International Journal of Food and Agricultural Economics
ISSN 2147-8988, E-ISSN: 2149-3766
Vol. 10, No. 2, 2022, pp. 173-184

INTERDEPENDENCE OF EXTENSION AND IMPROVED VARIETY ADOPTION

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Abstract:

This paper, seeks to empirically establish the complementarity or otherwise between the decision to adopt improved soybean variety and the decision to participate in extension service training. The paper departs from the traditional binary dependent regression model (probit and logit) with extension treated as one of several covariates and instead model the binary outcomes of the decisions to adopt improved varieties, and access to extension services simultaneously using bivariate probit model. Data for the study is from 1432 farmers across the three regions of northern Ghana to jointly model the determinants of access to agricultural extension services and adoption of improved soybean variety (Jenguma). We found a positive correlation between the decisions to adopt improved soybean variety (Jenguma) and access to agricultural extension services. The implication is that, the decision to adopt the variety is interrelated with access to agricultural extension services. Hence, access to agricultural extension services is complementary to the decision to adopt new soybean varieties. Findings also indicate that, the decision to adopt improved soybean varieties is influenced by younger, less educated farmers with large farms and ownership of parcels. Given that agricultural extension service is a public good, we recommend that the government of Ghana allocates more human, financial, and technical resources to the extension services to enhance the delivery of extension services to farmers so as to improve the adoption of productivity enhancing technologies.

Keywords: *Adoption, bivariate probit, Ghana, Jenguma and agricultural extension.*
JEL Codes: C31, O13, O33, Q01, Q10, Q16

1. Introduction

The attainment of millennium development goals 1 and 2 (MDGs) of no poverty and zero hunger in Sub-sahara Africa (SSA) is strongly rooted in increasing agricultural productivity particularly crop productivity since the majority of the population in SSA is engaged in agriculture. Sadly, agricultural productivity increases in the sub-region has been very slow relative to other continents. Despite the development of several improved agricultural technologies in the past decades (Nakano et al. 2018), the adoption and use intensity of such are very low. A greater majority of farmers in SSA are smallholders characterized by small land holdings, low input use, and low yields. Therefore, the adoption of improved agricultural technologies by the smallholder farmers in SSA is expected to spur agricultural productivity growth, increase incomes and ultimately reduce poverty (Asfaw et al. 2012; World Bank 2008; Janvry & Sadoulet 2002).

Agricultural trainings delivered through extension services are potential effective methods of diffusing improved technologies to farmers in order to equip them with the necessary knowledge required for farm decision making. The agricultural extension service, serves as the main avenue for disseminating improved farming practices, improved tools, fertilizer use and high yielding varieties to rural farmers in Ghana (Date-Bah 1985 cited in Wahaga 2018). The role of agricultural extension in dissemination of information especially in rural communities is not lost on the government of Ghana. Through the Ministry of Food and Agriculture (MoFA), the Government of Ghana has over the years invested and continue to invest in the agricultural extension services by recruiting more personnel to reduce the extension agent to farmer ratio and providing other logistics to ensure efficient extension service delivery to farmers. Apart from the public extension services provided freely by government, other stakeholders in the agricultural sector, especially non-governmental organizations have been engaged in the provision of agricultural extension services to smallholder farmers in an effort to improve their welfare.

A number of empirical research has been conducted on the effect of agricultural extension on improved technology adoption. For example, Ghimire et al. (2015) observed a positive and significant effect of access to extension services on adoption of improved rice varieties in Central Nepal while Anang et al. (2020) reported a statistically significant effect of agricultural extension services on the adoption of improved maize varieties in Northern Ghana. In another study, Emmanuel et al. (2016) found that rice farmers' access to agricultural extension services promotes the adoption of chemical fertilizer in Ghana. Further, Suvedi et al. (2017) also observed a positively significant effect of extension training on adoption of improved crop varieties in Nepal. Extension delivery was also found to be statistically significant determinant of adoption of rice varieties among rural household in Pakistan (Chandio & Yuansheng, 2018). Among wheat farmers in Pakistan, extension was found to have positive influence on the adoption of improved wheat varieties (Chandio & Yuansheng, 2018). However, Uaiene (2011) did not find significant effect of extension service on adoption of improved seeds, fertilizer use, pesticide use, and mechanization in Mozambique. However, these studies used the binary probit and logit models where extension service delivery variable is treated as a covariate. This study therefore departs from the previous studies where we would simultaneously model the decision to adopt and extension delivery using bivariate probit. This model allows us to test complementarity or otherwise between extension delivery and adoption of agricultural technologies.

The effect of agricultural extension on improved technology adoption has often been taken as given by authors who study the impact of agricultural extension access on outcome variables such as yield, income, and welfare. Such authors take for granted that, once farmers have received extension education, their yields and incomes will improve without first establishing whether the provision of extension service does lead to adoption of improved technologies. In this paper, we seek to empirically establish the complementarity or otherwise between the decision to adopt improved varieties and the decision to participate in extension service training. Again, in the literature that explore the effect of agricultural extension on technology adoption, the methodology has mostly been a binary dependent regression model (probit and logit) with extension treated as one of several covariates. We depart from this trend and instead model the binary outcomes of the decisions to adopt improved varieties, and access to extension services simultaneously using bivariate probit model. This we do, arguing that the decisions to adopt improved technology and access to extension services are influenced by the same covariates, and that the error terms of the two binary decisions are related. Thus, we contribute to the literature on the complementarity of the decision to adopt and extension delivery. We also contribute to the determinants of agricultural technology adoption, and also the factors influencing farmers' access to agricultural extension services. This paper would contribute towards policy in the extension delivery system to for the adoption of productivity improving technologies in the agricultural sector of Ghana.

2. The Role of Agricultural Extension

Extension service was established for the welfare of the agricultural sector. Effective extension services would often lead to technology adoption which involves adequate and timely access by farmers to relevant information and suitable motivations to adopt a new technology if it suits their socioeconomic and agroecological conditions. For example, farmers who are exposed to regular visits from agricultural extension agents are more likely to adopt new and improved technologies through practical demonstrations on how to use such technologies from extension agents (Wahaga 2018). Essential to adoption are the availability of improved technology, access to modern inputs and resources, and profitability at an acceptable level of risk because, farmers get information from many sources (Anderson and Feder 2004; Suri 2011). Again, farmers attitude and knowledge about current agronomic practices and self-aversion lies more in their familiarity with extension services which can significantly influence adoption (Mahapatra 2002; Kreuter et al. 2001).

Extension is usually at its maximum impact in the early stages of technology dissemination, where information imbalance is high. This is because, as more farmers become aware of the new technology, the impact of extension diminishes until there is the need for new and improved technologies (Anderson and Feder 2004). Technical support and participatory technology development process are important to technology adoption. Hence, farmers benefit from research and extension most if the processes of technology development and diffusion are participatory and the farmers' treated as equal partners (Settle et al. 2014; Anderson and Feder 2004). Extension services has been used since the 1960's to promote adoption of agricultural technologies (Everson & Nwabu 1998). There is vast literature indicating high adoption rates and pointing out that extensive use of extension services to promote technology adoption brought about by such adoption rates (Evenson & Mwabu 1998; Suri 2011; Ouma et al. 2002; Hassan et al. 1998b). Technology diffusion may largely be influenced by visits of agricultural extension agents to farmers which tends to be a major source of information for agricultural development or technological improvements in the agricultural sector (Abdulai and Huffman 2005). However, with the literature supporting the importance of extension towards adoption of agricultural innovations, no statistical test has been done to confirm or otherwise of the extension theories. This paper therefore seeks to test the various literature of extension and adoption of technology using the bivariate probit model.

Agriculture is the key to poverty alleviation and economic development because it significantly contributes to gross domestic product and a source of livelihood for a large proportion of the population (Sharma, 2002). In the late 1940's, agricultural extension in the developing nations was mainly on the administrative traditions of the former colonial powers which were geared towards producing and marketing export commodities. Extension programs took a new dimension in the newly independent African and Asian economies in the 1950s where these nations pursued to increase food production and to spread the benefits of improved farming techniques to more farmers (Picciotto & Anderson 1997; Sharma 2002). In the late 1960s to the early 1970s, technology diffusion became pivotal in the arena of agricultural extension. This was a powerful paradigm shift to introduce new high-yielding and fertilizer-responsive crop varieties for dissemination to curb food shortages which forced food prices high. These conditions created a favourable condition for the adoption of good agronomic practices and high yielding varieties (Picciotto & Anderson 1997; Sharma 2002).

An increase in the number of farmers adopting a technology is largely dependent on the methods of communication which serve as indicators for effectiveness of technology adoption. Extension services ensure a wider coverage of technologies (Araya and Mohammed 2014; Kreuter et al. 2001). Participants have first-hand information from extension services which may encourage better understanding and higher adoption rates (Ricker-Gilbert 2008). This is because, extension services are found in most communities in most countries. Here, the extension system plays a pivotal role in enhancing the adoption of technologies. However, most extension systems lack adequate staff, infrastructure, and funding especially in marginal areas (Muruganandam et al. 2013). Sharma (2002), adds that technology generation and its application will have to focus more on optimizing available resources to adapt technologies specifically to agro-ecological or social circumstances to promote profitability, productivity and sustainable farming. Another method for effective adoption of technologies according to Maruganandam et al. 2013 was through personal contact. This was because first-hand provision of appropriate knowledge enabled clarity, continuity, and consistency which reduced misconceptions and thus technology adoption.

There is, therefore, the need for a more farmer participatory approach in the processes of technology development and dissemination as the extension agent is no longer seen as the expert who has all the useful and technical solutions to farmers problems. The indigenous practical knowledge of farmers and their ingenuity are major sources and resolution to local problems in collaboration with extension agents (Abdulai & Huffman 2005). However, there are other extension channels that do not conform to the conventional agricultural extension services channel. These may include agro-chemical shops, print material, neighbors, relatives, television and radio. This is true for countries whose extension services can no longer match with population growth (Juanhen & Niehof, 2011). This is also true because, technology transfer is either a formal or informal procedure and individuals can adopt new technologies through their daily endeavors as they struggle to make a living (Wahaga 2018). Wahaga 2018, illustrated that, to promote widespread technology transfer and adoption, agricultural policies must emphasize farmer-to-farmer innovation transfer.

3. Methodology

3.1 Conceptual Model

We present economic framework of farmers' decision problem to jointly adopt a technology and to use extension service in this section. Farmers always face the decision problem of having to choose between their current practice (status quo) and new technology. This is rightly so, because there are consequences to the choices they eventually make and farmers are not certain which choice is best for them due to the stochastic states of nature (Anderson, Dillon, & Hardaker, 1977). As a result, choice is based on risk–return characteristics and expected profit that farmers anticipate as consequence of their decisions. Under a set of assumptions, we find the random utility theory to be an appropriate framework to analyze the decisions of farmers. In the first place, we assume that a given farmer $i's$ choice is a discrete binary event where he/she can adopt improved soybean variety or not and can participate in agricultural extension service training or not. Secondly, the profit utility, U_i, towards a farming system varies across individual farmers as a random variable that we later on assume to be normally distributed. Then, we assume that farmer i is an economically rational agent who chooses the alternative that yields the highest utility level.

Formally, we denote adoption of improved soybean varieties by s and use of extension service by c. When farmer i adopts improved soybean variety or uses extension service, s or c takes the value '1' respectively. Conversely, s or c takes the value '0' when he/she does not adopt improved soybean varieties or use extension services. Farmer $i.$ acting rationally, will choose to adopt improved soybean varieties whenever its profit utility, U_{i1}, is greater than that of the status quo, U_{i0}. Same rationality applies to the use of extension services. The utility of Farmer i is a deterministic functional model that is related to a set of some farmer and farm specific observable characteristics x_{ij} and farmer specific stochastic component ε_i. Again, we assume Farmer i's utility to be linear in the observable characteristics and the stochastic component and is represented as follows:

$$Ui = \begin{cases} U_{i1} = x'_{i1}\beta_1 + \varepsilon_{i1}, \ for\ adopters\ of\ soybean\ varieties \\ U_{i0} = x'_{i0}\beta_0 + \varepsilon_{i0}, \ for\ non-adopters\ of\ soybean\ varieties \end{cases} \tag{1}$$

Where ε_{ij} is the stochastic term assumed to have mean zero, $\forall_j = 1\ or\ 0.$ Farmer i chooses to use improved soybean variety or extension service only if $U_{i1} > U_{i0}$. The probability of Farmer i using improved soybean variety and or using extension service can be shown as:

$$P(1) = pr(U_{i1} > U_{i0}) \tag{2}$$

Equation (2) can be rewritten as:

$$P(1) = pr(x'_{i1}\beta_1 + \varepsilon_{i1} > x'_{i0}\beta_0 + \varepsilon_{i0}) \tag{3}$$

$$P(1) = pr(\varepsilon_{i0} - \varepsilon_{i1} > x'_{i1}\beta_1 - x'_{i0}\beta_0) \tag{4}$$

$$P(1) = pr(\varepsilon_{ij} < x'_{ij}\beta_j) \tag{5}$$

$$P(1) = F(x'_{ij}\beta_j) \tag{6}$$

F is the cumulative frequency distribution (CDF) of ε_{ij}, thus its functional form depends on the assumptions on the distribution of ε_{ij}. When a normal distribution of ε_{ij} is assumed, then a probit model arises. For farmer i, the probability of adopting improved soybean variety and or using extension service is given as:

$$F(x'_{ij}\beta_j) = \int_{-\infty}^{x'_{ij}\beta_j} \frac{1}{\sqrt{2}} \exp(\frac{-t^2}{2})dt \tag{7}$$

where $j = "s"$ for improved soybean variety and $j = "c"$ for using extension service.

3.2 The Bivariate Probit Model

An approach to this problem is to investigate the probability that a farmer $i's$ decision to adopt a new variety is a function of a range of characteristics, including access to extension service delivery or the vice versa using univariate probit or logit models. Instead, this paper adopts a bivariate probit approach to investigate the interrelatedness between decision to adopt and access to extension service training.

In modelling the probability of the i^{th} farmer adopting improved soybean variety and also using extension service, we could estimate two single probit models. However, these single probit models might produce inconsistent probabilities should we not account for the correlation between ε_c and ε_s (Greene, 2003)

To account for the correlation between ε_c and ε_s, we employed the bivariate probit model in this paper. The model is based on the joint distribution of the assumed normally distributed error terms; i.e. ε_c and ε_s, and helps to determine the interdependence or otherwise of the two dichotomous outcome variables; adopting improved soybean variety and using extension service. The models can be specified as shown below:

$$y_{is}^* = x_{is}'\gamma_s + \varepsilon_{is},\ y_{is} = 1 \text{ if } y_{is}^* > 0,\ y_{is} = 0 \text{ if } y_{is}^* \leq 0 \quad (8)$$
$$y_{ic}^* = x_{ic}'\gamma_c + \varepsilon_{ic},\ y_{ic} = 1 \text{ if } y_{ic}^* > 0,\ y_{ic} = 0 \text{ if } y_{ic}^* \leq 0 \quad (9)$$

Where $E(\varepsilon_{is}) = E(\varepsilon_{ic}) = 0,\ Var\ (\varepsilon_{is}) = Var(\varepsilon_{ic}) = 1$

Cov $(\varepsilon_{is}, \varepsilon_{ic}) = \rho\ \ \forall i = 1,2,3, \ldots., n$

The bivariate cumulative distributive function is given as:

$$\phi_2(\varepsilon_s, \varepsilon_c, \rho) = \frac{1}{\sqrt{2\pi(1-\rho^2)}}\exp\left(-\frac{0.5(\varepsilon_s^2 + \varepsilon_c^2 - 2\rho\varepsilon_s\varepsilon_c)}{1-\rho^2}\right) \quad (10)$$

where ϕ is the cumulative distribution function. When $\rho = 0$, then the distributions of s and c are said to be independent. Hence the use of univariate probit or logit models would be justified. A significantly positive ρ is interpreted as the presence of complementarity or interdependence between the two dichotomous outcome variables and a negative and significant ρ would be interpreted as the existence of substitutability evidence between the two dependent outcome variables (Asfaw, Di Battista, & Lipper, 2016; Kassie et al.,2015).

3.3 Data and Sample Selection

The data for this study were collected from 1432 farmers in the three regions (Northern, Upper East, and Upper West) of northern Ghana through a survey conducted during the 2015/2016 cropping season. Farmers were sampled through a multi-stage sampling procedure. The first stage involved a random sampling of 22 districts across the three regions of northern Ghana (10 in Northern, 6 in Upper West, and 6 in Upper East). Following the districts selection, five communities in each selected district were randomly sampled giving a total of 110 communities. The last stage of the sampling process involved purposive sampling of 10 farm households from each community selected resulting in a total of 1100 farm households. The 1432 farmers used in this study were members of the households interviewed.

4. Empirical Results and Discussion

This section presents the empirical results of the study including a description of the variables used in the model and their prior expectation signs.

4.1 Description of Variables Used in the Models

Table 1 below presents a summary of the variables used in the model as well as a priori expectations of the variables. Disaggregated between adopters and non-adopters, the average age of adopters was about 41 years old; 3 years lower than that of non-adopters. However, the average age was the same (42 years) when farmers were disaggregated between those who received extension training and those who did not receive extension training. The age distribution suggests that, the farmers in the study area are the active working age. At least 65% of the sampled farmers were male, reinforcing the dominance of male in farming and farm decision making in the study area. Again, at least 32% of the farmers interviewed were heads of their households. This is not unusual in the study area where the heads of households are usually older and no longer take decisions on farming activities. Generally, a significant number of the farmers in the sample had some level of formal education. It is worth noting that about 86% of farmers who received agricultural extension training had some level of formal education. However, it is surprising that about 78% of non-adopters of the improved soybean variety had some formal education while nearly 60% of the adopters had formal education giving that education is often positively related to adoption of new technologies. As shown in Table 1, the average plot size of farmers who adopted Jenguma was about 2.7 acres; about 0.5 acre more compared to non-adopters. When disaggregated based on extension training, farmers who received extension training owned about 3.2 acres, which was about 1.2 acres more than the plot sizes of farmers who did not receive extension training. Majority of the farmers (at least 71%) were self-employed with farming largely being their main employment source. Majority (68%) of adopters of Jenguma owned their lands compared to only 22% among the non-adopters. Similarly, 64% of farmers who had extension training were the owners of the land on which they cultivate as against 37% among those with no extension training. Across all categories, the monthly average income of farmers in our sample was less than GHC 50[i] ($8.62), indicating the level of poverty among the population. Only 44% of farmers who adopted Jenguma received extension training which was still higher than the 31% from the non-adopters category. Majority (64.8%) of farmers who received extension trainings adopted the Jenguma variety. However close to 50% of farmers who did not receive extension trainings still adopted the improved variety as shown in Table 1 below.

4.2 Complementarity between Jenguma Adoption and Access to Agricultural Extension Services Decisions

The main objective of this study sought to determine whether the decisions by farmers in the study area to adopt improved soybean variety (Jenguma) and to access agricultural extension service are complementary or otherwise. We opted for a bivariate probit model to jointly analyse the factors determining each outcome of the two binary variables. The results of the bivariate probit model are presented in Table 2. The likelihood ratio test of the covariance term (ρ) between the two error terms is statistically significant ($p \leq 0.01$), implying that the use of the bivariate probit model is justified and more appropriate compared to two univariate probit models. This means that the decisions to adopt improved soybean varieties and having access to agricultural extension services are complementary. This is consistent with the joint decision to adopt a new variety and having access to extension. This is also consistent with existing literature (Araya and Mohammed 2014; Kreuter et al. 2001) because agricultural extension agents are the main channels through which farmers receive information on improved production practices.

The results of the bivariate probit model identified factors that influence both adoption of the Jenguma soybean variety and access to extension education training. Age, education, plot size, employment status and land tenure are significant factors that affect adoption of Jenguma variety and access to extension training.

Contrary to the apriori expectation, age of farmer influences adoption of improved soybean variety negatively, suggesting that younger farmers are more likely to adopt improved soybean varieties than older farmers. The result is in line with the view that older farmers are more reluctant to change their production practices while younger farmers are more adventurous and are thus more likely to choose improved varieties. The result is consistent with the findings of Yimer et al. (2019) who observed a negative relationship between adoption of wheat seed and

Table 1. Description of Variables Used in the Model

Variable	Description	Hypothesis		Summary Statistics							
				Adopters (n=788)		Non-adopters (n=644)		Extension training (n=544)		Non-extension training (n=888)	
		Adoption	Extension	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	Age of farmer in completed year. Continuous variable	+	+	41.02	11.36	44.02	10.97	42.36	11.99	42.41	10.83
Sex	Sex of the respondent. Dummy (1=male, 2=female)	+	+	0.65	0.47	0.66	0.47	0.68	0.47	0.65	0.48
Household Head	Farmer household status. Dummy (0=Other, 1=head)	-	+	0.44	0.47	0.34	0.47	0.32	0.47	0.36	0.48
Education	Whether farmer had some education or not Dummy (0=No education, 1=Some education)	+	+	0.59	0.49	0.78	0.41	0.86	0.35	0.57	0.495
Plot Size	Average plot size owned by farmer. Continuous variable	-	-	2.67	5.05	2.18	1.59	3.18	5.64	1.97	1.84
Employment	Employment status of farmer. Dummy (0=Otherwise, 1=Self-employed)	+	+	0.71	0.45	0.78	0.41	0.72	0.45	0.75	0.43
Land Tenure	Land ownership of the farmer. Dummy (0=otherwise, 1=owned)	+	+	0.68	0.11	0.22	0.46	0.64	0.21	0.37	0.62
Income	Monthly Income of farmer. Continuous variable	+	+	36.67	112.6	46.03	146.75	46.39	168.07	37.72	97.83
Extension Training	Whether farmer received extension training in the past or not? Dummy (0=Not received, 1=Received)			0.44	0.49	0.306	0.46	na	na	na	na
Adoption	Whether farmer Adopted soybean variety, Jenguma or not? Dummy (0=not adopted, 1=adopted)			na	na	na	na	0.648	0.48	0.49	0.5

Source: Field survey, 2015.

age of farmers in Ethiopia. The result however contradicts the finding of Anang et al. (2020) who found a positive relationship between adoption of improved rice varieties and age of farmer.

Education is shown to have a negative relationship with adoption of Jenguma as shown in Table 2. This result is contrary to expectation and indeed contradicts most of the results on technology adoption (Anang et al. 2020; Ghimire et al. 2015) as education is expected to aid farmers make informed decisions. One possible reason for this observation is that perhaps educated farmers do not particularly like the Jenguma soybean variety due to some traits it might have. However, a more plausible reason for the negative effect of the education variable could have been that it was not measured accurately. Plot size positively influences adoption of Jenguma, an indication that farmers with large plot areas are more likely to adopt Jenguma than those with small plots. Again, farmers with large plots of land may have the luxury of using part of it to try new varieties. Our finding is consistent with that of Ghimire et al. (2015). The fact that, Jenguma is a non-shattering variety, large farm size holders would prefer that due to waiting time of harvest.

Results also indicate the importance of land tenure in adoption of improved soybean varieties. Specifically, our findings show that land ownership positively affects adoption of Jenguma. This suggests that farmers who are owners of their lands are more likely to adopt Jenguma compared to farmers who rent or borrow lands to farm. Our result is consistent with Bago et al. (2018), who found that ownership of government land title positively affects the adoption of improved varieties in Niger. We also observed that self-employment negatively affects adoption of improved soybean varieties. What this means is that farmers who are self-employed are less likely to adopt improved soybean varieties.

Table 2. Maximum Likelihood Estimates of Bivariate Probit Model

Variable	Adoption Model		Extension Training Model	
	Coef.	Se	Coef	Se
Constant	1.066***	0.430	-0.915***	0.366
Age	-0.044***	0.004	0.0081***	0.003
Sex	0.374	0.035	-0.115	0.284
Household Head	0.127	0.349	0.018	0.282
Education	-0.861***	0.087	0.813***	0.089
Plot Size	0.119***	0.013	0.054***	0.013
Employment	-0.210***	0.083	-0.228***	0.08
Land Tenure	0.538***	0.053	0.214***	0.039
Consumption Income	0.001	0.001	0.001	0.001
LR test ($\boldsymbol{\rho}$=0)	53.404***			
LL	-1662.971			
Wald $\boldsymbol{\chi^2_{(18)}}$	453.980***			
N	1,432			

The bivariate probit model results in Table 2 also provide probability estimates of factors that significantly affect access to agricultural extension services. For example, access to agricultural extension is positively influenced by age of farmers, suggesting that older farmers are more likely to access agricultural extension services compared to younger farmers. The results is consistent with the findings of Suvedi et al. (2017), Emmanuel et al. (2016), and Danso-Abbeam et al. (2018) in their studies in Nepal and northern Ghana respectively. Results also show a positive relationship between access to agricultural extension services and educational level of farmers, indicating that more educated farmers are more likely to access agricultural extension services compared to less educated farmers. Our result is contrary to that of Anang et al. (2020), who found a negative correlation between education and access to extension services among rice farmers in northern Ghana. Our findings however agrees with that of Wossen et al. (2017), in their study in Nigeria. Furthermore, plot size is found to positively influence access to agricultural extension services, a result which is consistent with our a priori expectation. It is also consistent with findings of Danso-Abbeam et al. (2018) who found extension access to be positively related to farm size allocated to maize farms in northern Ghana. The results is also consistent with that of Emmanuel et al. (2016), in their study among rice farmers in northern Ghana. Similarly, land tenure is positively related with access to agricultural extension services, indicating that farmers who own lands have higher probability of getting access to extension services than farmers who rent or borrow lands. Our results also show self-employment to be negatively related with access to agricultural extension services, suggesting that, self-employed farmers are less likely to get access to extension services.

5. Conclusion and Recommendations

The study assessed the complementarity between the decision to adopt an improved soybean variety (Jenguma) and access to agricultural extension services. Our results indicated a positive correlation between the decisions to adopt improved soybean variety (Jenguma) and access to agricultural extension services. The implication is that, the decision to adopt soy bean variety is interrelated with farmers access to agricultural extension services. Hence, government of Ghana needs to allocate more human, financial, and technical resources to the extension services division to enhance the delivery of extension services to farmers so as to improve the adoption of productivity enhancing technologies.

Our study also contributed to the literature on factors likely to influence adoption of improved soybean varieties. We found that, younger, less educated, unemployed farmers, large farm sizes and ownership of agricultural land are factors identified to influence adoption of improved soy bean variety. Hence, in promoting improved varieties we recommend that, younger, less educated farmers with large acreages and owns their land should be targeted. The likely factors influencing access to agricultural extension services were identified. We found that, older farmers with education who have large farm sizes and owns their parcels of land are the likely factors influencing access to extension service delivery. We therefore recommend extension services department of the Ministry of agriculture to target older and educated farmers with large farm sizes who owns their parcels for extension delivery to improve farmers agricultural productivity.

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[i] $1=GHC 5.8