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Adoption of organic waterleaf farming for sustainable food production in Akwa Ibom State, Nigeria

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Abstract

Taking decisions to manage resources in a precautionary and responsible manner in order to protect the health and wellbeing of current and future generation and the environment should be top in the priority list of all farmers. However, several factors affect farmers' decisions to adopt sustainable agriculture friendly innovation. An empirical study was conducted in Akwa Ibom State, Niger Delta region of Nigeria in 2017-2018 cropping season to estimate the factors that influence the decision whether or not to adopt organic farming by waterleaf producers. Through the multistage sampling technique, 300 representative smallholder farmers were selected. With the aid of questionnaires, primary data were collected from farmers. Using Probit model, data obtained from field survey were analyzed. Results revealed that the probability of using organic technology in waterleaf farming increased where household heads have high literacy, larger household sizes and extension contact. Access to credit also positively influenced adoption of organic farming by producers with a marginal effect value of 0.38. Since information is the centre piece of education, measures aimed at enhancing human capital development of waterleaf farmers to enable them make informed decisions on organic farming would be a sensible policy option. Also, increased and effective extension and credit services are recommended to enhance the adoption of organic farming technology. Findings are indicative of the need to focus on market-oriented policies that will encourage waterleaf farmers to invest in and adopt improved farming technologies.

Keywords: Organic; Waterleaf; Farming; Farmers; Technology; Adoption

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1. Introduction

Soil health is fundamental asset for agricultural sustainability and is the most important part of any cropping system (Pretty, 2002; Etim, 2015). Due to over use and agricultural intensification by the poor, many cropping systems are under threat as soils have been damaged, eroded and are unproductive. Etim (2017) reported that poverty has propelled many families to over-use land and other natural resources. Intensive agricultural production systems have also put a significant pressure on natural resources and caused continuous increase of agro chemicals application. This has however resulted in a considerable damage to these natural resources and created serious environmental pollution and health hazard (Shaban, 2015). Degradation of soil fertility due to over use of land and chemical fertilizer are critical factors affecting sustainability agricultural systems. A recent study by Njeru (2016) posited that the adverse environmental impact associated with increasing industrialization of agricultural production and the belief that agricultural challenges can be solved by the appropriate use of machines and chemicals has accelerated the development of alternative farming methods.

Etim (2017) corroborated that since the environment is of utmost importance and serious concern to people living in poverty, resources must be conserved as much as possible to ensure sustainability. But one of the effective means of supplementing the depleted natural soil nutrient, maintaining good soil conditions and restoring the health of poor soils for cropping on a sustainable basis is by use of organic fertilizer. According to Njeru (2016), organic farming has been put forth by many agriculturalist, development practitioners and social scientists as one such alternative for small-scale food producers. Agriculture being the mainstay of most Nigeria's rural economy relies heavily on environmental resources and for Nigeria to end hunger, achieve food security and sustainable agriculture by 2030, environmental sustainability by way of organic farming should be prioritized.

Following the theory of diffusion and adoption of innovation by Rogers (1995), socio-economic characteristics of the sample could have significant effect on the decision-making process towards adoption. These may well be farm and farm characteristics, age of farmer, gender of farmers, education of farmer and size of farmer's household. Others are participation in agricultural extension activities, experience in farming and membership of farmer-based organization. Tiffin and Balcombe (2011) studied horticultural producers in UK and found that age of farmer did not significantly influence adoption of organic technology. Earlier study by Burton et al. (2003) found a negative and statistically significant coefficient for the age variable using the same data-set. For fruit and vegetable farmers in France, Mzoughi (2011) concluded that there was no effect of age of farmers on adoption of organic technology. However, evidence of Kallas et al. (2010) for grapes in Spain based on 26 organic and 94 conventional farmers showed that younger farmers had a higher probability to adopt organic technology. Using Probit model, Wollni and Andersson (2014) provided a contrary conclusion for agricultural producers in Honduras that age of household head was positively related to adoption of organic technology.

With respect to gender, Ragasa (2012) in a review of technology adoption in agriculture concluded that women have much slower observed rates of adoption of a wide range of technologies than men. In Benin, Tovignan and Nuppenau (2004) showed that households with large family sizes were more amenable to adopting organic technology in cultivating cotton. Latruffe and Nauges (2014) confirmed that higher level of formal education was strongly associated with adoption of organic farming. Rana et al. (2012) showed that experience in farming positively and statistically influenced technology adoption. Economist have provided considerable evidence about agricultural technology adoption and diffusion among farmers in developing countries (Sunding and Zilberman, 2001; Conley and Udy, 2003). But decisions to use a technology depend partly on how farmers receive, process and evaluate information about innovations. To formulate policies aimed at promoting the adoption of organic farming technology as an urgent intervention for health and environmental risk associated with the use of agro chemicals, an understanding of factors influencing the adoption of organic farming technology is required. This study was necessitated on this premise and aimed at estimating factors influencing the adoption decisions of organic farming technology by waterleaf farmers.

2. Methodology

The study was conducted in Akwa Ibom State of Nigeria. The state lies between latitude $4^0$33' and $5^0$53' North and longitude $7^0$25' and $8^0$25' East with an estimated population of 5.3 million people. The state is circumscribed on the east by Cross River State, to the west by Rivers and Abia States and to the south by Atlantic Ocean. There are six (6) Agricultural Development Project (ADP) zones in the state viz: Uyo, Oron, Abak, Etinan, Eket and Ikot Ekpene. It is located within the humid tropical rainforest belt and is characterized by 2 distinct seasons namely-long rainy season and short dry season. The annual precipitation ranges between 2000mm to 3000mm. Multi-stage sampling technique was adopted for this study. First, 3 out of the 6 ADP zones were selected. Secondly, 10 villages were randomly selected from each of the zones to make 30. Thirdly, 10 waterleaf farmers were selected per village to make a total of 300. Primary data were collected from the representative farming households with the aid of questionnaires.

2.1. Theoretical framework

Adoption behaviour models range from simple relationships to complex multivariate analyses. Logit, Probit and Tobit models are commonly used to identify factors that influence decisions to use a new technology (Makokha et al., 2001; Imai, 2003). Whereas Logit and Probit models are appropriate when the dependent variable is dichotomous (0,1), Tobit model is useful for continuous values that are censored at or below zero (Anley et al., 2007). The underlying economic theory on factors that influence the decision to use organic fertilizer is based on the assumption that waterleaf farmers are motivated by utility maximization (Shakya and Flinn, 1985; Adesina and Zinnah, 1993). Farmers form expectation of the costs and benefits of a technology on the basis of own experimentation on through analysis of information from early adopter and key informants in their communities. Following Marenya and Barrett (2007), and Nkamleu and Adesina (2000), it is assumed that farmers behave consistently with utility maximization and that organic farming is adopted when the anticipated utility from adoption exceed that of non-adoption. Though not directly observed, the utility (uij) for a given farmer (i) to use a particular practice (j) can be defined as a farm-specific function of a vector of explanatory variables (x), and an error term with zero mean (eij). This function can be represented as

$$Ui_j = \beta j\, X_i + ei_j \quad j=1,0;\ i= 1 \text{ --------- } n \qquad (1)$$

where j = 1 represents technology adoption and j=o represents non-adoption. Thus, the ith farmer adopts (j=1) if Ui1>Uio.

For empirical purposes, the expected utility of adoption Uij can be posited from a farmer's observed binary choice of adoption or non-adoption which implies a probit or logit model (Anley et al., 2007). In the context of the choice of whether or not to adopt organic farming, the probit model is specified (Fufa and Hassan, 2006) as

$$Y = F\,(w + \propto xi) = F(zi) \qquad (2)$$

Where Y is the discrete adoption choice variable, F is a cumulative probability distribution function, ∝ is a vector of unknown parameters, x is a vector of explanatory variables and z is the z – score of the ∝ x area under the normal curve. The expected value of the discrete dependent variable in equation (2), conditional on the explanatory variables, is given by

$$E\,[Y/X] = 0\,[1\text{-}F\,(\propto^1 x)] + [F\,(\propto^1 x)] = f\,(\propto^1 x)] \qquad (3)$$

and the marginal effect of each explanatory variable on the probability of adoption is given by

$$\frac{\delta E[Y/X]}{\delta x} = \emptyset(\propto^1 x) \propto \qquad (4)$$

where Ø (.) is the standard normal density function (Fufa and Hassan, 2006). The Probit model is suitable for analyzing adoption decisions that have dichotomous values, but if the adoption choice has a continuous value range censored from below (and/or above) then the Tobit model is appropriate on this paper, interest is in analyzing only the binary adoption choice. Therefore, Probit model are operationalised in this paper.

2.2. Empirical model

The general form of the Univariate dichotomous choice model can be expressed as in equation (5)

$$P_i = p\,(y_i = 1) = G(X_i, \theta),\ i = 1 \,........\, n \qquad (6)$$

With the assumption that the random variables y_i are independently distributed equation (6) states that the probability that the ith farmer will adopt a given technology such as organic farming P_i (y_i =1), is a function of the vector of explanatory variables, Xi, and the unknown parameter vector (Gujarati, 2009; Tahirou et al., 2015)

The empirical model of the Probit model employed can be expressed as in equation (7).

$$Yi = \beta_0 + \beta_1\,Sex + \beta_2\,Age + \beta_3\,Edu + \beta_4\,H\,Size + \beta_5\,Cred + \beta_6\,Fas + \beta_7\,MFOrg + \beta_8\,Ext + \beta_9\,Amt\,O + \mu \qquad (7)$$

where the dependent variable (Yi) is a dummy variable where adopters of organic farming are scored 1 and non-adopters are scored o. The explanatory variables include farmer and farm specific factors postulated to influence adoption of technologies.

Table 1. Description of Variables

Variables	Definition and Measurement	Units
Sex	Sex of the household head (1 if male, o if otherwise)	
Age	Age of the household	years
Edu	Level of education	years
H size	Number of people living together under the same roof and eating from the same pot	
Fas	Size of farmland	hectare
M F Org	Members of farmers' organization (1 if yes, 0 if otherwise)	
Ext	Access to information on organic fertilizer through extension agents (1 if yes, 0 if otherwise)	
Amt Org	Amount spent on purchase of organic fertilizer	Naira

3. Results and discussion

3.1. Socio-Economic characteristics of waterleaf farmers

Figure 1 shows that there were more women (73.33 percent) farmers than men (26.67 percent) farmers. This result agrees with Udoh (2005) and Udoh and Etim (2006) who reported that waterleaf cultivation is predominantly done by women.

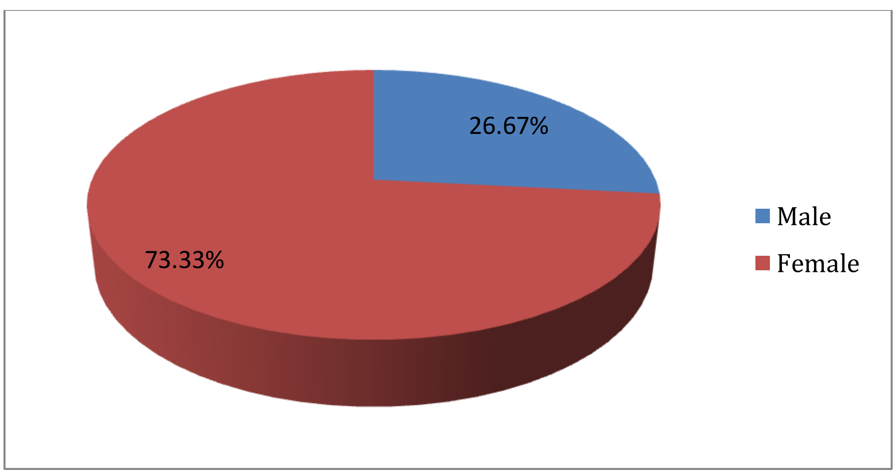

Figure 1. Sex of the Farmers

The age distribution of the farmers is revealed in Figure 2.0. It shows that most farmers (60 percent) were within the economically active and productive age. The least number of farmers (10 percent) were within the age of range of 1-20 years.

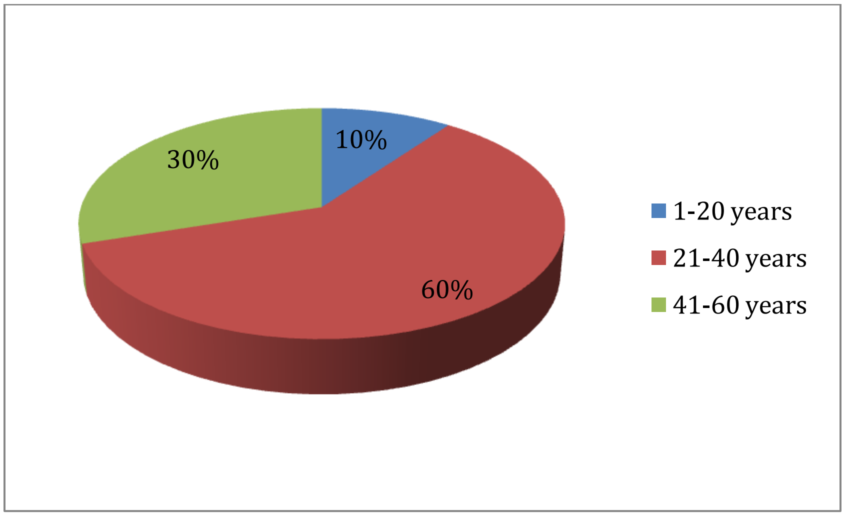

Figure 2. Age of the Farmers

The educational level of the farmer is revealed in Figure 3.0. Results shows that the farmers were educated as majority of them (66.67 percent) attained secondary schools. This implies that waterleaf farmers were faster and better adopters of agricultural technologies.

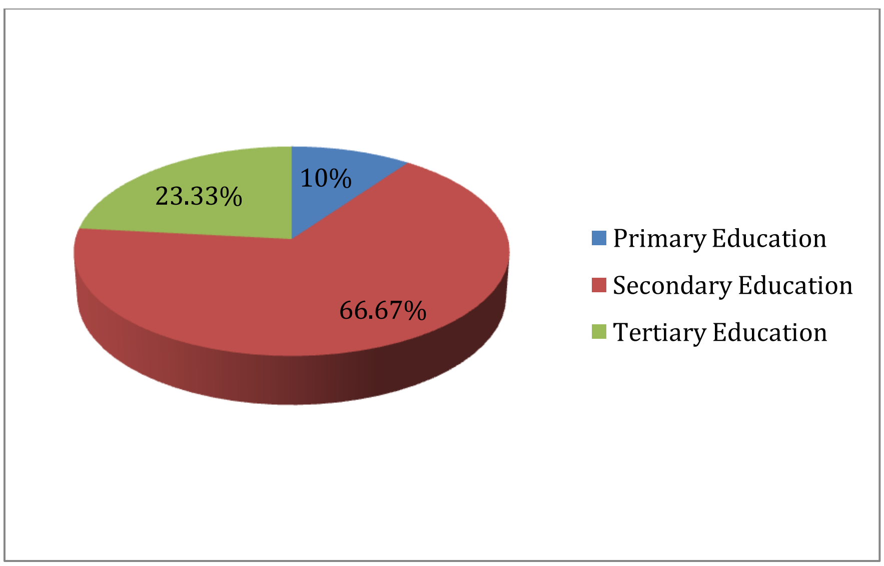

Figure 3. Educational Level of the Farmers

Figure 4.0 shows that about 73.33% percent of had 1-5 household members whereas only 26.67 percent had 6-10 household of members. The smallness of most household members implies that family labour availability was limited.

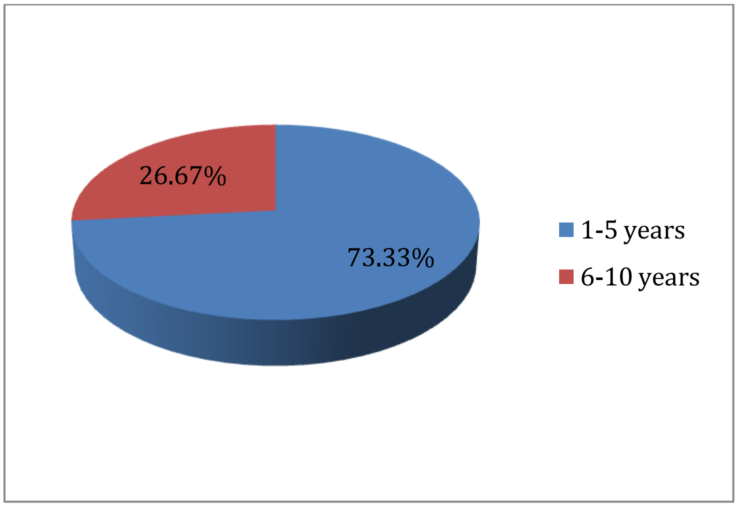

Figure 4. Household Size of the Farmers

Figure 5.0 shows that majority (60 percent) of farmers had no access to credit facilities whereas only 40 percent could access is credit facility.

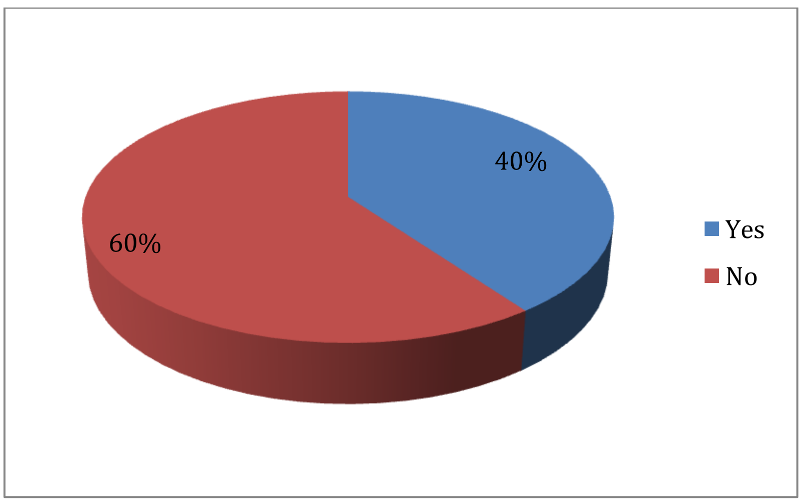

Figure 5. Farmers' Access to Credit facilities

Figure 6.0 shows that 80 percent of farmers cropped plots ranging between 1-1.5 hectares whereas only 20 had plots ranging from 1.6-2.0 hectares. This result implies that majority of farmers were farming mainly for subsistence.

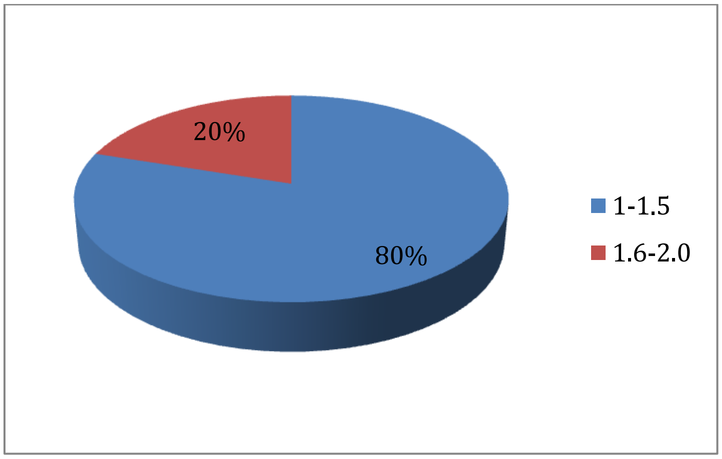

Figure 6. Farm size

3.2. Adoption of organic farming

The adoption rate of organic farming is shown in Figure 7.0. Adoption here is defined with a dichotomous variable (adopt/not adopt based on the general frequency of use and non-use of organic technology. It is pertinent to note that adoption rate does not give any information on the intensity of organic farming use. Figure 1 reveals that the adoption rate of organic farming was 41 percent. The non-adopters of organic farming was 59 percent. The low adoption rate of organic farming may be attributable to the limited extension role in creating awareness on the importance of organic technology.

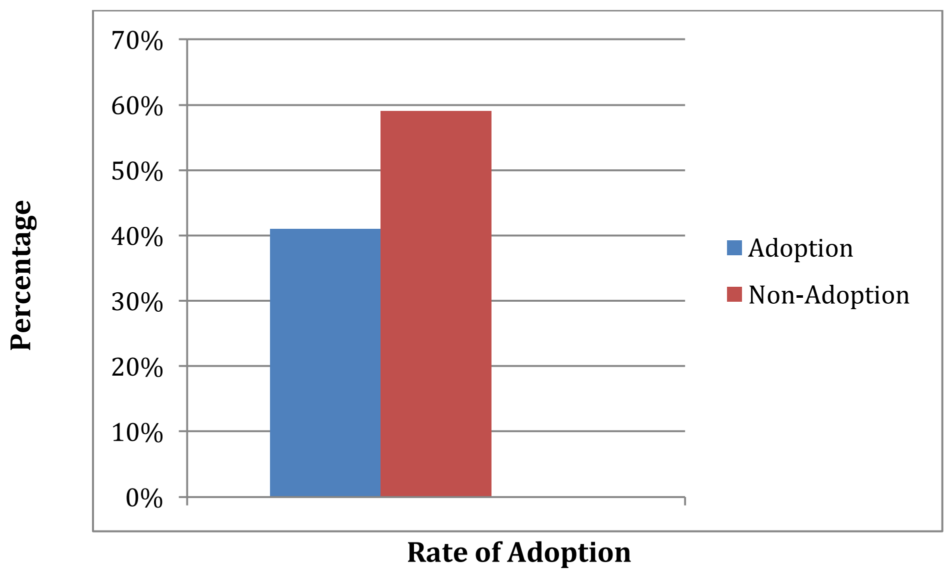

Figure 7. Farmers' Adoption Rate of Organic Farming

3.3. Determinants of adoption

The result of Probit model is shown in Table 2. The log likelihood function of -1482.52 for the Probit model and the chi-squared value of 112.05 show that the model is a good fit for explaining the relationship between regressands and the regressor.

Table 2. Determinants of Adoption of Organic Farming

Variable	**Probit Estimates**	**Marginal Effect**
Constant		
Sex	0.166 (1.383)	0.018
Age	0.624 (1.945)*	0.112
Edu.	0.558 (2.480)**	0.351
Hh size	0.711 (1.685)*	0.282
Cred.	0.221 (4.170)***	0.380
Fas	0.720 (1.2720	0.045
F Org	0.420 (1.469)	0.006
Ext.	0.086 (3.739)***	0.082
Amt 0	0.525 (1.319)	0.033
Number of observation	300	
Log-likelihood function	-1482.52	
Restricted log-likelihood	1606.30	
Chi-squared	112.05	

***, ** and * are significant at 1%, 5% and 10% respectively
Notes: Figures in parentheses represent t-statistics.
Source: Computed from Field Survey Data, 20

As expected, education was positively and significantly related to adoption of organic technology. This implies that the more educated the households are, the greater the propensity to adopt organic fertilizer. A unit change in education increased the probability of adopting organic farming by about 0.35. This result is synonymous with earlier empirical findings by Etim and Udoh (2006), Udoh and Etim (2013); Etim and Udoh (2014), Etim and Edet 2014, Nkamleu and Adesina (2000) and Etim (2015) that human capital plays a positive role in the acquisition of new ideas and materials promoting technological change typically favour literate farmers.

Age indexes experience and service as evidence for human capital suggesting that small holder farmers with more years of farming experience acquired from accumulated years of experimentation with various agricultural technologies are more likely to adopt innovation faster than waterleaf farmers with less experience in farming. Earlier empirical studies by Etim and Okon (2013) Khai et al. (2008); Aye and Mungatama (2010), Etim et al. (2013) and Etim (2015), corroborate with this finding. Age could positively or negatively affect adoption. Younger farmers are more likely to adopt agricultural technology and vice versa. In this study however, age has a positive impact on adoption.

Household size was positively and significantly (p<0.10) related to adoption of organic farming. This implies that large households were better adopters of organic technology. Tahirou et al. (2015) also found that household size is a critical factor in the adoption of technology. A large family in a rural farming community is indicative of abundance labour and plays a key role in the adoption of labour intensive technologies (Lee 2005). Similar studies by Croppenstedt and Demeke (1996), Zegeye et al. (2001) and Doss et al. (2003) also reported that households with large families are more likely to adopt technologies.

Access to extension programs showed a strong positive relationship to adoption of organic farming. A unit increase in access to extension services, increases the probability of adoption by about 0.08. Bamire et al. (2001), Mazvimavi and Twomlow (2009), and Tahirou et al. (2015) also found that the validity of extension activities is a key in promoting the uptake of new technologies.

The sign of the parameter of access to credit is positive and the magnitude is statistically significant ($p<0.01$). The marginal effect of 0.38 implies that access to credit will increase the probability of adoption of organic farming by 0.38. This finding is consistent with those of Djokoto, et al. (2016).

4. Conclusion

The study investigated the adoption of organic waterleaf farming. Using cross sectional data from 300 waterleaf farmers, the study sought to estimate the factors that influence adoption of organic farming. Results of the study indicate that the most critical factors influencing the adoption of organic technology by waterleaf farmers were age, educational level, household size, access to credit and smallholder farmers' access to extension services. Policy thrust should be directed at strengthening and improving extension services for effective and efficient delivery of organic technology to waterleaf farmers. Also encouraging farmers to read and write will provide information for taking informed decisions on organic technology adoption.

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