension methods respectively, while 16.02 percent subscribed to five (5) extension methods to receive information on improved production techniques. Only 1.47 percent of the farmers did not subscribe to any extension method, with no farmers subscribing to all eleven (11) identified extension methods. The rest are as presented by Table 4.

Subscripting to many extension methods by farmers should expose them to new and improved innovations which should intend, increase their capacity to adopt innovations to enhance agricultural productivity. However, there are several factors influencing farmers' subscription to many extension methods which the next section discusses.

Determinants of Extent of Subscription to Extension Methods – Standard Poisson versus Generalised Poisson Models

The estimates of factors influencing farmers' intensity of subscription to extension methods are presented in Table 5 by comparing the estimates of standard and generalized Poisson models. Diagnosis test was conducted to examine which model was more robust with efficient estimates. The model diagnosis tests are shown in Table 5.

To begin with, the coefficient of the delta was found to be negative and significant at 1 percent, indicating the presence of under-dispersion and supporting the use of the Generalised Poisson Regression (GPR) model. Similarly, both the deviance goodness of fit (296.673; Prob>chi^2 (517) =1.000) and Pearson goodness of fit (273.064; Prob>chi^2 (517) =1.000) were found to be insignificant, indicating that the standard Poisson Regression (PR) model is not appropriate for the analysis but rather the GPR model. Further test using AIC and BIC revealed that GPR performs better than standard PR model as AIC and BIC of the GPR recorded lower values compared to the PR model. We therefore proceed on the account of the diagnosis tests to discuss the results of the GPR.

Table 3: Farmers' subscription to extension methods

Extension method		Subscription Freq.	%	Mean value	Rank
Household		224	41.2	3.95	3rd
School approach	Lectures/discussions	174	32.0	6.19	5th
	Demonstration plots	395	72.7	3.04	2nd
Mass media	Radio	390	71.8	4.32	4th
	Television (TV)	154	28.4	7.03	8th
	Video	192	35.4	6.88	7th
	Mobile phone	342	63.0	6.43	6th
	Drama	107	19.7	7.68	9th
	Posters	117	21.6	8.59	10th
	News paper	101	18.6	9.1	11th
Farmer to farmer		349	64.3	2.8	1st
Kendall's W[a]	0.45***				
Chi-Square	1258.622				
Df	10				
N	543				

Notes: The ranking was done from 1 to 11, 1 being the most subscribed to, and 11 being the least. The mean was measured on a 5-point Likert scale. 5 being most effective and 1 being least effective. [a]Kendall's coefficient of concordance. ***1% Level of significance.

Source: Adapted from **Azumah *et al.* (2018)**.

Table 4: Distribution of extent of subscription to extension methods

Number of ext. method used	Freq.	%
0	8	1.47
1	7	1.29
2	39	7.18
3	106	19.52
4	143	26.34
5	87	16.02
6	43	7.92
7	23	4.24
8	69	12.71
9	16	2.95
10	2	0.37
11	0	0.00
Total	543	100
Mean value		4.69
Standard deviation		2.03

Source: Analysis of field data, 2019

Variables which were found to have significant effect on the intensity of farmers' subscription to extension methods include off-farm business, farm size, membership of farmer association, extension visits, land tenure, road network, contact with researchers, regional location, and years of involvement in irrigation practice.

Farm size was positive and statistically significant at 1 percent level, corroborating with our a priori expectation as shown by Table 1. The implication is that farmers with relatively larger farm plots were more likely to subscribe to many extension methods than farmers with smaller farm size, corroborating with **Lugman *et al.* (2019)**.

Similarly, membership of farmer association was found to have positive and significant effect on intensity of subscription to extension methods. This indicates that there was a higher probability for farmers who belonged to farmer associations to subscribe to several extension methods to receive information on production methods. Farmer association is supposed to expose farmers to many extension agents, research scientist and non-governmental organisations, giving the opportunity to farmers to subscribe to many extension methods.

Consistent with our a priori expectation in Table 1, land tenure system had positive effect on farmer intensity to subscribe to extension methods and was also significant at 1 percent level. This interprets to mean that if a farmer owned land the land on which he/she farmed, there was a greater likelihood of that farmer subscribing to several extension methods compared to those who cultivated on leased land. Direct contact of a farmer to a research scientist was also found to have a positive and significant effect on intensity to subscribe to extension methods.

Table 5: Estimates of determinants of extent of subscription to extension methods - count data model

Variable	Standard Poisson			Generalized Poisson Regression		
	Coefficient	Std. Err.	P>z	Coefficient	Std. Err.	P>z
Sex	-0.016	0.057	0.777	-0.022	0.042	0.606
Education	0.001	0.005	0.770	0.004	0.003	0.208
Experience	-0.005	0.003	0.148	-0.002	0.002	0.345
Off-farm business	-0.080	0.052	0.123	-0.067***	0.037	0.067
Farm size	0.014***	0.005	0.009	0.014***	0.004	0.001
Farmers association	0.137***	0.050	0.006	0.131***	0.036	0.000
Extension visits	-0.021***	0.005	0.000	-0.018***	0.003	0.000
Land tenure	0.188***	0.068	0.006	0.157***	0.049	0.001
Road network	-0.193***	0.051	0.000	-0.216***	0.037	0.000
Research	0.170***	0.056	0.002	0.140***	0.040	0.001
Region	0.225***	0.059	0.000	0.190***	0.042	0.000
Credit	-0.085	0.073	0.246	-0.053	0.053	0.314
Irrigation (years)	0.009**	0.004	0.018	0.008***	0.003	0.006
Constant	1.215***	0.103	0.000	1.248***	0.073	0.000
Model diagnosis tests						
Atanh delta				-0.358***	0.041	
Delta				-0.344***	0.036	
Deviance goodness-of-fit	296.673: Prob > chi2(517) = 1.0000					
Pearson goodness-of-fit	273.064; Prob > chi2(517) = 1.0000					
Likelihood-ratio test of delta=0:				$chi^2(1)$ = 89.67; Prob>=chi^2 = 0.0000		
LR $chi^2(13)$			184.330			268.87
Prob > chi^2			0.0000			0.0000
Log likelihood			-1025.954			-981.119
Pseudo R^2			0.082			0.121
AIC			2079.908			1992.237
BIC			2139.755			2056.359
Dispersion						-0.344

Source: STATA 14 estimation, 2019

Meaning if a farmer had direct contact with research scientist, the probability of that farmer to subscribe to several extension methods increased. Also, the location variable had positive and significant (5% level) effect on subscription intensity to extension methods. The implication is that farmers in the Upper East were more likely to subscribe to many extension methods than farmers in the other regions in the study area.

Again, we found that number of years of practicing irrigation was positive and significantly related to intensity to subscribe to extension methods at 1 percent level. This can be interpreted to mean that farmers who spent more years in irrigation are more likely to subscribe to many extension methods than their counterpart rain fed farmers. Agricultural extension visits had significant and negative effect on intensity farmers to subscription to extension methods. This implies that farmers with less extension visits had a higher probability to subscribe to many extension methods.

Off-farm business had negative coefficient and significant at 1 percent. This indicates that the probability of a farmer's intensity to subscribe extension methods is likely to reduce if the farmer engaged in off-farm businesses. Off-farm business or employment has the tendency to reduce farmers' capacity to subscribe to extension methods due to lack of time and space to engage fully in agricultural activities, reducing the need for extension mechanisms.

Access to good road network had negative and highly significant effect, hence, reduced likelihood of extent of subscription by farmers to various extension methods.

CONCLUSIONS

Agricultural technology transfer mechanisms have been perceived by farmers in northern Ghana to influence the adoption of improved production techniques. This study was conducted to ascertain the factors that influence the intensity of subscription of farmers to various agricultural extension methods using count data modelling. Farmer-to-farmer extension method, the use of demonstration farms, and household extension methods are the most significant mechanisms to communicate information to farmers in northern Ghana. Farm size, membership of farmer association, number of years spent as an irrigation farmer, research and location (region) are significant in influencing farmers' subscription to agricultural extension methods and should be considered by extension agents who extend knowledge on improved production techniques to farmers. There is the need for government and non-governmental organisations who operate in the agricultural space, to recognise the importance of the farmer-to-farmer extension method as well as the use of field demonstrations to train farmers on improved practices. Radio, as a mass media mechanism should be used to complement the advantages of the conventional methods, to deploy information on improved agricultural technologies to farmers.

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