



Determinants of Adoption of Improved Maize Varieties in Zabzugu-Tatale Districts in the Northern Region of Ghana: A Case Study of Obatanpa Variety

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Abstract

Low yield of maize continue to affect the livelihood of smallholder farmers in the Zabzugu-Tatale area despite the introduction of a high yielding Obatanpa maize variety. The study used a cross-sectional survey design with 240 randomly sampled household heads growing maize to examine determinants of adoption of Obatanpa varieties (IMVs) by farmers in the Zabzugu-Tatale area in the Northern Region of Ghana. A binary logistic model was used to examine the factors that determine the adoption of Obatanpa maize variety by farmers in Zabzugu-Tatale. The results showed a high (58.8%) level of adoption of Obatanpa in the study area. The logistic regression analysis shows that sex, household size, number of years of education of the household head, membership to FBOs, farm size, farmers' awareness of Obatanpa, access to credit and access to extension service had positively significant relationship with adoption of Obatanpa maize variety. Age, however, had inversely significant relationship with adoption of Obatanpa maize variety. The paper recommends that MoFA should mandate the formation of FBOs to enhance farmers' access to resources. MoFA needs to also work with private partners to increase farmers' access to credit facilities at low interest.

Keywords:

Obatanpa, improved maize, adoption, Zabzugu-Tatale, Northern Region

1. Introduction

Maize is the most important staple food crop across sub-Saharan Africa consumed by half of the population in various forms (starch, flour and other industrial purposes). Ghana produced 1,871,695 Tons in 2010, 1,683,984 Tons in 2011; 1,949,897 Tons in 2012; 1,764,477 Tons in 2013 and a decline of 1,762,000 Tons. Thus from 2010 to 2014, maize output in Ghana dropped from 1,871,695 Tons to

1,762,000 Tons, (World Atlas, 2016). USDA (2016) report showed that maize output in Ghana declined from the 1,762 MTs in 2014 to 1,692 MTs in 2015, but slightly increased to 1,800 MTs in 2016, thus 6.38% increase. South Africa continuous to lead as the largest producer of maize in Africa and tenth next to France in the World, producing 10,629 MT (greater than Nigeria's by 3,114 MT and Ghana by 8867 MT) in 2014, depreciated to 8214 MT (22.72%)

in 2015 and then tremendously increased to 16700 MT (103.31%) in 2016 which is 6016 MT greater than a combination (10684 MT) of maize output of Nigeria, Uganda (1884 MT) and Ghana.

The common maize varieties grown in sub-Saharan Africa contains 10% grain protein, deficient in two essential amino acids, lysine and tryptophan, yet the consumption of normal maize-based foods without adequate protein supplements leads to widespread malnutrition (kwashiorkor, a fatal syndrome characterized by initial growth failure, irritability, skin lesions, edema, and fatty liver) especially among infants, pregnant women and lactating mothers (Twumasi-Afryie et al. 2006), and to respond to this problem an inter-institutional and multidisciplinary research (the Crops Research Institute (CRI), Kumasi, Ghana in collaboration with the International Institute of Tropical Agriculture (IITA), Ibadan; the International Maize and Wheat Improvement Center (CIMMYT), Mexico; and the Sasakawa Global 2000 (SG 2000)) was initiated in 1989 to produce a high and stable yielding quality protein maize (QPM) varieties which are high in these two essential amino acids, and to promote the production and consumption of these varieties in Ghana and other Countries. This effort resulted in the development and release of Obatanpa, a medium maturing QPM composite, in 1992 to help improve the protein nutritional status and the health of a large population of low-income groups in sub-Saharan Africa who depends on maize as a major component of their dietary intake (Twumasi-Afryie et al. 2006).

Obatanpa GH has been widely adopted by farmers and consumers in Ghana, covering more than 50% of the maize hectareage (650 000 ha) in the country. Boadu et al. (2015) indicated that, in Northern Ghana, Obatanpa was the dominant maize variety adopted by farmers, accounting for more than 76% of all maize varieties planted between 2012 and 2013. Obatanpa is resistant to Maize streak virus (MSV), low land rust (incited by *Puccinia polysora* Underw) and moderate levels of resistance to blight caused by *Bipolaris maydis* (Nisikado and Miyake) (Twumasi-Afryie et al. 2006). This drives more farmers to choose Obatanpa variety to other maize varieties.

The majority of existing literature on agricultural technology adoption is focused on Green Revolution (GR) technologies such as irrigation, fertilizer use, and the adoption patterns of high-yield variety (HYV) seeds, (Parvan, 2011). The adoption of high-yielding-varieties (HYV) of crops by farmers in developing countries has been viewed as the solution to lower incomes in agriculture and food insecurity (Ibrahim et al, 2012). An understanding the factors that determine the sustained use of improved maize

varieties is of essence to policymakers and stakeholders in the agricultural sector. To Arhin (2014), low yields in maize in Ghana could be blamed on low adoption of maize technologies – a situation that worth researching. Similarly, low yield of maize in Northern Ghana has been attributed to poor adoption of improved maize varieties by farmers in the (Morris et al., 1999; Aidoo et al., 2014). This paper, therefore examined the factors that determines the adoption of improved maize varieties in the Zabzugu-Tatale area with emphasis on Obatanpa maize variety.

The first step in creating a more successful agriculture development project is to gather comprehensive data on the factors by which highest rates of adoption can be explained (Parvan, 2011). Exploring factors that influence farmers' adoption will assist development agencies in the sector to identify areas to direct their efforts, building the appropriate incentives into their projects to overcome farmers' limitations. Several studies have been undertaken by researchers in agriculture technologies towards best practices and increased quality and quantity of output. Among these researchers include Doss et al., (2003) who conducted a 22 micro-level studies on agricultural technology adoption in Ethiopia, Kenya, Tanzania, and Uganda during 1996-1999. They established that technologies were adopted across Eastern Africa, yet they maintained that considerable scope remained to improve the productivity of smallholder agriculture in higher potential regions with high levels of adoption. They also found that a variable that had higher correlation with adoption was extension – a service that continued to play an important role in disseminating information on new varieties and how to manage them.

Teferi et al. (2015) studied the factors that affect the adoption of improved maize varieties by smallholder farmers in Central Oromia, Ethiopia by collecting data from 300 randomly sampled maize producing households. This was analyzed using a logistic regression model to assess the determinants of adoption. Adoption of improved maize varieties among households was found to be positively influenced by adult-literacy, family size, livestock wealth, access to output market and credit access for the new varieties. On the other hand, farmer associations, distance to main markets and fertilizer credit negatively influenced adoption. Thus, the finding of this study revealed that educating farmers, strengthening extension services, improving farmer associations and improving market opportunities are some of the measures that need to be taken to enhance adoption of improved maize varieties by farmers.

In a research into the determinants of adoption of improved maize varieties in Osun State in Nigeria, 360 respondents using descriptive statistics to estimate the level of adoption and a double hurdle model to assess the determinants of adoption, Kuti (2015) found that about 320 respondents representing 89% of the total (360) sample were adopters of improved maize varieties. Age of the household head was found to be statistically significant at 1% level with negative relationship. The coefficient of level of formal education of the household head was positive and statistically significant at 1% level. The coefficient of farming experience was positive and statistically significant at 1%. Household size was statistically significant and positively related to the probability of adoption at 5%. Total farm size of the respondent was positive and had statistically significant influence at 1% level on the adoption of improved maize varieties; and distance of the farmers' village to market centre was found to be statistically significant with negative relationship at 5% level.

Akinbode and Bamire (2015) studied the determinants of adoption of improved maize varieties in Osun State, Nigeria. Descriptive statistics and double hurdle model were used as analytical tools. Results showed 97.8% level of awareness of improved maize varieties while about 91% of the estimates were adopters and 8.8% were non-adopters. The results of the double hurdle model showed that level of education, farming experience, household size, and farm size had positive significant relationship with the probability of adoption of improved maize varieties. However, age and household's distance to market were inversely significant determinants of adoption of improved maize varieties in the study area. Age, level of education, household size, farm size, frequency of contact with extension agent, off farm income and membership in association determined use intensity of improved maize varieties.

In a research into the adoption of improved maize varieties and common bean varieties in Mozambique, Lopes (2010) also estimated the likelihood of household adoption of improved maize varieties using probit model. Household size, age of the household head and years of formal education were socio-economic factors found to have positively significant relationship with adoption of improved maize variety in the study area. Access to extension services and access to information about improved maize variety were also institutional factors that positively and significantly influenced adoption of improved maize variety.

Using logistic regression to analyze the factors influencing adoption of the recommended

maize technology package in Makuyu Division and Murags South District of Kenya, Felistus (2009) found that gender, education, and income levels of the farmers had significant and positive relationship with adoption of the entire package. However, cost of the technology, complexity and high-perceived risks had negative influence on adoption of the entire package. At 5 percent level of significance, high level of adoption of the entire package was found among female farmers. Fifty four percent of the adopters were females while forty-six percent were males. This finding differs from the norm that, females are disadvantaged economically and may not afford costs involved in adoption of new agricultural technologies.

In the analysing of the effects of adoption of improved maize seed on household food security in Gwoza Local Government Area of Borno State, Nigeria, Idrisa et al. (2012), assessed the determinants of adoption of improved maize seed using probit regression model. The study revealed that education, yield of maize seed, access to extension contact and access to credit significantly and positively influenced the likelihood of the adoption of improved maize seed. The study also found that adoption of improved maize varieties reduced the incidence, depth and severity of food insecurity among farming households in the study area.

In another research, Tura et al. (2010) conducted a study into adoption and continued use of improved maize seeds in Central Ethiopia on a sample of 120 maize producing households, and analyzed data using bivariate probit model. The study revealed that household size, farm size, access to credit, off-farm income, and membership to FBO positively influenced adoption of improved maize varieties in Central Ethiopia. Only literacy of the household head inversely related to adoption of improved maize varieties in the study area.

Baruwa et al. (2015) also examined the adoption of improved maize varieties among farming households in Osun State, Nigeria. A multistage sampling procedure was adopted to collect data from 100 farming households in Ife Central and Ilesha East Local Government Areas with the aid of structured questionnaire. Both descriptive and inferential methods were used to analyse the data. Logit model was used to determine the factors affecting adoption and the intensity of adoption of improved maize varieties. Results indicated that the major factors significantly influencing the adoption of improved maize varieties in the study area were level of education of the farmers ($p < 0.01$), farm size ($p < 0.05$), gestation period ($p < 0.05$), access to credit ($p < 0.01$). The level of education of the farmers and

access to credit had positive relationship with adoption while farm size and gestation period of the seed negatively influenced adoption of improved maize varieties. Farming experience ($p < 0.05$) determined the intensity of adoption of improved maize varieties in the study area. The study recommended that to increase maize production in Nigeria through adoption of improved maize varieties, credit should be made available to farming households and dissemination of research outputs should be targeted at the women maize farmers and not just men. Also, improved maize seeds with early maturing varieties should be disseminated to farmers.

Monela (2014) also studied access to and adoption of improved maize and rice among farmers in Mbeya and Morogoro Regions of Tanzania using a binary logistic regression to analyze the impacts of improved seed related factors on the chances of farmers adopting the seeds. The analysis showed that access to land for maize and rice production and awareness of improved seeds exerted the highest positive impact on the chances of smallholder farmers adopting improved maize and rice seeds in the study area.

Ademiluyi (2014) also conducted a study into adoption of improved maize varieties among farmers in Bassa Local Government Area of Plateau State, Nigeria, using a logit regression model to analyze factors influencing adoption of improved maize varieties. The results of the logit model showed that age, access to extension agents, fertilizer, cooperative membership and output were significant. Age, yield, and cooperative membership had positive relationship with adoption of improved maize varieties. However, extension contacts and fertilizer use had inverse relationship with adoption of improved maize varieties.

In another study conducted on the adoption of improved maize varieties and its effects on yields among smallholder maize farmers in Eastern and Central Uganda, Mugisha and Diiro (2010) used a binary probit model to examine the determinants of the level of adoption. Findings revealed that a higher (80%) level of improved maize variety adoption of in the study area. Findings further indicated that extension advisory services were positively related to the adoption, suggesting that increased interaction between farmers and extension service providers results in an increased awareness and knowledge about improved maize varieties.

Gregory and Sewando (2013) studied the determinants of the probability of adopting quality protein maize (QPM) technology in Tanzania using a logistic regression model. The study revealed a low (30%) level of adoption and high (90%) level non-adoption. Results indicated that education of the

household head, farmers' participation in demonstration trials, field day participation, and numbers of livestock owned positively influenced the rate of adoption. Access to credit, and poor QPM marketing problem perception by farmers negatively influenced the rate of adoption.

Kasirye (2013) examined the determinants of improved agricultural technology adoption in Uganda with particular focus on improved seeds and fertilizer technologies, using a nationally representative panel data set of 1,600 farming households, collected by the Ugandan Bureau of Statistics in 2005/6 and 2009/10. Analysis from the probit regression model showed that farmers with low education and land holdings are less likely to adopt improved seeds and fertilizer, while peer effects play a big role in influencing farmers to either use improved seeds or fertilizer. Cattle keeping farmers in Western Uganda were more likely to abandon fertilizers and possibly resort to organic manure from livestock excreta.

Fadare et al. (2014) analyzed the factors influencing adoption decisions of maize farmers in Nigeria, using a selected portion of the Nigeria Living Standard Measurement Survey data. They applied a probit model as tools for the analysis. Results showed that 67.6% were non adopters while the remaining 32.4% were adopters. It was also found that higher levels of education attained and farm size, as well as access to fertilizer and extension services were socioeconomic and institutional factors that would increase the probability of adopting IMV among farmers.

On a cross-sectional data of 160 maize growing households, Mmbando and Baiyegunhi (2016) also analysed the socio-economic and institutional factors influencing adoption of improved maize varieties in Hai District of Tanzania, using the logistic regression model. Empirical results showed that off-farm income, access to extension services, access to credit, farmers' membership to association and participation in on-farm trials and demonstrations were statistically significant factors influencing the adoption of IMVs. Results suggested that improving smallholder farmers' basic education, access to extension service and credit facilities, and the promotion of farmers' groups/association could increase adoption of improved agricultural technologies. Mmbando and Baiyegunhi (2016) recommended the need for research institutes and extension services to enhance on-farm trials and demonstrations of improved agricultural technologies, in-order to enhance farmers' awareness and adoption of technologies.

Mignouna et al. (2011) identified the adoption determinants and causal impacts of adoption

of imazapyr-resistant maize (IRM) on income and poverty among maize farming households in Kenya, using a logistic model and Heckman selection-correction model. Results from a randomly selected sample of 600 households consisting of 169 adopters and 431 non-adopters revealed that household head's age, level of education, household size, membership to social group, access to extension services, and perception of IRM positively influenced the probability of adopting the technology.

In another study on the drivers of adoption of improved maize varieties in Moist Transitional zone of Eastern Kenya using double hurdle model, Ouma et al., (2014) found that ownership of livestock, extension visits, and membership to farmers' group, and land size for crop production exerted a positive influence on adoption. However, they also realized that age had inverse relationship with adoption; thus increase in age resulted in decrease in the likelihood of a farmer adopting improved maize varieties. Ouma et al. (2014) assumed that this inverse relationship between age and adoption of improved maize varieties was due to the fact that as farmers grow older, there is an increase risk aversion and a decreased interest in using new agricultural technologies such as improved seed. Young household heads on the other hand display a lower risk aversion attitude and, are more likely to adopt new technologies that have better yields compared to the indigenous technologies.

Also, in a study on inorganic fertilizer and improved maize variety adoption decisions by farmers in Kenya by Ogada et al. (2014), the level of education of the farm household head, access to agricultural credit, land ownership and farm size positively influenced adoption of inorganic fertilizer and improved maize varieties in Kenya while distance to input markets exerted negative relationship on adoption.

Katengeza et al., (2012) studied drivers of improved maize variety adoption in drought prone areas of Malawi to identify the determinants of adoption and adoption-intensity of improved maize varieties in Malawi by estimating a double hurdle model based on household-level survey data collected in the districts of Balaka and Mangochi in 2008. They found that labour endowment, access to rural credit, livestock wealth, access to agricultural extension, farm size and access to off-farm employment all significantly increase the likelihood of adoption of improved maize varieties. Households where the head had membership of a social group were also found to be less likely to have adopted. The intensity of adoption was found to be negatively related to livestock wealth and fertilizer use. Conversely, the age of the household head, the labour endowment of

the household and the proportion of household members engaged in off-farm activities were factors that were found to be positively related to intensity of adoption. The study suggested the need to enhance adoption and intensity of adoption of improved maize varieties in Malawi among other things improving access to rural finance through credit and improving access to agricultural extension.

Morris et al. (1999) conducted a research into adoption and impacts of improved maize production technology in a randomly selected 20 districts in Ghana of which Damongo, Salaga, and Walewale were part; they found that characteristics of (1) technology; (2) farming environment into which the technology is introduced; and (3) farmer making the adoption decision are adoption determinant factors of improved maize varieties.

Aidoo et al. (2014) also studied factors determining the use of certified maize seeds by farmers in Ejura-Sekyedumasi Municipality in Ghana and the results from the study showed that farm size, level of education, extension contact and access to credit were the main factors that significantly influenced the use of certified maize seed by farmers.

Alhassan and Salifu (2015) examined the determinants of farmers' adoption of improved maize varieties (IMVs) in the Beehi and Kpongu communities of the Wa Municipality involving cross-sectional survey with 300 systematic sampled household heads growing maize, using a binary logistic regression model. The logistic regression analysis showed that age, marital status, level of education of household head, farmers' maize production experience and varietal characteristics were the most significant factors influencing adoption of improved maize varieties. Farmers' years of education and years of experience in farming maize had positive relationship with adoption of improved maize varieties in that as the years of education and experience increase, the farmers' likelihood of adopting improved maize varieties increased. Yet age had inverse relationship with adoption of improved maize varieties. However, farm labor, extension services and belonging to farm organization exerted insignificant influence on adoption.

2. Materials and methods

Sampling and Sample Size

Both primary and secondary data was used for the study. Primary data was from respondents of households engaged in maize production in the Zabzugu-Tatale district. The total maize producing households was 18,055. Also secondary data was sourced from Ghana Agricultural Productivity Survey (GAPS) conducted in 2015. Based on the total maize

producing households, a sample size n was computed using the formula by Cochran, (1963) as follows:

$$n = \frac{\hat{p}(1 - \hat{p})z^2}{e^2}$$

(1).

Where n represents the sample size, \hat{p} is the population proportion or sample proportion, z is the z-score obtained from the standard normal distribution table at a given confidence level and e is the margin of error. An acceptable margin of error often used in survey research falls within 4% to 8% at 95% level of confidence. In that regards, the research allowed a level of precision of 4.4% at 95% level of confidence. The population proportion was arrived after taking the percentage of maize farmers to the total population of the two districts under study. According to a 2015 Ghana Agricultural Productivity Survey, there are a total of 17,463 people involve in maize farming in the Zabzugu and Tatale-Sanguliarea. Zabzugu and Tatale-Sanguli Districts has a total population of 123,854 people (63,815 and 60,039 respectively). The population proportion was therefore arrived at 14.1%. This is expected to yield the larger sample size that is representative of the true population. From the standard normal distribution table, the confidence level had a z-score of 1.96. The sample size can therefore be computed as;

$$n = \frac{0.141(1 - 0.141)1.96^2}{0.044^2} = 240.3361$$

The research, from the computation, used 240 respondents, (i.e. 240 maize farmers).

Sampling Procedure

A three-stage, randomized sampling procedure was used. This involved selection of (1) zones, (2) communities, and (3) maize farmers.

Stage 1: Study area was stratified into ten (10) Agricultural Zones (AZs), and five zones were selected through simple random sampling (lottery) method;

Stage 2: four (4) communities were randomly selected from each of the 5 AZs to make up twenty (20) communities.

Stage 3: Then a total of 240 respondents (sample size) were selected from these communities based on equal allocation. Twelve (12) respondents were selected in each of the communities from the list of farmers (sample frame) obtained from the respective zonal extension officers. This made up the sample size of 240 maize producing households in the study area. The communities selected for the study included the following; Zabzugu, Laagbani, Gumpila, Kworli, Woribogu, Sabare, Nakpali, Kuntumbiyili, Mantili, Tatale, Nachamba No. 1,

Kuyoli, Nakpali-borle, Bidiribombe, Bekunjib, Bilando, Bachadoo, Sanguli, Nagbindo and Nanbone.

Method of Data Analysis

A logit regression model was used to analyze the effect of the determinants of adoption of improved maize varieties. Based on Berkson (1951), a logit model has a probability distribution conditional on a vector of covariates X_i and expressed by:

$$\Pr(Y_i = 1|X_i) = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)} \quad (2).$$

Where β is a vector of parameters. The parameters of a logit regression model is estimated using the Maximum Likelihood Estimation (MLE) or the Generalized Likelihood Linear Model (GLM) when the function is a logit.

Measure of Level of Adoption of Obatanpa

Afolami et. al. (2015), a farmer was defined as an adopter if he or she was found to have grown at least one of the introduced improved cassava varieties for at least one season prior to the year the data for the study were collected and still had the variety on his/her farms in the year the data were collected. This study adopted the model used by Afolami (2015) based on the assumption that for a farmer to make decision on whether or not to adopt the improved maize variety, they must have first examined the derived benefit from the adoption or otherwise of the improved maize variety. Therefore, in this study, adopters of Obatanpa maize variety refers to the proportion of farmers who cultivated improved Obatanpa maize for at least one season before the year (2015/2016) the data were collected and still cultivated Obatanpa maize variety in the data collection year (2015/2016) farming season. A farmer was adopter if he or she was found to have cultivated either fresh improved Obatanpa maize seeds from improved seed dealer or have recycled Obatanpa maize variety with the year 2015/2016 season inclusive. The adoption variable was coded 1 if a farmer cultivated an improved Obatanpa maize variety and 0 if he or she did not cultivate Obatanpa. The level of adoption was estimated by comparing, in percentages, the proportion of farmers using Obatanpa maize variety as against non-users of Obatanpa maize variety. Based on this, adoption was regressed over sex, marital status, experience, access to extension services, access to credit, variety awareness, access to certified seed, off-farm income, level of education as well as farm size. This was analysed using the logit model and expressed as follows:

$$\text{Logit}(P_i) = \log\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad (3).$$

Table 1. Description and Measurement of Variables Used in the Adoption (Logistic) Model

Dependent Variable	Independent Variable	Means of Measurement	A prior Expectation
Obatanpa Maize Variety Adoption (1=Adoption, 0=Otherwise)	Gender of Household Head	Dummy (1=male, 0= otherwise)	+
	Marital status	Dummy (1=male, 0= otherwise)	+/-
	Household Head experience	Number of years in maize farming	-
	Access to extension service	Dummy (1=access, 0=otherwise)	+
	Access to credit	Dummy (1= access, 0= otherwise)	+
	Awareness of Obatanpa maize variety	Dummy (1=aware of Obatanpa, 0=Otherwise)	+
	Access to certified Obatanpa	Dummy (1=access and 0 if otherwise)	+/-
	Off-farm income	Money (GHc)	+
	Formal education	Number of years in school	+
	Farm size	Hectares	-
	Age	Number of Years	-
	Membership of farmer association	Dummy (1=Member, 0= otherwise)	+
	Access to radio and TV	Dummy (1= Access, 0= otherwise)	+

3. Results and discussion

3.1 Socio-Demographic Characteristics of Respondents

Socio-demographic characteristics of the respondents as shown in Table 2 below indicated a mean value for sex was 0.92, indicating higher (92 percent) male respondents over females who constituted only 8 percent of the sample. Most of the respondents were male-headed households. Findings also showed that respondents who were married represented 85.4 percent while 14.6 percent were single.

The average age of respondents was 32 years with minimum of 18 years while the maximum age was 72 years respectively. This shows that majority of respondents were in their active age and confirms a positive relationship between age and risk aversion as argued by Ouma et al. (2014). The minimum and maximum years of farming was 3 and 36 respectively with an average of 10 years in farming. Also, average household size was 13 persons, with 2 persons as the least and maximum 35 persons as the most.

Results from Table 2 below also showed that the average number of years a farmer attained in education was 2 years but the maximum number of years attained by a farmer was 21 years. Similarly, Fadare et al., (2014), and Alhassan and Salifu (2015) found low education among maize farmers in Nigeria and Ghana respectively. However, this was contrary

to the higher literacy (65%) among the sampled maize producing households found in the studies of Taferi et al. (2015) and Akinbode & Bamire (2015). For FBO membership, 25.4 percent belonged to an FBO while the remaining farmers with non-FBO membership were 73.7 percent.

Furthermore, farmers' access to extension service was averaged at 0.492 indicating that about 49.2 percent of maize producing households had access to extension service. The mean values for awareness of Obatanpa and access to credit were 0.94 and 0.14 and implied that extension agents performed relatively well in facilitating Obatanpa awareness, but performed poorly in assisting farmers to form farmer groups including access to credit.

3.2 Determinants of Adoption of Obatanpa Maize Variety

This section presents the results of the regression analysis on the factors determining adoption of improve Obatanpa maize variety. Sex, age, marital status, years of experience in farming maize, access to extension service, access to credit, farmer awareness of Obatanpa seed, access to certified Obatanpa seed, off-farm income, years of formal education, farm size (hectares), membership of farmer based organization, and access to radio and TV were predictor (independent) variables that determine farmers' decision to adopt improved Obatanpa maize variety in the study area.

Among all the variables that significantly influence adoption of Obatanpa seed, only age of a farmer was found to inversely influence farmers' decision to adopt Obatanpa. The rest had positive effects on adoption. The pseudo R square for the model was 0.8454, this implies that about 84.54% of variations in the dependent variable are explained by the independent variables. Thus, the independent variables offer a good explanation for maize farmers' decision to adopt Obatanpa seed variety in the study area.

Results from Table 3 showed that sex of household head had a positive marginal effect, which implied that male headed households has a 72.9% probability of adopting Obatanpa seed variety increases. However, in the findings of Felistus (2009) in Kenya, sex had positively significant relationship with adoption but female-headed households had the greater tendency of adopting improved maize variety package than male-headed households at 5% level of significance. In the findings of Fadare et. al., (2014) and Ogada et al. (2014) sex of household heads had no significant relationship with adoption of improved maize varieties in Nigeria.

The marginal effect for age was 0.021 and indicates the decision to adopt Obatanpa decreases with increase in age. An indication that as if a farmer household head age increases by one year, there is tendency that farmer adopting Obatanpa seed variety will reduce. This result is consistent with the findings of Mignouna et al., (2011) in Kenya; Ouma et. al., (2014) in Eastern Kenya; Kuti (2015) in Osun State in Nigeria, and Salifu et. al. (2015) in Wa Municipality in Ghana. Their findings showed that age of the respondents had an inversely but significant relationship with adoption, which implies that older people have a lower tendency of adopting improved maize variety. Among the reasons given for this inverse relationship between age and adoption of improved maize varieties by Ouma et al. (2014) is that as farmers grow older, there is an increase in risk aversion and a decreased interest in using new agricultural technologies such as improved seed and the vice versa. However, contrary to this finding is that of Akinbode & Bamire (2015); Ademiluyi, (2014) in which age rather had positive relationship with adoption of improved maize varieties among farmers in Bassa Local Government Area of Plateau State and in Osun State respectively in Nigeria. Also inconsistent with findings in this study are that of Taferi's et al., (2015); Mignouna et al., (2011); and Lopes, (2010) in which age had direct relationship with adoption of improved maize varieties among maize farming households in Ethiopia, Kenya and Mozambique respectively.

Also, household size had a positive marginal effect, and implies a direct relationship between household size and farmer's decision to adopt Obatanpa seed variety. That is if the household size increases, the probability of a farmer adopting Obatanpa increases. The marginal effect of 0.041 implies that, if one person increases a household size, the probability of a farmer will adopt Obatanpa maize variety increases by 4.1%. This finding confirms that of Teferi et al., (2015); Akinbode & Bamire, (2015); Kuti, (2015); Mignouna et al., (2011); Lopes, (2010); and Tura et al. (2010) which showed a direct relationship between household sizes and farmers' decision to adopt improved maize varieties. To Akinbode and Bamire (2015), households with larger household size have higher farm labour that propels following agronomic practices (such as row planting) that accompany cultivation of improved maize varieties.

Similarly, household head's membership to a farmer-based organization had positive marginal effect of 0.149 and statistically significant at 10%. This implies that, being a member of a FBO has a likelihood of 14.9% of adopting Obatanpa seed variety. This findings agrees with the results of Tura et al., (2010); Mignouna et al., (2011); Kasirye, (2013); Ouma et al., (2014); Ademiluyi, (2014); and Mmbando and Baiyegunhi (2016) which showed that membership to a farmer-based organizations increases a farmer's likelihood of adopting improved maize varieties. Farmers' membership to FBOs creates for them an avenue for exposure to improved agricultural technologies and also provides access to credit, and other fertile grounds for adoption of agricultural technologies. On the contrary, Katengeza et. al., (2012) and Teferi et al., (2015) found maize farmers' membership to FBO to have inverse relationship with adoption of improved maize varieties in Malawi and Ethiopia respectively. Salifu et. al. (2015) and Fadare et al., (2014) found no significant relationship between membership to a farmer-based organization and adoption of improved maize varieties.

Farm size had a positive marginal effect and statistically significant at 1%. This means that, farm size has a direct relationship with farmer's decision to adopt Obatanpa seed variety and is confirmed by a marginal effect of 0.063. This indicates that a hectare increase in farm size results in a 6.3% probability of the farmer adopting Obatanpa seed variety in the Zabzugu district. This is consistent with results of Kasirye, (2013); Fadare, (2014); Ogada et. al. (2014); Ouma et. al., (2014); Kuti (2015); Tura et al. (2010) and Katengeza et. al., (2012) that farmers with large farm size have a greater likelihood of adopting improved maize varieties. Farmers having large farm

size have the opportunity to try improved maize technology in some parts of their farmlands before fully adopting if the need be, contrary to farmers with small farm size who fear to risk their small acres to the fate of innovations they do not know. On the contrary, Baruwa et al. (2015) found farm size to have inverse relationship with adoption of improved maize varieties among farming households in Osun State, Nigeria.

Furthermore, farmers' awareness of Obatanpa strongly influences their decision to adopt Obatanpa maize variety. This was due to the positive marginal effect of 0.874 and statistically significant at 1%. This finding is in line with Monela, (2014); and Lopes, (2010) indicating that a farmer's awareness of improved maize variety positively influences adoption of improved maize varieties.

A farmer's access to credit had positive effects on adoption and statistically significant at 5% with a marginal effect 0.247. This implies that maize farmers who have access to credit has a 24.7% likelihood of adopting improved seed variety relative to non-access farmers. This is supported by findings of Aidoo et al. (2014), Tura et al. (2010), Ogada et al., (2014); Katengeza et. al., (2012); Idrisa et al., (2012); Teferi et al., (2015); Baruwa et al. (2015), and Mmbando & Baiyegunhi (2016). On the contrary Gregory and Sewando (2013) found access to credit negatively influencing adoption of improved maize varieties in Tanzania.

Access to extension service also had a positive marginal effect of 0.357 and statistically significant at 5%. This showed a direct relationship between farmer's access to extension service and adoption of Obatanpa seed variety. Farmers who had access to extension service had a 35.7% probability of adopting Obatanpa compared to farmers who had no access. This finding confirms that of Doss et. al., (2003); Mugisha and Diiro, (2010); Mignouna et al., (2011); Katengeza et. al., (2012); Idrisa et al., (2012); Gregory and Sewando, (2013); Aidoo et al., (2014); Fadare et. al., (2014); Ouma J. et. al., (2014); Akinbode and Bamire (2015); and Mmbando and Baiyegunhi (2016) which indicated a direct relationship between access to extension services and farmers' decision to adopt improved maize varieties. Contrary to this finding is the result of a study into adoption of improved maize varieties among farmers in Bassa Local Government Area of Plateau State, Nigeria by Ademiluyi (2014), which found an inverse relationship between extension service and adoption of improved maize varieties. However, in the finding of a study into the determinants of farmers' adoption of improved maize varieties (IMVs) in the Beehi and Kpong communities of the Wa Municipality in Ghana by Salifu et. al. (2015), extension service was insignificant with adoption of improved maize varieties, meaning that whether farmers' access to extension service had no effect on the likelihood of adopting improved maize varieties remained the same.

Table 2. Descriptive Statistics of farm and farmer characteristics

Variables	Variable description	Mean	Standard deviation	Min.	Max.
Adoption	Farmer has adopted Obatanpa maize seed variety	0.588	0.493	0	1
Sex	Sex of the farmer	0.92	0.277	0	1
Marital status	Marital status	0.854	0.354	0	1
Age	Number of years lived	31.97	14.33	18	72
Experience	No. of years in maize farming	10.10	6.599	3	36
Household size	No. of persons in a household	12.50	6.598	2	35
Years of education	Number of formal schooling years completed	2.14	4.936	0	21
Membership to FBO	Belonged to a farmer based organization or not	0.25	0.436	0	1
Farm size	Hectares of farm plots cultivated	11.04	8.406	1	55
Awareness of Obatanpa seed variety	Have information Obatanpa or not	0.94	0.243	0	1
Access to credit	Needed credit and was able to get	0.14	0.345	0	1
Access to certified Obatanpa		0.50	0.501	0	1
Access to extension service	Received at least one extension visit by a farmer on maize production	0.49	0.501	0	1
Access to TV and Radio		0.17	0.377	0	1

Table 3. Factors affecting adoption of improved maize seed variety (Obatanpa)

Variables	Marginal effects	Standard Error	Z
Gender	0.729***	0.285	2.56
Marital status	0.249	0.295	0.84
Age	-0.021**	0.009	-2.46
Experience	0.009	0.011	0.80
Household size	0.041***	0.014	2.88
Years of education	0.006	0.010	0.61
Membership to FBO	0.149*	0.078	1.90
Farm size	0.063***	0.022	2.85
Awareness of Obatanpa seed variety	0.874***	0.104	8.14
Access to credit	0.247**	0.095	2.60
Access to Obatanpa	0.189	0.117	1.62
Access to extension service	0.357**	0.142	2.51
Access to TV and Radio	0.101	0.075	1.35
Number of observations	240		
LR chi ² (13)	275.04		
Prob> chi ²	0.0000		
Pseudo R ²	0.8454		
Log likelihood	-25.1417		

Note: ***, ** and * denote 1%, 5% and 10% respectively

4. Conclusion and recommendations

It is evident that credit enables producers to access inputs such as improved seedling, fertilizer, and hired labour, acquire other farm tools that may be needed in the production process. This shows the role of credit in cash or in-kind in agricultural productivity and intensification in the Northern region of Ghana. The youth has a high tendency of adopting new technology and is evident in Obatanpa maize variety adoption and confirms that, emerging technologies should target the youth. This category of farmers are in their productive stage and hence ready to try new technologies and interventions. Government and the private sector should demand a demand-driven extension technique to support emerging technologies such as Obatanpa maize variety. These extension services will raise farmers' awareness on the effectiveness of this variety towards increased adoption. Membership to farmer organization was a source of technology adoption due to influence members have on each other. It is also assumed that innovations diffused faster among members of an FBO compared to individual farmers. This FBO membership enhances members effective collective action and hence their ability to demand for efficient technologies such as adoption of Obatanpa. This therefore requires government and development agencies to support in building the capacities of FBOs towards improved productivity.

Obatanpa variety adoption is high in the Zabzugu and Tatali-Sanguli areas but farmers still prefer using stored seeds than certify seeds. Stored

seeds viability is not reliable and hence a high tendency of low yields. This requires extensive awareness and education from extension agents on farmers acquiring certify seed from seed producers for maximum yields. Also, government and private seed companies should set up mobile seed outlets as well as community seed banks for easy access to seed.

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