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# Factors influencing improved Maize Farming Technologies adoption in Yendi Municipality of Northern Region of Ghana

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## ABSTRACT
*Low technology adoption continues to affect the production of maize in Ghana, including the Yendi municipality, which is one of the high maize producing areas. The study examined the factors influencing the adoption of improved maize farming technologies in the Yendi municipality. Data was collected from 154 randomly selected maize farmers using questionnaires and in-depth interviews. Descriptive statistics and Poisson Regression Model were used to analyze the demographic characteristics of maize farmers as well as the socioeconomic factors influencing the adoption of improved maize farming technologies. The study revealed that 59% of the maize farmers had no contact with agricultural extension agents, which could negatively affect adoption of improved maize farming technologies. The Poisson regression analysis showed that education, farm size, credit and extension contact significantly influenced the adoption of improved maize farming technologies in the area. Maize farmers therefore need to be adequately trained on the technologies to understand their full benefits to enable them adopt them fully. The study recommends that Ministry of Food and Agriculture (MoFA) together with Development Partners (DPs) should facilitate farmers' access to credit and provide more logistics to facilitate access to extension services.*

## INTRODUCTION
In sub-Saharan Africa, maize is the widely-grown staple food crop with annual coverage of more than 33 million ha (FAOSTAT, 2015). It covers an estimated 200 million ha of cultivated land in Sub-Saharan Africa thus nearly 17%, and is grown in diverse agricultural fields and consumed by people who have different socio-economic backgrounds and food preferences (FAOSTAT, 2015). Maize is also the most widely consumed staple food in Ghana with increasing production since 1965 (FAO, 2013). It is grown in many parts of Ghana with an estimated of 15 % production in Northern Ghana. Maize produced in Ghana on average has recorded an increase of 13.3 % in 2012 (MoFA, 2013). However, production has been fluctuating for the past two decades, which affects household incomes sources and threatens food security (MoFA-SRID, 2009). The low maize yields is probably due to multiples of traditional farming practices that include the use of low-yielding varieties, low plant population, poor soil fertility and inadequate and improper application of fertilizers and improper weed control (Bidzakin *et al.,* 2014).

Low staple crops and livestock low production remain a key challenge in realising food security in Africa including Ghana. This has led to high food and nutrition insecurity, malnutrition and poverty, especially for the resource-constrained smallholder farmers, mostly rural farmers, practicing rain-fed agriculture (Gurney *et al.,* 2006; World Bank, 2007). To reverse the low productivity in maize production the utilisation of new maize farming technologies is paramount. However, crop farmers seem to have relatively low rates of adoption of modern crop varieties and other agricultural technologies associated with increased crop yields (Peterman *et al.,* 2010). The adoption of improved maize farming technologies is important for boosting maize production and improving on household livelihood and food security in Ghana and Africa as a whole. The adoption of improved farming technologies influences the increasing rate of agricultural output. It also regulates how the increase in farming output impacts on the poverty levels and degradation of the environment (Meinzen-Dick *et al.,* 2002). For farmers to gain from research station technologies, when perceived to be proper they proceed to implement the technologies on their farms (Meinzen-Dick e*t al.,* 2002). The use of improved maize based technologies in on-farm demonstration fields have resulted in yields of 4-5 tonnes per hectare (Bidzakin *et al.,* 2014). This indicates that improvements can be realized if farmers resort to the use of improved seeds, fertiliser and improved production practices and proper technologies (Bidzakin *et al.,* 2014). This makes the improvement in agricultural production and sustainability largely dependent on farmer's willingness and access to new technologies.

However, there are barriers to adoption of improved maize technologies which include: unavailability of credit, inadequate capacity of seed companies impeding product delivery at large scale, lack of awareness, inadequate availability of improved maize seed, and unaffordable seed price (Tahirou *et al.,* 2009; Fisher *et al.,* 2015). Technology adoption is pro-poor if it benefit the poor relatively more than non-poor (Kakwani, 2005). Clearly, such innovation or technology must be affordable to the poor in the society. Furthermore, its benefit must also be significant relative to its cost (including the adoption risks it involves). Although the benefits and determinants of adopting new farm technologies are stressed in the literature, the impact of these new technologies on poverty reduction is not well articulated. Partly, agricultural extension and advisory services seem to be crucial in addressing the low maize productivity by providing and encouraging farmers to adopt improved maize farming technologies to boost their productivity. However, the failure in the delivery of these extension services has a major influence in the adoption of improved maize technologies.

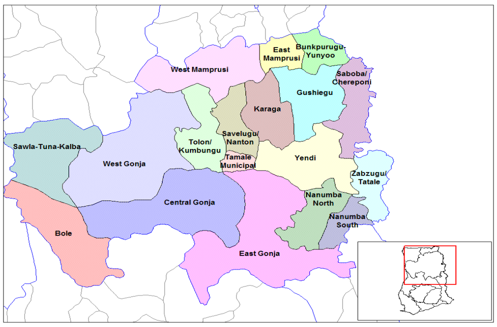
Maize is a major staple crop for most Ghanaians and is usually used as a substitute for other major cereals that are in short supply. In spite of the increase in maize production in Sub-Sahara Africa over the years, Ghana has a supply deficit of maize to make up for this shortage through imports (Codjoe, 2007). This is not surprising as the ever increasing demand for maize for various domestic and industrial purposes keep growing, due to high population and low productivity of maize. This deficit can partly be addressed with increase in production, as there is enormous potential for maize cultivation in Ghana (Codjoe, 2007). Undoubtedly, the maize subsector is mainly small-scale and is overwhelmed with usage of local technology, inadequate extension services, no or insufficient application of vital inputs e.g. fertiliser and improved planting material, lack of support for credit and inputs provision, extension and research services and agro-management practices (MoFA, 2009). These factors hamper maize productivity in Ghana to which the Yendi municipality is no exception. However, previous studies have revealed that, low maize productivity growth in Ghana is mainly caused by low adoption of improved technologies that include improved varieties, agronomic practices, and inadequate usage of purchased inputs (MoFA, 2011). It is therefore indisputable that the adoption of improved technologies for maize production is an important means to increase the productivity of smallholder agriculture in Africa that will lead to economic growth and improvement of the welfare of many poor households (Kassie *et al.,* 2011; Asfaw *et al.,* 2012). The adoption of technology pattern and crop farmers' perceptions has remained unclear in most developing countries especially Ghana. The perceptions of crop farmers are mostly considered subjective but have direct influence on decisions to adopt improved technologies and are therefore very important in economic modeling (D'Antoni *et al.,* 2012).

Over the years improved maize farming technologies were developed by MoFA to enhance the production of maize in the Northern region of Ghana including the study area, due to the huge potential of its production in the area. Since, the introduction of these technologies they have not been an independent extensive research conducted to assess the adoption of improved maize technologies and to assess the socio-economic factors that influence the adoption of these technologies. The study therefore sought to assess the factors influencing the adoption of improved maize farming technologies in the Yendi Municipality.

## MATERIALS AND METHODS

### Study Area

The study was conducted in the Yendi Municipality (Figure 1) which is the capital of the Dagbon Kingdom. It is located in the Northern Region and lies between Latitude $9^0$–$35^0$ North and $0^0$–$30^0$ West and $0^0$–$15^0$ East (GSS, 2014). Strategically, the Municipality is located at the heart of the eastern corridor of the Region with a landmass of 1,446.3 sq. km Ghana Statistical Service, 2010). The capital of the Municipality is Yendi, which is about 90 km from the Tamale (GSS, 2014).




### Research Design

The study adopted a descriptive survey research design for the study; both qualitative and quantitative approaches were employed. Descriptive survey design was appropriate for the study since it enabled the collection and analysis of both qualitative and quantitative data. Quantitatively, the study used the closed-ended sections of the questionnaire to obtain data on the factors influencing the adoption of improved maize farming technologies. Qualitatively the study used the open-ended sections of the questionnaire to collect data on the factors influencing the adoption of improved maize farming technologies in the study area.

### Sampling Technique

A multistage sampling technique was used for the selection of respondents. At first stage, the entire municipality was stratified into three strata (zones). At the second stage Simple random sampling was used to select twelve (12) communities and one hundred and fifty-six (154) maize farming households (respondents). A simple proportion formula was used to calculate for the number of maize farmers who were interviewed in each zone.

### Data Collection and analysis

Data were collected using questionnaires, Focus Group Discussion (FGD). Both descriptive statistics and Poisson regression model were used in the analysis of data collected. Descriptive statistics such as tables, mean, and standard deviation were used to analyse the first objective (which objective is considered as first objective and then second objective as the manuscript has only one objective stated above). The second objective was analyse using Poisson regression model to assess the socio-economic factors influencing the adoption of improved maize farming technologies.

### Poisson Model Specification

The Poisson regression model is best suited in the context of econometrics for estimation of models with count data dependent variable, and is the starting point for count data analysis (Cameron and Trivedi, 1990; Greene, 2003). It was employed for the estimation of the maize farmers' decision on how many improved maize farming technologies farmers adopts. The probability of adopting $k$ improved maize farming technology given $n$ independent improved technologies is represented by the binomial distribution:

$$P(Y = k) = \binom{n}{k} P^k (1 - P)^{n-k} \quad \dots \dots \dots (1)$$

Where $\binom{n}{k} = \frac{n!}{k!(n-k)!} \quad \dots \dots \dots (2)$

and $p$ is the probability of adopting, $k$ *is* improved technology, y stands for y factorial.

Statistical theory states that a repetition of a series of binomial choices, from the random utility formulation, asymptotically converges to a Poisson distribution as $n$ becomes large and $p$ becomes small:

$$\lim_{n\to\infty}\binom{n}{k}P^k(1-P)^{n-k} = \frac{e^{-\lambda}\mu^k}{k!} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where μ is the mean distribution, such as the mean number of technologies adopted by the farmer. The formula presented in (1) allows modelling of the probability that a household adopts the number of improved maize farming technologies *k* given a parameter μ.

The maize farmers make series of discrete household decisions that sum across an aggregation of choices to a Poisson distribution. The Poisson regression model is the development of the Poisson distribution presented in (1) to a non-linear regression model of the effect of independent variables *x I* on a scalar dependent variable *y*. The density function for the Poisson regression is

$$f(y/xi) = \frac{e^{-\mu i}\mu^y}{y!} \ and \ y = 0, 1, 2 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where *f(y)* denotes the probability that the variable *y* takes non-negative integer values, and where y! stands for *y* factorial. μ is the mean of distribution, such as the mean number of technologies adopted by the maize producer. Where the mean parameter as the function of the regressors x*i* and parameter vector β is given by

$f(y/xi) = \mu = \exp(x'\beta)$ and *y* = 0, 1, 2….n

**EMPIRICAL MODEL**

The empirical Poisson model used to assess the factors influencing adoption of improved Maize farming technologies is specified below:

$$ADOPT = \beta_0 + \beta_1 AFR + \beta_2 EXV + \beta_3 HHS + \beta_4 ACR + \beta_5 EDU + \beta_6 MS + \beta_7 FE + \beta_8 GM + \beta_9 FS + \mu_i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where;

ADOPT = adoption (Count data is the weighted sum of improved technology adopted)

AFR = Age of the farmer (in years)

EXV = Extension contact (1 if extension service available and 0 otherwise)

HHS = Household size (Number of persons in the household)

ACR = Access to credit, dummy (1 if farmer has access to credit and 0 otherwise)

EDU = Education is the number of years a farmer spends in school measured (in years)

MS = Marital status (1 if a farmer is married, and 0 otherwise)

FE = Farmer experience is the number of years a farmer engaged in farming activities measured (in years)

GM = Membership of a farmer association, measured as a dummy (1 for membership of an association and 0 otherwise).

FS = Farm size is the number of hectares a farmer used to cultivate maize, measured in hectares.

## RESULTS AND DISCUSSIONS

**Demographic Characteristics of the Maize Farmers**

Descriptive statistics estimated from the sample of 154 maize farmers are presented in table 1. The results showed that 58.4% of the household respondents were males. This is expected as males dominate in the production of maize in the Northern region of Ghana. Gender influences the adoption of technologies as it affects the sourcing of agricultural information and use. Female farmers are more risk loath (Croson and Gneezy, 2008) and perceptions that women are not supposed to be farmers also limit their accessibility to agricultural information sources (Doss, 2001).

83 % of the respondents were married. Comparatively, the findings of this survey seem to learn support from findings of GSS (2014) that reported that about 54.6 % of the populations aged 12 years and older in the Municipality are married, with small proportions of divorced cases of 1.1 %, separated (0.7 %) and widowed (3.9 %). The observed trend could be due to the fact that majority of the population in the Municipality are Moslems (GSS, 2014). As marital status also influences the desire increase in productivity for family consumption and income is high among farmers who are married than their counterparts who are not married (Opara, 2008) consider revising the information/quotation from Opara as it contains many grammatical errors.

The survey revealed that; the mean age of the respondents was 40 years with a standard deviation of 6.57 years. It was obvious from the survey that the majority of the respondents who cultivated maize were within the economically active age group as the average age shows a relatively young population. Age is also considered to be a determinant of adoption of improved technology. Older farmers are supposed to have increased knowledge and experience over time and are able to evaluate information of technology than younger farmers (Mignouna *et al*., 2011; Kariyasa and Dewi, 2011).

**Table 1: Statistics of Maize Farmers Demographic and Socio-Economic Characteristics**

| Variable | Mean | Std Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Age | 40.46 | 6.57 | 26.00 | 56.00 |
| Sex | 0.58 | 0.49 | 0.00 | 1.00 |
| Marital status | 1.36 | 0.93 | 1.00 | 5.00 |
| Farm size | 1.95 | 1.14 | 0.40 | 6.40 |
| Household size | 8.25 | 3.52 | 4.00 | 26.00 |
| Maize farming experience | 14.93 | 7.94 | 2.00 | 36.00 |
| Access to credit | 0.01 | 0.11 | 0.00 | 1.00 |
| Extension contact | 0.41 | 120.6 | 0.00 | 1.00 |
| Group membership | 0.17 | 0.36 | 0.00 | 1.00 |
| Farmer income | 2.29 | 0.10 | 1.00 | 5.00 |

The study revealed that respondents' household size comprised an average of 8 individuals with a standard deviation of (3.52) (Table 1). Comparatively, the average household size of the respondents seems to be consistent with the average household size of 9.3 persons in the Yendi Municipality reported by GSS (2014). This large family size may serve as cheap and reliable source of labour for maize farming within the household. As household size can be used to measure labour availability which influence adoption process as larger household have the ability to relax the labour limits required during introduction of improved farming technology (Bonabana-Wabbi, 2002; Mignouna *et al.,* 2011).

The survey revealed that about 75.32 % of the respondents have no formal education, 13.64) had primary education, 6.49% had middle and junior high education, 3.9% (6) had secondary education and 0.65% had tertiary/ college education. It is obvious from the survey that majority of the maize farmers in the Yendi Municipality have not had formal education. Which could consequently affect their adoption of improved maize farming technology as enlightenment enhance people decision making and analysis of situations. Since, access to agricultural information is influenced by the farmer's level of education. Farmers with formal education stand a high chance of adopting a new technology to increase production. Education gives the farmer ability to derive, decode and evaluate useful agricultural information for production (Ani, 1998).

The average number of years in school in the area among the sample respondents was about 2 years. Imoru and Ayamga (2015) also found the average number of years in school among maize farmers in the Northern region of Ghana to be 2 years. This low level of education among the rural households in the Yendi Municipality may have negative impact on adoption of agricultural technologies. The mean years of schooling of the respondent farmers in the area also mean they are unable to read and write. High level of education among farmers would make them more responsive to many agricultural extension programmes and policies (Agwu *et al*., 2008) leading to adoption of new and improved technologies.

The mean farm size of households in the study area was about 1.9 hectares with a standard deviation of 1.4. This small farm size shows that farmers in the area are smallholders (Table 1). This implies that greater proportion of the maize farmers in the area was smallholder maize farmers. This is an indication that farming in the area is at the subsistence level. This could constraint the adoption of improved technologies due to the small farm size (Agwu *et al*., 2008). One of the resources that are an indicator of wealth and proxy for social status and influence is land size which has influence on farmers in the Yendi Municipality and in the country as a whole. In terms of maize farming experience, an average of 14 years with a standard deviation of (7.94) was recorded among the sampled farmers. The mean number of years in maize farming has shown a significant experience in maize farming and this can have significant effect on the adoption of new and improved farming technologies in maize farming. The farmer's socio-economic characteristics that include level of education, farm size and farming experience influence the adoption of improved technologies (Hudson and Hite, 2003).

**Institutional Characteristics of the Respondents**

The study showed that 41% of respondents were also visited by an extension officer during the maize production season, about 40.3 % of the respondent farmers do not have access to any of these institutional factors, less than 20 % of the sampled respondents belonged to farmer groups in the area and only 1.3 % of them were able to access credit for their maize farming (Table 2). It can be deduced that about 59 % of the maize farmers interviewed have not had contact with agricultural extension agents, which can negatively affect adoption of improved maize farming technologies. As it is reported by Agwu *et al*. (2008) that low extension farmer contact does not augur well for adoption of agricultural technologies.

Generally, institutional factors deal with the degree in which institutions impact on technology adoption by smallholders (Meinzen-Dick *et al*., 2004). Institutions include all the services to agricultural development such as finance, insurance and information dissemination (Meinzen-Dick *et al*., 2004). The institutional factors considered in this study are group membership, access to credit and access to extension services. Membership of farming based groups is a positive coefficient with adoption (Gbegeh and Akubuilo, 2013). Farmers who have membership to cooperatives that can pull resources together for their individual gain give them the opportunity to adopt many technologies than other farmers who are not members. Also, members of cooperatives get more reliable information on improved farm management practices than non-members of cooperatives. Farm based organisations links the individual farmer to the larger society and exposes the farmer to a variety of ideas.

**Socio-Economic and Institutional Factors Influencing Adoption of Improved Maize Farming Technologies**

This section presents the socio-economic and institutional factors influencing the adoption of improved maize farming technologies among maize farmers in the Yendi municipality. The results from the estimated parameters of the Poisson regression model have shown that four factors were statistically influencing the adoption of improved maize farming technologies in the area. The factors that were significant include: education, maize farm size, access to credit and access to extension contact. The results have shown that the variables included in the model were all strongly influencing the adoption of improved maize farming technologies in the area as the $Chi^2$ value was significant at the 1 % ($P< 0.01$) (Table 2). However, the variables in the model could not explain the variation of probability of adoption better as the Pseudo $R^2$ only explained 2 % of the variation in the adoption of the improved maize farming technologies by the variables.

Education was expected to have positive influence on the adoption of improved maize farming technologies, the results have shown that education influence adoption positively. The implication of this is that higher educated farmers are likely to adopt improved maize farming technologies than farmers with low level of education. Educated farmers are expected to show better adoption of technology because of their ability to understand the benefits of technology adoption and the trust they have in extension officers (Oyekale and Idjesa, 2009). However, this finding is not surprising as the majority of the respondent farmers do not have any form of formal education. Several studies on adoption have shown positive relationship between adoption and education (Lawal *et al*., 2004; Oyekale and Idjesa, 2009; Singh *et al*., 2010; Kayode and Adekoya, 2013). Singh *et al.* (2008) also found education to have negative effect on the adoption of integrated pest management in paddy but did not show any significant level.

**Table 2: Estimates of Poisson Regression Model showing the Socio-Economic and Institutional Factors Influencing the Adoption Improved Maize Technologies**

| Variable | Coefficient | Robust std error | p>\|z\| |
|---|---|---|---|
| Constant | 0.7708 | 0.7278 | 0.29 |
| Marital status | 0.0076 | 0.081 | 0.925 |
| Age | 0.021 | 0.0354 | 0.554 |
| Household size | 0.006 | 0.0059 | 0.313 |
| Education | 0.0188 | 0.0099 | 0.059*** |
| Maize farming experience | 0.0029 | 0.007 | 0.681 |
| Maize farm size | 0.0885 | 0.0298 | 0.003* |
| Group membership | 0.0494 | 0.0706 | 0.484 |
| Credit | 0.1793 | 0.104 | 0.085*** |
| Extension | 0.1881 | 0.0653 | 0.004* |
| Number of Observation = 154 | Prob > $Chi^2$ 0.0000 | | |
| Wald $Chi^2$ = 39.76 | Pseudo $R^2$ = 0.0214 | | |

* = 1% level of significance and *** = 10 percent level of significance

As expected, maize farm size was significant at the 1 % level and influence adoption of improved maize farming technologies positively. Farmers with relatively large maize farm size were more likely to adopt improved maize farming technologies than those with relatively small maize farm size. Singh *et al.* (2008) found farm size to have negative relationship with adoption in both paddy and cotton production in Haryana and Punjab in India. The probability of a farmer adopting the maize farming technologies increases by 0.0885 % if the farmer increases his or her farm size by 1 hectare (Table 2). This result is consistent with Singh *et al.* (2010) who found that farm size of land holding was having a positive correlation with adoption of commercial cabbage cultivation technology in District Ghaziabad in India.

As expected of credit from the study, credit access was also impacting positively on the adoption. Access to credit was statistically significant at the 10 % level of significance and negatively influenced the adoption of maize farming technologies. This means that farmers who accessed credit in the production season were less likely to adopt the improved maize farming technologies than those who could not access any credit. The coefficient of access to credit was -0.1793 (Table 2) implying that if a farmer have a credit access of one Ghana cedis, such a farmer adoption of the improved maize farming technologies would be increase by 0.1793 (Table 2) when all other factors of production are kept constant. Also, having access to extension contact has an influence on the adoption of improved maize farming technologies. Extension contact was significant at the 1 % and positively influenced the adoption of the improved maize farming technologies in the area. This result is consistent with the findings of Sulo *et al*. (2012).

However, variables such as marital status, age, household size, experience and farmer group membership showed positive relations with adoption but were non-statistically significant.

## Conclusions

The paper examined factors influencing the adoption of improved maize technologies in the Yendi district of the Northern region of Ghana. The study found that the majority (81.75%) of the maize farmers are in the age range of 26-55 years, which implies that maize farmers are within the active age bracket. The study also found that 58% of the household respondents were males. In terms of farming experience, the respondents have an average of 14 years of maize farming, which implies that maize contributes importantly to their livelihood**.** Therefore, an enhancement in the production in the form of knowledge would directly improve their source of livelihood**.** The study further revealed that respondents' household size comprised an average of 8 individuals with a standard deviation of (3.52). Factors such as education, farm size, credit and extension contact were the statistically significant factors that influenced the adoption of the improved maize farming technology in the area. The implication is that farmer extension contact is critical for the adoption of improved technologies. The study also recommends more farmer-extension officer contact as extension contact was also significantly influencing adoption of the improved maize farming technologies. The Ministry of Food and Agriculture employ more extension officers into the system. Alternatively, MoFA should intensify the e-extension method of extension delivery to complement the extension-farmer deficit. Furthermore, MoFA can also train more community-based extension volunteers who live in the communities with the farmers and assist in the extension activities. Farm size influences the adoption of the improved maize farming technologies. The policy implication of this is that, farmers should be assisted to increase their farm size as large scale farmers are usually innovators. Government should assist farmers with production inputs to enable them increase their farm sizes. The study recommends that Ministry of Food and Agriculture (MoFA) together with Development Partners (DPs) should facilitate farmers' access to credit, and provide more logistics to facilitate access to extension services. Farmers need to be trained on the technologies to understand the full benefits of the technologies to enable them adopt the technologies fully.

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