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Research Article

Analysis of Farmers' Adoption and Dis-adoption of Improved Maize Varieties among Smallholder Farmers in the Northern Region, Ghana

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Abstract

This study assesses the factors influencing farmers' decisions to adopt or dis-adopt improved maize varieties of the Northern region of Ghana, specifically in the Gushegu district and Yendi Municipal, both of which are known for extensive maize cultivation. Through cross-sectional study design, 400 maize farmers in the two districts were surveyed with interviews used to collect data from the sampled farmers. Descriptive statistics, particularly percentage and frequency, were used to analyse the adoption and dis-adoption of improved maize varieties data while the probit regression model was used to analyze factors influencing the adoption and dis-adoption of improved maize varieties data. The study revealed that all farmers were aware of the existence of Obatanpa, Mamaba, Aburohemaa, Obaatan, Abontem and Pana improved maize varieties. Additionally, the study revealed that Obatanpa maize variety had the highest adoption rate of 100%, but it also experienced dis-adoption at a rate of 86.5%. However, varieties like Golden Crystal, Bankyehemaa, Cidaba and Dodzi were neither adopted nor dis-adopted by farmers in the study area, due to its low yield and susceptibility to pest attacks. The study also revealed that respondent's gender, educational status, farm size, farming experience, credit access, labor availability, access to extension, perceived high yield and seed availability were significant predictors of the adoption of improved maize varieties. The study concluded that the high dis-adoption rates of Obatanpa, Mamaba, Aburohemaa and Panaa resulted from their inability to perform well under local climatic conditions, coupled with inadequate promotion by extension agents and contact farmers. The study recommends that the government, through the Ministry of Food and Agriculture (MoFA), should focus on promoting the benefits of less commonly used and abandoned maize varieties like Dadaba and educating farmers on how to sustain their adoption for longer periods.

Keywords: Adoption, Dis-adoption, Improved maize varieties, Smallholder farmers, Ghana

INTRODUCTION

Smallholder farmers, who account for more than 90% of farmers in developing countries, face numerous challenges that limit their productivity and incomes globally (Abraham M, et al., 2020). These challenges include a lack of market access, a lack of finance and a lack of appropriate technologies and inputs (Adekambi SA, et al., 2020). Access to appropriate technologies and inputs is especially critical because it directly affects agricultural productivity (Ademiluyi IO, 2014). Farmers in Africa face many similar challenges as those in other developing countries where smallholder agriculture is the economic backbone (Adzawla W, et al., 2021). Low agricultural productivity is a significant challenge for African smallholder farmers and it is largely due to the use of traditional farming methods and limited access to modern technologies and inputs (Amare A, et al., 2017). Among the technologies promoted to African smallholder farmers in order to increase productivity and income are improved maize varieties (Bensch G, et al., 2015). However, adoption of improved maize varieties among African smallholder farmers has been uneven, with many farmers

abandoning them altogether, a phenomenon known as dis-adoption (Danso-Abbeam G, et al., 2017). A lack of access to inputs, poor quality inputs or insufficient training on how to use the technology can all lead to dis-adoption (Ehiakpor DS, et al., 2021).

Agriculture is an important sector of the Ghanaian economy, employing roughly half of the workforce and accounting for more than 20% of GDP (Fisher M, et al., 2014). Furthermore, maize is an important staple crop in Ghana and smallholder farmers grow the majority of it (Hailu BK, et al., 2014). Researchers in Ghana have developed and promoted several improved maize varieties in recent years, including Obatanpa, Mamaba and Aburohemaa, Obaatan, Bankyehemaa and Mamaba-6, which have outperformed traditional maize varieties in yield (Ifie BE, et al., 2022). These improved varieties are expected to increase smallholder farmers' productivity and income (Jaleta M, et al., 2018).

Smallholder farmers in Ghana, including those in the Northern Region, have been slow to adopt improved maize varieties and associated production practices (Jones-Garcia E, et al., 2021). While some farmers have embraced these technologies, resulting in significant increases in crop yields and income, others have been hesitant (Kafle B, 2010). According to Kuivanen, et al., in Ghana's Northern Region, approximately 63% of farmers used improved maize varieties and had higher yields and incomes than those who used traditional varieties (Katengeza SP, et al., 2019). Furthermore, Adekambi, et al., discovered that 71% of farmers in Ghana's Upper East Region adopted improved maize varieties during the first year of introduction (Kuivanen KS, et al., 2016). In the Ashanti Region of Ghana, Ifie, et al., discovered that 69% of the farmers in the study area had adopted improved maize varieties (Kurgat BK, et al., 2020). Farmers who used improved maize varieties had higher yields and incomes than those who used traditional varieties, according to the study (Lunduka R, et al., 2012).

Farmers, on the other hand, have abandoned improved maize varieties, according to some studies (Mgbenka RN, et al., 2016). For example, Ragasa, Chapoto and Kolavalli, discovered in the Northern Region of Ghana that some farmers who had previously adopted improved maize varieties had discontinued their use for a variety of reasons, including low yields, high seed costs and poor-quality seeds (Mmbando FE, et al., 2016). Similarly, Martey, Etwire and Kuwornu, discovered that due to low yields, insufficient extension services and a lack of credit, some farmers in Ghana had abandoned improved maize varieties. Adzawla and Alhassan also reported that farmers in Ghana's Upper East Region had abandoned improved maize varieties due to low germination rates, yields and seed quality. This inconsistency in the adoption of improved maize varieties and practices has resulted in uneven progress in improving maize productivity and income among smallholder farmers in the Northern Region, potentially impeding the achievement of food security and poverty reduction goals.

As a result, there is a need to understand the factors that influence smallholder farmers in Ghana's Northern region's adoption and rejection of improved maize varieties and practices. The study's objective is to provide a comprehensive examination of farmers' adoption and dis-adoption of improved maize varieties and practices in Ghana's Northern Region. The study sought to investigate the factors influencing farmers' decisions to adopt or abandon improved maize varieties, among smallholder farmers in the Northern Region of Ghana. By shedding light on the drivers of adoption and dis-adoption, the study can help to develop more effective policies and interventions to promote the adoption of improved maize varieties and practices among smallholder farmers in Ghana's Northern Region. Finally, this can help to increase food security and reduce poverty in the region.

MATERIALS AND METHODS

The study was conducted in Ghana's northern region, specifically in the Gushegu District and Yendi Municipal, both of which are known for extensive maize cultivation. The climate in these two districts is similar to that of the Sudan savanna, with annual rainfall ranging from 800 mm to 1100 mm. The region experiences a long dry season from November to April and a short rainy season from May to October. The temperature ranges from 25°C to 40°C during the rainy season, with high humidity. The soil types in the districts are diverse, including sandy loam, loam and clay loam. These soils are known to be fertile and suitable for maize cultivation, with traditional farming methods being used by the majority of farmers.

Research design and approach, sampling techniques, data collection and analysis

The primary goal of this study was to assess the factors influencing farmers' decisions to adopt or abandon improved maize varieties in the Northern region. Thus, a cross-sectional study design was used, with data collection and analysis using a mixed-methods approach.

According to the Ministry of Food and Agriculture (MoFA), the Northern region has 123,626 smallholder maize farmers. A sample size of 400 maize farmers was determined for this study using Cochran's sampling size determination formula. A multistage sampling technique was used to select a representative sample of smallholder farmers in Ghana's Northern Region. Two districts were deliberately chosen for their high maize production levels in the first stage. The districts in question were Gushegu and Yendi Municipal. Because all communities in the two districts cultivate maize, in the second stage, five communities within the selected districts were chosen at random. The Gushegu district (Kpatinga, Zinindo, Gaa, Geluwei and Nayogu) and the Yendi Municipality (Kuni, Limpua, Malzeri, Adibo and Cherefoyili) were chosen. Finally, forty (40) maize farmers were chosen at random from the communities using a systematic sampling technique. Data was gathered using structured questionnaires and

key informant interviews. A group of maize farmers and extension officers from the two district capitals served as key informants for the study. These key informants included two (2) lead maize farmers and two (2) extension officers from Yendi and Gushegu. The key informant interviews looked at the different types of improved maize varieties that were available in the areas, as well as the challenges associated with their use. Quantitative data from key maize farmers were collected to support the depth of the analysis, percentage, frequency and the probit regression model were used to analyze quantitative data.

Probit regression model

In this study, a farmer is considered a dis-adopter if he or she cultivated improved maize varieties in previous cropping seasons, but was no longer cultivation it as at the time of this study. Since adoption refers to the use and continuous usage of an innovation, many factors that influence adoption are expected to have an impact on dis-adoption or discontinuous use of an innovation. In the case of improved maize variety dis-adoption, the farmer will make two interconnected discrete choices. First, the farmer decides whether to adopt the improved maize variety, particularly "Pana". Second, he or she decides whether to continue cultivation (adoption) or discontinue cultivation (dis-adoption). If reducing the farm size cultivated with the improved maize variety to zero results in a utility gain, a farmer decides to stop cultivating the improved maize variety. A binary staged probit (bivariate probit) model was specified for the adoption and discontinue use choice (dis-adoption) of improved maize varieties. As a result, the probit regression model was used to investigate the factors that influence smallholder farmers in Ghana's Northern Region's adoption or abandonment of improved maize varieties.

The general form of the probit model is:

$$P(Y=1|X) = \Phi(\beta 0 + \beta 1X1 + \beta 2X2 + ... + \beta kXk) \quad \ldots\ldots (1)$$

where $P(Y=1|X)$ is the probability of adoption or dis-adoption of improved maize varieties and practices given a set of explanatory variables X1, X2, ..., Xk and β0, β1, β2, ..., βk are the model parameters to be estimated. The function Φ is the cumulative distribution function of the standard normal distribution **(Table 1)**.

The probit model for analyzing adoption and dis-adoption in the study was specified as follows:

$$Y1=Y2= \beta 0+ \beta 1X1+\beta 2X2 +\ldots\ldots +\beta nXn \quad \ldots\ldots (2)$$

Where the explanatory variables are defined in as

$$\text{Adoption-}_{PANA1}/\text{Dis-adoption-}_{PANA1}=\beta 0+\beta 1(\text{Age})+\beta 2(\text{Sex})+\beta 3(\text{Education})+\beta 4(\text{Farm size})+\beta 5(\text{Experience})+\beta 6(\text{Credit access})+\beta 7(\text{Farm ownership})+\beta 8(\text{Labour availability})+\beta 9(\text{Household size})+\beta 10(\text{Access to market})+\beta 11(\text{Access to extension services})+\beta 12(\text{FBO membership})+\beta 13(\text{Perceived high yield})+\beta 14(\text{Perceived ease of cultivation})+\beta 15(\text{Seed availability})+\varepsilon$$

Table 1. Description, measurement and hypothesized sign of variables used in the probit regression model.

Variable	Description	Measurement	Hypothesized sign
Dependent variable			
	Adoption of "Pana"	Yes=1, no=0	+
	Dis-adoption of "Pana"	Yes=1, no=0	+
Independent variables			
X_1	Age of respondent	Years	+
X_2	Sex of respondent	1=Male, 0=Female	+/-
X_3	Education	Years in school	+
X_4	Farm size	Acres	+
X_5	Experience in farming	Years in farming	+
X_6	Credit access	Yes=1, no=0	-
X_7	Farm ownership	Yes=1, no=0	+/-
X_8	Labour availability,	Yes=1, no=0	+
X_9	Household size,	Number of people	+
X_{10}	Access to market	Yes=1, no=0	+
X_{11}	Access to extension service	Yes=1, no=0	+/-
X_{12}	FBO membership	Yes=1, no=0	+
X_{13}	Perceived high yield,	Yes=1, no=0	+
X_{14}	Perceived ease to cultivate	Yes=1, no=0	+/-
X_{15}	Seed availability	Yes=1, no=0	+

RESULTS AND DISCUSSION

This section presents results and discussion on the types of improved maize varieties adopted and dis-adopted as well as factors influencing the adoption and dis-adoption of improved maize varieties.

Farmer's awareness of types of improved maize varieties

The results of a study on farmers' awareness of different types of improved maize varieties in the study areas are shown in Table 2. According to the findings, all farmers were aware of the existence of Obatanpa, Mamaba, Aburohemaa, Obaatan, Abontem and Pana. Some varieties, however, such as Cidaba and Dodzi, have 0% farmer awareness, indicating that none of the farmers in the study are aware of these improved maize varieties. Furthermore, farmers' awareness of varieties such as Dadaba, Golden Crystal and Bankyehemaa varies. Dadaba has a 75% awareness rate, with 300 farmers aware and 100 farmers unaware of it. Golden Crystal has a 70.5% awareness rate, with 282 farmers aware and 118 farmers unaware. Bankyehemaa has a 71.8% awareness rate, with 287 farmers aware and 113 farmers unaware. Farmers' awareness of improved maize varieties directly contributes to increased agricultural productivity and food security. In a study conducted in Tanzania by Mmbando and Baiyegunhi, farmers who were aware of improved maize varieties had higher adoption rates and higher maize yields than farmers who were not aware. Amare and Simane discovered in Ethiopia that farmers' awareness of improved maize varieties was positively correlated with their adoption decisions. As a result of this high level of awareness among the various varieties, most farmers are likely to adopt and continue to use improved maize varieties **(Table 2)**.

Table 2. Farmer's awareness of types of improved maize varieties.

Awareness levels of improved maize varieties	Aware		Unaware	
	Frequency	Percentage	Frequency	Percentage
Dadaba	300	75	100	25
Golden crystal	282	70.5	118	29.5
Obatanpa	400	100	0	0
Mamaba	400	100	0	0
Aburohemaa	400	100	0	0
Obaatan	400	100	0	0
Bankyehemaa	287	71.8	113	28.2
Cidaba	0	0	400	100
Dodzi	276	69	124	31
Abontem	400	100	0	0
Panaa	400	100	0	0

Adoption and dis-adoption rates of improved maize varieties

The result in Table 3, revealed that adoption and dis-adoption rates for Dadaba maize variety are identical at 20.8%. The analysis implies that farmers in the study area have technically stopped using Dadaba maize variety. The low adoption of Dadaba maize variety is attributed to lack of seed availability, lack of promotion or extension efforts and poor performance under local conditions. Additionally, the study revealed that Obatanpa maize variety had the highest adoption rate at 100.0%, but it also experienced dis-adoption at a rate of 86.5%. As a result, the net change in adoption for Obatanpa maize variety is 13.5%, indicating a positive trend in its adoption. It is imperative to recognized that farmers understand the advantages of this variety, which could include increased yield, improved pest and disease resistance or better adaptation to local conditions. Obatanpa's high adoption rate is consistent with findings from other studies. In Ghana, for example, Wongnaa, et al., discovered that Obatanpa maize variety was the most widely adopted maize variety among farmers in the Ashanti region.

Furthermore, the adoption of Mamaba maize variety was initially at 65.5% and it experienced a dis-adoption rate of 52.5%, resulting in a net change of 13.0%. This suggests continued interest in Mamaba maize variety among farmers. Also, Abontem maize variety had an adoption rate of 20.0% and a dis-adoption rate of 16.3%, resulting in a net change of 3.7%, signifying a slight increase in adoption. This result aligns with a study by Owusu, et al., identified that a moderate increase in the adoption of Abontem maize variety. Also, Obaatan maize variety witnessed a notable increase in adoption, with an adoption rate of 55.3% and a dis-adoption rate of 36.0%. The net change in adoption for Obaatan is 19.3%, indicating a significant positive trend in Ghana.

Additionally, adoption and dis-adoption rates for Panaa maize variety are both at 71.3%. This means that maize farmers in the study area have completely stopped using Panaa. However, other studies have reported varying adoption and dis-adoption rates for Panaa. For example, a study conducted in Ejusi, Ghana found a higher rate of Panaa maize variety adoption by farmers. However, the situation is completely different as farmer

has stopped using it. However, varieties like Golden Crystal, Bankyehemaa, Cidaba and Dodzi were neither adopted nor dis-adopted by farmers in the study area. These improved maize varieties have been abandoned by farmers at a higher rate than others because of lack of market availability, low yield, susceptibility to pests and diseases and poor grain quality. Furthermore, van Rheenen, et al., discovered that farmers in Ghana stopped using the maize variety Bankyehemaa due to its low yield and susceptibility to pest attacks **(Table 3)**.

Table 3. Adoption and dis-adoption of improved maize varieties adopted by farmers.

Improved maize varieties	Adoption	Dis-adoption	Change in adoption
Dadaba	20.8	20.8	0
Golden Crystal	0	0	0
Obatanpa	100	86.5	13.5
Mamaba	65.5	52.5	13
Aburohemaa	37.8	30.8	7
Obaatan	55.3	36	19.3
Bankyehemaa	0	0	0
Cidaba	0	0	0
Dodzi	0	0	0
Abontem	20	16.3	3.7
Panaa	71.3	71.3	0

Factors predicting adoption of improved maize varieties

According to the results in Table 4, the Pseudo R2 value of 0.638 indicates that the model accounts for 63.8% of the variance in the outcome variable, which is a measure of the model's goodness of fit. This implies that the model has a relatively high degree of predictive power, indicating that the model's independent variables are good predictors of the outcome variable. In addition, the Log pseudo-likelihood value of -265.923 estimates the model's log-likelihood function.

The results also revealed that, in the study, 9 of the 15 variables were significant predictors of the adoption of improved maize varieties. These variables were the respondent's gender, educational status, farm size, farming experience, credit access, labor availability, access to extension, perceived high yield and seed availability.

Sex of respondent

According to Table 4, female farmers are less likely than male farmers to use improved maize varieties. When all other variables are held constant, the sex coefficient is -0.236, indicating that female farmers have a 23.6% lower chance of adopting improved maize varieties than male farmers. At p 0.05, the result is statistically significant, implying that the likelihood of obtaining this result is less than 5%. Gebre, et al., discovered that female-headed households were less likely than male-headed households to adopt improved maize varieties in Ethiopia. Similarly, Fisher and Kandiwa discovered in Malawi that female-headed households were less likely than male-headed households to adopt hybrid maize.

Education of respondent

When all other predictors are held constant, the coefficient for education is 0.085, indicating that a one-unit increase in education level is associated with a 0.085 increase in the odds of adopting improved maize varieties. The result is statistically significant (p 0.001), indicating that education has a non-random effect on adoption. According to Tesfaye, Bedada and Mesay, education is a significant predictor of the adoption of improved maize varieties in Ethiopia, with each additional year of education increasing the odds of adoption by 24%.

Farm size

The adoption of improved maize varieties is associated with larger farm size, according to the findings. When all other predictors are held constant, a one-unit increase in farm size is associated with a 0.042 increase in the odds of adopting improved maize varieties. The result is statistically significant (p 0.01), indicating that the relationship between farm size and adoption was not coincidental. The findings agree with those of Lunduka, Fisher and Snapp, who discovered that farm size was a significant predictor of the adoption of improved maize varieties in Malawi.

Farming experience

When all other predictors are held constant, the coefficient for experience is 0.031, indicating that a one-year increase in farming experience is associated with a 0.031 increase in the odds of adopting improved maize varieties. The result is statistically significant (p=0.001), indicating that prior adoption experience predicts future adoption. It should be noted that this finding is consistent with previous research on agricultural innovation adoption. For example, Kwarteng Amaning, Aidoo and Sarfo-Mensah discovered that farming experience was positively related to the adoption of improved maize varieties in Ghana. However, it is important to note that the influence of farming experience on adoption varies depending on context and other factors.

Credit access

Credit access has a -0.194 coefficient, indicating that farmers with credit are less likely to adopt improved maize varieties. The result is statistically significant (p=0.05), indicating that access to credit is a significant predictor of adoption. According to the findings, farmers' adoption of improved maize varieties is negatively impacted by credit availability. This means that farmers who have access to credit are less likely than farmers who do not to adopt improved maize varieties. The coefficient of -0.194 indicates that the effect is statistically significant at the 5% level, indicating that the observed relationship is not coincidental. This finding is consistent with the findings of Kafle's study on the determinants of improved maize variety adoption in developing countries, which discovered that farmers with access to credit were less likely to adopt improved maize varieties.

Labour availability

Labor availability is a significant predictor of the adoption of improved maize varieties, with a coefficient of 0.282 and a p-value less than 0.01. After controlling for other factors, an increase in labor availability increases the likelihood of adopting improved maize varieties. The findings are consistent with those of Udimal, et al., who discovered that the availability of family labor was a significant factor influencing the adoption of new crop varieties in Ghana.

Access to extension

When all other predictors are held constant, the coefficient for access to extension is 0.279, indicating that farmers with better access to extension services are more likely to adopt improved maize varieties. Access to extension services predicts adoption significantly (p=0.01).

This finding is consistent with Kassie et al., findings, who conducted a study on the determinants of technology adoption in Ethiopia and discovered that access to extension services was one of the most important predictors of adoption.

Perceived high yield

The perceived high yield coefficient is 0.421, indicating that farmers are more likely to adopt improved maize varieties if they believe they will yield higher yields. The result is statistically significant (p=0.001), implying that perceived high yield is a significant predictor of adoption. Farmers' perceptions of the profitability of improved maize varieties were found to be a significant predictor of adoption by Simtowe, et al.

Seed availability

The seed availability coefficient is 0.227, indicating that farmers with improved maize seeds are more likely to use them. The result is statistically significant (p 0.05), implying that seed availability is a significant predictor of adoption. The magnitude of the coefficient, however, varies depending on the context and the specific factors influencing adoption in each location. Mmbando and Baiyegunhi discovered in Ethiopia that access to credit and extension services were more important predictors of adoption than seed availability **(Table 4)**.

Table 4. Factors influencing the adoption of improved maize varieties by farmers.

Adoption	Coefficient	Std. Error	Z	P>|z|
Age of respondent	0.015	0.008	1.87	0.061
Sex of respondent	-0.236**	0.102	-2.31	0.021
Educational status of respondent	0.085***	0.013	6.52	0.001
Farm size	0.042**	0.016	2.63	0.009
Experience of respondent	0.031***	0.008	3.89	0.001
Credit access	-0.194*	0.081	-2.4	0.016
Farm ownership	0.078	0.087	0.89	0.373
Labour availability	0.282**	0.103	2.73	0.006
Household size	0.002	0.008	0.24	0.81
Access to market	0.124	0.082	1.52	0.128
Access to extension	0.279***	0.093	3	0.003
FBO membership	0.156	0.104	1.5	0.133
Perceived high yield	0.421***	0.087	4.85	0.001
Perceived ease of cult	0.125	0.097	1.29	0.197
Seed availability	0.227**	0.097	2.34	0.019
Constance	-0.867***	0.211	-4.11	0
Number of observations	400			
LR chi2 (17)	73.41			
Prob > chi2	0			
Pseudo R2	0.638			
Log pseudo-likelihood	-265.923			
Note: ***, ** and * denote that the variable is significant at less than 1%, 5% and 10% respectively				

Factors predicting dis-adoption of improved maize varieties

The results in Table 5 show that the model explains 57.6% of the variation in the dis-adoption of improved maize varieties, with a pseudo R2 value of 0.576. This indicates that the predictors are effective at explaining the outcome variable. The log pseudo-likelihood value of -301.55 indicates that the model fits well, as a higher value indicates a better fit and a lower value indicates a poor fit. The results also revealed that, of the 15 variables studied, 7 were significant predictors of dis-adoption of improved maize varieties. Respondent age, gender, farm size, farming experience, farm ownership, household size and seed availability were the variables studied.

Age of respondent

The age coefficient is positive, indicating that the dis-adoption of improved maize varieties increases with age. The coefficient is statistically significant at the 0.01 level, indicating that age is a significant predictor of dis-adoption. This finding agrees with the findings of Kurgat et al., who discovered that older farmers in Kenya were less likely to adopt new agricultural technologies such as improved crop varieties.

Sex of respondent

Because the sex coefficient is negative, females are less likely than males to reject improved maize varieties. The coefficient is statistically significant at the 0.01 level, indicating that gender is a significant predictor of dis-adoption. Gender effects on agricultural innovation adoption and disadoption, including improved maize varieties, have yielded mixed results in studies.

Farm size

The farm size coefficient is positive, indicating that larger farm sizes are more likely to be abandoned. The coefficient is statistically significant at the 0.01 level. It should be noted, however, that not all studies have found a link between farm size and dis-adoption. In Ghana, for example, Ehiakpor, Danso-Abbeam and Mubashiru discovered that smallholder farmers with larger farms were more likely than those with smaller farms to sustain the adoption of improved maize varieties. As a result, agricultural practice or technology and other factors such as access to information, credit and markets, the relationship between farm size and dis-adoption may differ.

Farming experience

Because the experience coefficient is negative, more experienced farmers are less likely to reject improved maize varieties. The coefficient is statistically significant at the 0.05 level. This finding is consistent with Ademiluyi's findings, which discovered that experience was a significant factor in the adoption of improved maize varieties in Nigeria. The authors contended that experienced farmers had more crop management knowledge and skills, making them better able to deal with any challenges associated with new technology.

Farm ownership

Farmers who own their land are less likely to reject improved maize varieties, according to the farm ownership coefficient. The coefficient is statistically significant at the 0.01 level. This finding is consistent with the findings of Hailu, Abrha and Weldegiorgis, who discovered that farm ownership was positively related to the adoption of improved crop varieties and the use of modern agricultural inputs in Ethiopia.

Household size

The household size coefficient is positive, indicating that larger households are more likely to be dis-adopted. The coefficient is statistically significant at the 0.01 level. This finding is consistent with Bensch, Grimm and Peters discovery that larger household sizes were associated with lower rates of technology adoption and use.

Seed availability

The seed availability coefficient is positive, implying that farmers who have better access to improved maize seeds are less likely to abandon them. The coefficient is statistically significant at the 0.05 level. This discovery is surprising because it contradicts the widely held belief that greater access to improved seeds leads to higher adoption rates. Farmers in Malawi who had access to subsidized maize seeds, according to Katengeza, Holden and Lunduka, were less likely to adopt drought-tolerant varieties. One possible explanation for this finding is that farmers with greater access to improved seeds may have higher expectations of them and are more likely to abandon them if they fail to meet those expectations. According to Sinyolo, farmers in South Africa who had higher expectations for the performance of improved maize varieties were more likely to adopt them **(Table 5)**.

Table 5. Factors predicting dis-adoption of improved maize varieties.

Dis-adoption	Coefficient	Std. Error	Z	P>|z|
Age	0.034	0.226***	2.66	0.001
Sex	-0.157	0.013**	-1.382	0.008
Education	-0.067	0.114	-2.695	0.167
Farm size	0.041	0.025**	2.532	0.007
Experience	-0.01	0.016*	-1.138	0.011
Credit access	-0.221	0.009	-2.578	0.255
Farm ownership	-0.035	0.086**	-0.347	0.01
Labour availability	0.236	0.101	2.593	0.728

Household size	0.024	0.091**	1.31	0.01
Access to market	-0.082	0.018	-0.766	0.19
Access to extension	0.15	0.107	1.4	0.444
FBO membership	-0.112	0.107	-1.293	0.162
Perceived high yield	0.123	0.087	1.348	0.196
Perceived ease of cultivation	-0.191	0.091	-1.974	0.178
Seed availability	0.217*	0.097	2.526	0.048
Constance	-1.456***	0.226	-6.445	0.001
Number of observations	400			
LR chi2 (17)	62.93			
Prob > chi2	0.001			
Pseudo R2	0.576			
Log pseudo-likelihood	-301.55			
Note: ***, ** and * denote that the variable is significant at less than 1%, 5% and 10% respectively				

CONCLUSION

Maize varieties that have been improved have the potential to increase maize production productivity and profitability in Ghana's Northern Region. While some maize varieties are known to all farmers, others varieties are not known to them, because of several reasons related to awareness, access and adoption dynamics within agricultural communities. Finally, farmer adoption of improved maize varieties varies greatly, with some varieties being widely adopted while others receiving little or no adoption. Obatanpa has the highest adoption rate, indicating that farmers recognize its importance. Dadaba's adoption rate is low, which could be attributed to high demand of fertilizer to produce quality yield. The high rate of dis-adoption Mamaba, Aburohemaa, Obaatan and Panaa indicate that they performed well in local conditions or were promoted and recommended by extension agents or other farmers. The study also concluded that respondents' gender and educational status, farm size, farming experience, credit access, labor availability, access to extension services, perceived high yield and seed availability all influenced the adoption of improved maize varieties.

The study recommends that, the government, through the Ministry of Food and Agriculture, should focus on promoting the benefits of less commonly used and abandoned maize varieties, such as Dadaba and educating farmers on how to sustain their adoption for longer periods. Furthermore, seed companies and other stakeholders should work together to ensure that seeds of less commonly used and abandoned maize varieties are easily accessible to farmers, facilitating farmer adoption.

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