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Socioeconomic factors considered in adoption and use intensity of certified groundnut seed in Northern Ghana: Cragg's double-hurdle model approach

Dominic Tasila Konja[1]*, Franklin N. Mabe[2] and Michael Ayamga[2]

[1]Department of Applied Economics, School of Applied Economics and Management Sciences, University for Development Studies, Nyankpala Campus, Ghana, Ghana.
[2]Department of Agricultural and Food Economics, Faculty of Agricultural, Food and Consumer Sciences, University for Development Studies, Nyankpala Campus, Ghana, Ghana.

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Groundnut production is a major economic activity of smallholder farmers in Northern Ghana. However, these farmers face production losses through Aflatoxin infestation and bad weather conditions which require the use of right planting materials by farmers. This study seeks to analyze determinants of certified groundnut seed (CGS) adoption in Northern Ghana. A multi-stage sampling technique was used to collect cross-sectional data from 250 smallholder groundnut farmers. The Cragg's double hurdle regression model was used to analyze factors that affect farmers' decision to adopt CGS and its adoption intensity. The factors that affect farmers' adoption decision of CGS include, sex of farmer, membership of farmer-based organization (FBO), extension service, price of groundnut seed, distance to output market, distance to input market, and form of groundnut produce sale. The factors that predict farmers' adoption intensity of CGS include; sex of farmer, household size, education, extension service, previous income from groundnut, price of groundnut seed, distance to output market, distance to input market, and form of groundnut produce sale. The study recommends that Ministry of Food and Agriculture (MoFA) should intensify extension service delivery and promotions on CGS. Farmers should endeavour to join farmer-based organizations and village savings and loan associations to enable them get necessary information capacity to acquire CGS. Farmers should take advantage of planting for food and jobs so as to have access to CGS.

Key words: Certified groundnut seed, adoption intensity, Cragg's double hurdle model, Northern Ghana.

INTRODUCTION

Groundnut (*Arachis hypogaea* L) is an annual leguminous crop which requires less rain and has therefore become the preferred crop grown in semi-arid regions of the world. The average annual production of groundnut in Ghana between the years 2016 and 2018 is 460.21Mt, with a growth rate of 3.28% (Ministry of Food and Agriculture (MoFA), 2019).

Most of groundnut produced in the country is cultivated

*Corresponding author. E-mail: konjadominic@gmail.com.

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in the Northern, Upper East, and Upper West regions of Ghana. The Northern Ghana has a comparative advantage at producing groundnut in the country, however, the incidence of poverty and food insecurity is rampant relative to other regions in the country (Ghana Statistical Service (GSS), 2020). Groundnut is a cash crop and an improvement in its production could be used as an avenue to improve the livelihood of households in Northern Ghana. Despite the recognition of groundnut as a cash crop with the potential to alleviate poverty in Northern Ghana, it is evident that obtained yield per hectare is inadequate. According to MoFA (2019), the average yield of groundnut for the country in 2018 was 1.63Mt/ha and this figure is substantially lower than the potential national yield of 3.50 Mt/Ha.

Low productivity of groundnut can be ascribed to numerous factors including, poor-quality seeds, low yielding varieties, pest and diseases, poor agronomic practices, and poor farm management in Sub-Saharan Africa (Tanzubil, 2016, Ross and Klerk, 2012; Mukuka and Chisanga, 2014). In Ghana, the major constraint to groundnut production includes diseases particularly, early and late leaf spots diseases, which are widely distributed and occur in epidemic proportions in Northern Ghana (Thakur, 2014). Aflatoxin and leaves defoliation have also reduced the quality and the yield of groundnut in the North and Ghana at large. The contamination of Aflatoxin also seems to be the major constraint for Ghana groundnut export market especially to Europe and America (International Crops Research Institute for the Semi-Arid Tropics [ICRISAT, 2016]). Aflatoxin is mostly spread through groundnut seeds, meaning the use of Certified Groundnut Seed (CGS) will significantly reduce its incidence (Oyedele et al., 2017; Bankole and Adebanjo, 2003).

Productivity in groundnut production is highly linked to the type and source of seed used. Seed carries the genetic potential of the variety and determines the ultimate productivity of other inputs.

A continuous production of groundnut is extremely hindered by both biotic and abiotic factors. The most common biotic constraints comprise of the white grubs, millipedes, leaf hoppers, leaf spots, virus diseases, and termites (Owusu-Akyaw et al., 2014). Several studies on groundnut have affirmed that yield losses are mostly caused by soil arthropods in sub-Saharan Africa. In Africa, about 10 to 40% of groundnut losses in production are attributed to soil arthropods damages and this situation is similar for Ghana (Umeh et al., 1999; Johnson et al., 1981). Low kernel yields of groundnut have partly been ascribed to low soil fertility caused by unsuitable cropping systems (Golden Valley Agriculture Research Trust (GART), 2011), and use of low yielding varieties (Mukuka and Chisanga, 2014) which are prone to rosette disease and pests (Ross and Klerk, 2012). Groundnut rosette disease, early leaf spot, late leaf spot and rust are the major biotic constraints responsible for low yield of groundnut in Nigeria (Ajeigbe et al., 2014). Groundnut production in Ghana is also constrained by both early and late leaf spots diseases (Nutsugah et al., 2007).

Nigeria leads in the production of seed with 22,684.7 Mt and followed by Ethiopia (15,833.0 Mt), Uganda (14,600.8 Mt), Burkina Faso (3,543.1 Mt), Ghana (1,356.5 Mt), Tanzania (8,283.6 Mt), Mozambique (3,158.6 Mt) among others (AGRA, 2014). Meanwhile, not many countries have adequately addressed the question of providing farmers sufficient quantities and good quality seed. Many countries in Africa for example, annual seed demand exceeds production. In Ghana, the following improved groundnut varieties have been released over the years: Mani pinta (1986), Shi Tao Chi (Chinese) (1980), F-mix (1986), ICGS 114 (Sinkarzei) (1989), Endorpo Munikpa- SARGV (2005), Nkatiesari-SARGV (2005), Gusie-Balin-ICGV 92099 (2005), Kpaneli–ICGV 90084 (2005), Nketia SARI (2017), Yeny awoso (2017) and Samnut-22 (2017) (ICRISAT, 2017). The use of these improved groundnut varieties coupled with good management practices could be key to improving productivity in production (Irmansyah et al., 2017; Siringo et al., 2018; Rahman and Sakya, 2019). Irrespective of the release of these improved varieties, many farmers are still using local varieties. The exponential growth of the world's population is an apprehension to countries to find productive technologies that can increase food production to feed households globally. One of the effective ways is an increased usage of improved planting materials such as improved and certified seeds varieties. Improved seed varieties are one of the determinants that affect the productivity of groundnut (Irmansyah et al., 2017; Siringo et al., 2018; Rahman and Sakya, 2019). In Ghana, certified groundnut seed use is still low and this has incited researchers and policy makers to wander about likely cause of low use of certified groundnut seed. Also, there is a limited empirical study on socioeconomic factors likely to influence intensity of CGS use in production. Due to this argument, this study seeks to assess the socioeconomic factors that influence farmers' decision to adopt CGS in Northern Ghana where huge production is done.

MATERIALS AND METHODS

Study area

The above map shows the regions and districts sampled for this study. This research was carried out in Northern Ghana. This part of the country comprises of the northern, upper east, and upper west regions; however, this study sampled the first two regions (Figure 1). The northern regions are the driest regions in Ghana, owing to its proximity to the Sahara Desert and the Sahel region. The climate is hot and dry, with one rainy season. Agriculture, hunting and forestry are the main economic activities. The annual rainfall varies between 750 mm and 1050 mm. About 73% of households in northern Ghana are Smallholder farmers who cultivate approximately five acres (Dapilah and Nielsen, 2019; Ghana Statistical Service (GSS), 2019).

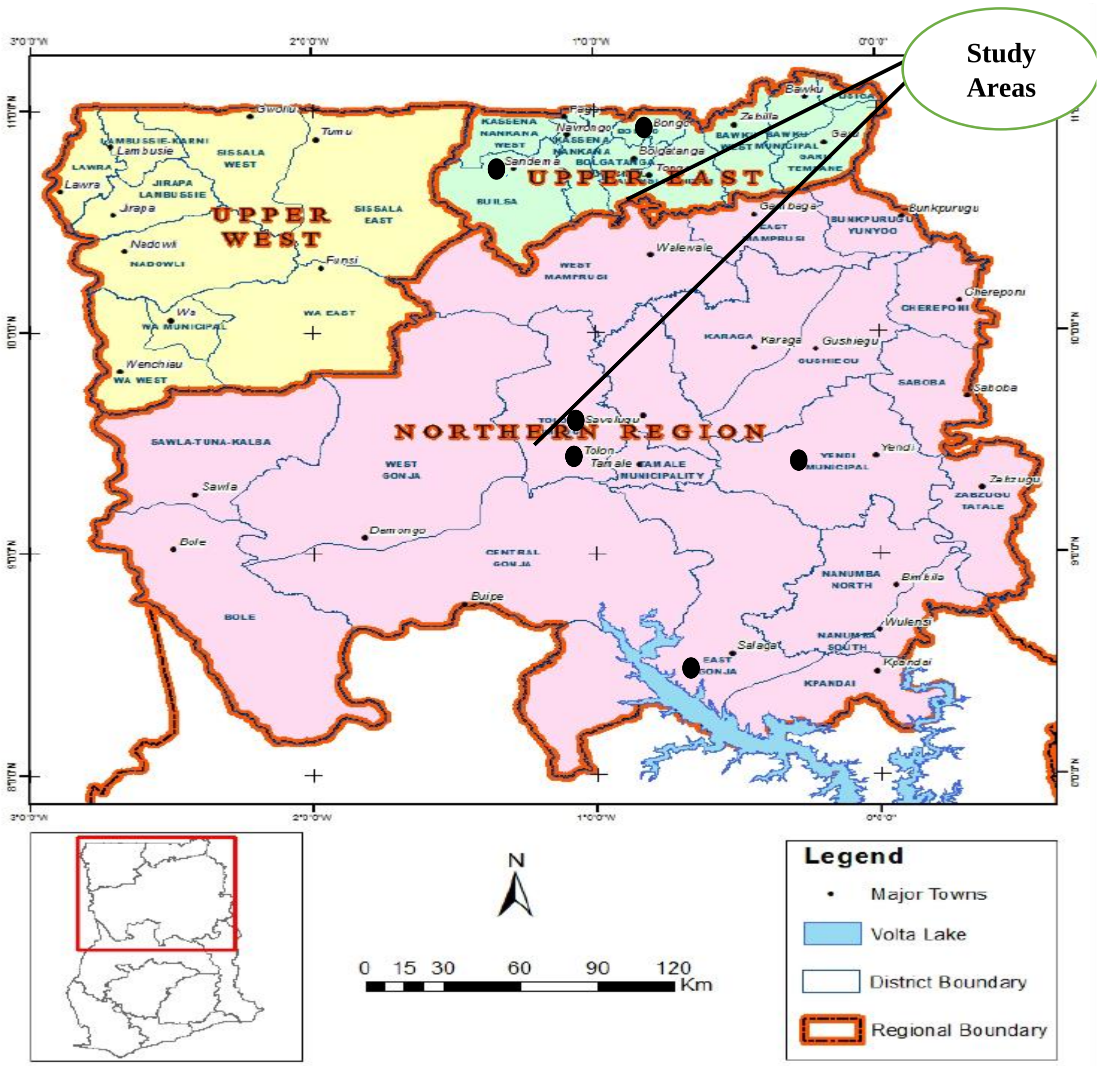

Figure 1. The Map of Northern Ghana.
Source: https://www.google.search?q=map+of+northern+ghana

Data collection, sampling procedure and sample size

The study collected cross sectional and primary data from groundnut farm households. A five-stage sampling technique was employed. In the first stage, northern region and upper east regions were randomly selected from Northern Ghana.

In the second stage, districts within the selected regions were clustered into two (that is, districts with average groundnut production figure less than 6000 Mt and figure greater or equal to 6000Mt) using information from Ministry for Food and Agriculture of Ghana. In the third stage, whilst four districts (that is, Tolon, Savelugu, Yendi, and East Gonja) were randomly selected from the northern region, two districts (that is, Sadema and Bongo) were also randomly selected from the upper east region. These six districts were randomly selected from the cluster of districts with average groundnut production figures greater or equal to 6000 Mt. In the fourth stage, random sampling was employed to select two communities each from the sampled districts. In the last stage, between 15 and 25 households producing groundnut were randomly selected from sampled districts such that every household has the chance of being included. The study used a sample size of 250 households.

Adoption intensity of CGS and its driving factors

Adoption intensity of CGS is expressed as the ratio of acres of land planted with CGS to total size of groundnut farm in acres. Adoption intensity of certified groundnut seed can be calculated as follows:

$$Y_i = \frac{Acres\ of\ CGS\ planted\ by\ ith\ farm\ household}{Total\ size\ of\ groundnut\ farm\ by\ ith\ farm\ household\ in\ acres} \quad (1)$$

Where, Y_i is the proportion of land area planted with CGS (signifying the extent or adoption intensity of CGS).

To analyse factors that influence households' adoption intensity of CGS, the Cragg's Double Hurdle Model (DHM) was employed. Groundnut farmers' decision to adopt CGS and adoption intensity is two separate decisions. These two decisions are closely connected but do not exactly follow the same data generation process. These two decisions of farm households are determined by two separate stochastic processes, where two equations incorporate the effects of explanatory variables (Cragg, 1971). The first hurdle of the Cragg's Double Hurdle Model is a probit regression model (PRM). The PRM was employed to identify the factors that influence farm households' decision to adopt CGS. This model is used when we want to predict the presence or absence of an outcome based on a set of explanatory variables. PRM has a dichotomous dependent variable which is modelled against various explanatory covariates specified as:

$$E_i = \alpha Z_i + \mu_i \quad (2)$$

Where: E_i is a dichotomous outcome variable, which takes the value of 1 if a farm household used CGS and 0 if otherwise. α denotes the vector of parameters to be estimated, Z_i is a vector of covariates, and μ_i represents the error term which is normally distributed with zero mean and constant variance.

The second hurdle of the Cragg's Double Hurdle Model is an outcome equation which uses a Tobit regression model (TRM) to analyze factors that predicts farm households' adoption intensity of CGS. With the second hurdle model, the information on both sides of the truncated model concerning farmers who did not adopt CGS is lost. The truncated regression model which is closely connected to the Tobit model is specified as:

$$Y_i^* = X_i\alpha + v_i \quad (3)$$

The log-likelihood function for the double-hurdle model following Greene (2000) is:

$$L = \prod_{Y_i} = \left[1 - \Phi(z_i'\alpha)\Phi(\frac{x_i'\beta'}{\sigma})\right] + \prod_{Y_i \succ 0}\left[\Phi(z_i'\alpha)\frac{1}{\sigma}\phi(\frac{y_i - \beta' x_i'}{\sigma})\right] \quad (4)$$

Where: Φ and ϕ represent the standard normal cumulative distribution function and density functions, respectively. The first part on the right-hand side of equation (4) represents the log-likelihood for a probit model, whereas the second part represents the likelihood for a truncated regression, with truncation at zero. As a result, the log-likelihood from the double hurdle model is the addition of log-likelihood functions from probit model and a truncated model. The empirical model of the truncated Tobit model is specified as shown below:

$$Y_i = \begin{bmatrix} \alpha_0 + \alpha_1 Sex_i + \alpha_2 Age_i + \alpha_3 Hhs_i + \alpha_4 Msta_i + \alpha_5 Edu_i + \alpha_6 Exp_i + \alpha_7 Ext_i \\ + \alpha_8 TFms_i + \alpha_9 SeedPx_i + \alpha_{10} Mob_i + \alpha_{11} \text{SaleFom}_i + \alpha_{12} Trans_i + \alpha_{13} PI_i \\ + \alpha_{14} DinputMkt_i + \alpha_{15} DoutputMkt_i + \alpha_{16} Credt_i + \alpha_{17} FBO_i + u_i \end{bmatrix} \quad (5)$$

Where: Y_i depends on the latent variable Y_i^* in equation 3 above. Table 1 depicts the description, measurement and expected signs of the explanatory variables in the truncated regression model.

RESULTS AND DISCUSSION

Summary statistics of variable

Table 2 presents the summary statistics of variables. The statistical t-test was used to validate the hypothesis that there are significant differences in the socioeconomic variables between users and non-users of CGS. The study shows that there is no significant difference of age and household size among users and non-users of CGS. Apart from number of males and females disaggregated by use and non-use of CGS respectively which are statistically significant at 10%, all the other variables in the table are statistically significant at 1%. The result indicates that majority (66%) of male farmers did not adopt CGS. The study noted that, about 46% of female farmers used CGS. It was also revealed that farmers with a mean farm size of 1.7 acres used CGS whilst those with a mean farm size of 2.1 did not. Etwire et al. (2016) also observed that farmers who did not adopt improved maize varieties had significantly large farm sizes (4.2 hectares) as compared to farmers who have adopted (3.1 ha). This means that farmers with small farm size are likely to adopt CGS relative to those with larger acreages.

It was also indicated in Table 2 that users of CGS had a greater number of extensions visits than non-users showing 2 and 1 number of times respectively. This connotes that; frequent contact of extension agents may increase their likelihood of adopting CGS. In the same vein, users of CGS had more number of FBO meetings than non-users (3 and 1 number of times respectively). This also implies that being a member of FBO increases a farmer's chance of using CGS in the study area. This study also found that 39% of groundnut farmers who were aware about the existence of CGS grew it whilst 32.8% did not. This confirms the importance of public advocacy on the existence of CGS on the market to increase its adoption in the study area.

As shown in Table 2, farmers who cultivated CGS sold large quantity of their output (220.9 kg) than their counterparts (158.0 kg). This means that, CGS producers are more market oriented than their counterparts who use local seeds.

From the table, farmers who cultivated CGS tend to consume more of their output (42.6 kg) than their counterparts who consumed an average of 36.2 kg of local groundnut. Also, groundnut farmers who cultivated CGS obtained higher output (337.9 kg) than their counterparts (251.9 kg). This means that, the yield of CGS is higher than local groundnut in production. Again, as farmers who cultivated CGS got higher revenue per acre (GH¢ 1330.9/acre), their counterparts who used recycled seeds obtained lower revenue per acre (GH¢ 822.8/acre). This means that, if groundnut farmers adopt CGS in production their income level would improve. It was noted that, groundnut farmers who travel longer distance (averagely 53.4 km) to input markets rather tend to cultivate CGS more than those who travel short distance (averagely 25.0 km). This could be ascribed to the fact that, NGOs and projects that provide inputs often deliver them to the farmers in their communities so farmers do not have to travel long distances to access them.

Determinants of use and adoption intensity of CGS

The Cragg's double hurdle model was used to estimate

Table 1. Definition and measurement of the explanatory variables.

Variable	Description	Measurement	Expected sign	
			1st hurdle	2nd hurdle
E_i	Decision to adopt CGS	1 if a farmers used CGS and 0 if otherwise		
Y_i	Adoption intensity of CGS	Ratio of acres of CGS to total acres of groundnut farm		
Household specific characteristics				
Age	Age of household head	Number of years	+/-	+/-
Msta	Marital status of household head	Dummy = 1 if married and 0 if otherwise	+	+
Sex	Household head's sex	Dummy = 1 if male and 0 if female	+/-	+/-
Edu	Household head's educational status	Dummy = 1 if educated and 0 if not educated	+	+
Hhs	Household's number of persons who assist on the farm	Number of persons	+	+
Exp	Household's experience in CGS farming	Number of years	+	+
Private asset variable				
TFms	Total farm land of the household	Acreage	+	
Mob	Mobile phone ownership of household head	Dummy = 1 if owned; 0 if not owned	+	+
Public social capital variable				
Ext	Household's access to extension services	Dummy =1 if accessed; 0 = not accessed	+	+
Credt	Households' access to credit	Dummy =1if accessed; 0 = not accessed	+	+
FBO	Household's membership of farmer-based organisation	Dummy =1 if a member; 0 = not a member	+	+
Transaction cost variable				
Trans	Households' access to transport means to market	Dummy =1 if accessed; 0 if not accessed	+	+
DoutputMkt	Distance between farmers' residence to output market	Kilometres (km)	+	+
DinputMkt	Distance between farmers' residence to input market	Kilometres (km)	+	
SaleFom	Groundnut form of sale	Dummy = 1 if shelled; 0 if otherwise	+/-	+/-
SeedPx	Price of 1kg of certified groundnut seeds	Ghana cedis (GH¢)	-	-
PI	Previous income from groundnut	Ghana cedis (GH¢)	+	+

Source: Authors' own design

the magnitude and direction of determinants of farmers' decision to use adoption intensity of CGS**.** The significant Wald chi-square value of 328.28 indicates that the explanatory variables jointly influence the farmers' decision to use adoption intensity of CGS. From Table 3, factors such as sex of farmers, FBO membership, extension service, price of groundnut seed, distance to output market, distance to input market and form of groundnut sale significantly affect farmers' decision to adopt CGS. The adoption intensity of CGS was predicted by sex of farmers, household size, education, mobile phone ownership, extension service, price of groundnut seed, income from previous year, distance to output market, and form of groundnut sale.

The result shows that sex of farmers was statistically significant 5% and negatively affects farmers' decision to adopt CGS. The negative association implies that male farmers are less likely to adopt CGS compared to females. Awotide

Table 2. Summary statistics of variables.

Variable	Mean		
	Users	Non-users	Difference
Household characteristic			
Age (years)	42.32	40.61	1.71
Female (n=125)	45.6	54.40	-8.80*
Male (n=125)	34.40	65.60	-31.20*
Household size	8.44	7.44	1.00
Years in education	2.75	2.44	0.31
Farm size (acres)	1.70	2.12	-0.42***
Public assets/ social capital variable			
Number of FBO meetings	3.40	0.78	2.62***
Number of extension meetings	2.03	0.62	1.41***
Awareness of CGS (%)	39.20	32.80	6.40***
Transaction cost variable			
Quantity of output sold (kg)	220.68	158.01	62.67***
Quantity of output consumed (kg)	42.57	36.17	6.40***
Quantity of output (kg)	337.58	251.90	85.68***
Total revenue from produce (GH¢)	1330.89	822.76	508.13***
Distance to input market (km)	53.44	24.95	28.49***

*** Significant at 1%, * Significant at 10% respectively. Absence of star (*) on a variable indicates no significance.
Source: Field survey, (2018).

et al. (2014) also found similar result in their study on assessing the extent and determinants of adoption of improved cassava varieties in south-western Nigeria. was statistically significant at 10% and negatively affects farmers' adoption intensity of CGS. The implication is that increasing household size reduces the area allocated to CGS. This could be that farmers with larger household sizes allocate much of their households' income on consumption which reduces their capacity to buy and use CGS. This result is consistent with Awotide et al. (2014) and Kuti (2015) who revealed an indirect relationship between household size and adoption of certified rice seed in Nigeria. Similarly, Jaleta et al. (2013) research also found that smaller household size increases adoption of maize varieties in Ethiopia. Contrary, Legese et al. (2009), and Kassie et al. (2010) found out that household size and adoption of improved technologies were directly related.

Education was significant at 10% and positively influences the adoption intensity of CGS. This means educated farmers are more likely to intensify the use of CGS compared to the uneducated farmers. Educated farmers are able to diagnose and observe the benefits of CGS and allocate more acres of their farm land for its cultivation. The finding is consistent with Asfaw et al. (2012), Bruce et al. (2014), Ghimire et al. (2015), and Kumar et al. (2016), who found significant and positive relation between education and adoption of new rice

Contrary, in the second hurdle, male farmers are more likely to increase their adoption intensity of CGS than females and this is significant 10%. Household size technologies. Farmer-based organization (FBO) membership was significant at 1% and directly affects the decision of farmers to adopt CGS. This indicates that farmers who belong to farmer-based organizations are more likely to adopt CGS than their counterparts. Such farmers are more likely to have information regarding new technologies, improved seeds and inputs, which influence them to adopt them. This finding agrees with that of Danso-Abbeam et al. (2017), Kwarteng et al. (2019), and Mmmbando and Baiyegunhi (2016). Mobile phone ownership was significant at 5% and negatively influences the adoption intensity of CGS. This connotes that farmer who owned mobile phones are less likely to adopt CGS relative to their counterparts.

The use of mobile phones could have been a medium to transmit agricultural and market information to farmers to increase awareness of new technology and market efficiency. However, this finding could be that such initiative is currently not available to groundnut farmers in the study area.

The coefficient of extension service was significant at 1% and positively affects the decision of farmers to use adoption intensity of CGS. This implies that farmers who have access to extension service are more likely to increase their decision to use and adoption intensity of

Table 3. Determinants of use and adoption intensity of CGS: Double hurdle model.

Variable	First hurdle		Second hurdle	
	Coefficients	Standard Error	Coefficients	Standard Error
Age (years)	0.016	0.02	0.006	0.005
Sex (male)	-0.867	0.433**	0.184	0.115*
Marital status (married)	-0.329	0.437	-0.052	0.113
Household size	0.002	0.051	-0.022	0.012*
Education (educated)	0.366	0.411	0.185	0.103*
FBO Membership (member)	2.8	0.540***	-0.201	0.238
Mobile phone ownership (owned)	0.254	0.501	-0.317	0.153**
Extension (accessed)	1.243	0.445***	0.263	0.102***
Credit (accessed)	-0.485	0.677	0.207	0.193
Farming experience (years)	-0.003	0.017	0.001	0.005
Previous income from groundnut farm (GH₵)	0.008	0.007	-0.003	0.001***
Price of groundnut seed (GH₵)	-0.103	0.038***	0.031	0.007***
Access to transport (accessed)	-0.009	0.395	0.131	0.11
Distance to output market (Km)	0.115	0.036***	-0.029	0.009***
Form of groundnut sale (shelled)	0.964	0.341***	0.437	0.080***
Distance to input market (Km)	0.033	0.010***	-	-
Farm size (acres)	-0.057	0.241	-	-
Constant	-1.454	1.565	0.011	0.393
Insigma_constant	-0.927	0.071***		
Number of obs.	250			
Wald Chi-squared (15)	328.28			
Pseudo R2	0.1356			
Log likelihood	43.118			
Prob.>Chi2	0.000			

*, ** and *** significant at 10, 5 and 1% respectively.
Source: Field survey, 2018.

CGS than those without. Farmers who have regular contacts with extension agents are more enlightened through advisory services on new technologies, hence, influence them to adopt and use.

Regular contacts with extension agents help in the transmission of message about the existence of new technology, its usage and benefits from the producers to the adopters (Mwangi and Kariuki, 2015; Kwarteng et al., 2019). Similarly, participation in extension training programmes has been identified to influence technology adoption positively (Monfared, 2011). Previous income from groundnut farm did not meet the expected result. The sign of the coefficient suggests that the propensity of farmers to increase the use of intensity of CGS in production diminishes whenever households' income from previous groundnut production reduces. Farmers in Ghana mostly use retained seeds from previous harvest as planting material for the next season and only purchase improved seeds again when they figure out that the retained seeds are losing its productive potency. Moreover, most farmers divert their household income realized from crop production into non-farm businesses which reduce their likelihood to invest in agriculture the next season. This finding is consistent to Danso-Abbeam et al. (2017) who also found that previous income from maize production affects adoption intensity of improved maize seed negatively.

Price of groundnut seed was 1% significant and inversely and directly influences farmers' decision to adopt and intensify the use of CGS respectively. This implies that, whilst farmers' decision to adopt CGS reduces as its price increases, it is otherwise for the extent of usage. Similarly, Kalinda et al. (2013) also found that high cost of technology hinders the adoption of new agricultural technologies. In the same vein, Gecho and Punjabi (2011), found that price of seed has an inverse relationship with farmers' decision to adopt. However, Anim and Mandleni (2012) found that technology adoption comes with cost; however, farmers are always willing to adopt and increase the extent of use on condition that the technology has the ability to increase productivity.

Distance to output and input markets respectively were statistically significant at 1% and revealed an inverse relationship with the decision of farmers to adopt CGS. The results imply that farmers whose residence are far from output and input markets respectively are more likely to adopt CGS than their counterparts. The sign of their coefficients does not conform to the authors expected result but consistent with the finding of Abegunde et al. (2018) research on adoption intensity of certified rice seed in Nigeria. This could be attributed to the fact that, non-governmental organizations (NGOs) and projects that provide inputs and buys output after harvest do that in the communities of farmers without the need of farmers to travel long distance to access them. As expected, in the second hurdle, distance to output market was statistically significant at 1% and inversely influences the extent of CGS usage in production. This implies that, households whose residence is far from the output market are less likely to increase the adoption intensity of CGS than their counterparts. Longer distance of output market to farmers' residence increases marketing cost which diminishes their financial capacity to intensify the use of CGS in production. Form of groundnut sold was statistically significant at 1% and directly influences farmers' decision of adoption and use intensity of CGS. The study noted that farmers who sold their groundnut produce in the shelled form are more likely to increase their decision to adopt and use intensity of CGS respectively. There is value addition to shelled groundnut relative to the unshelled and this relieves buyers from spending time and money for shelling. Due to value addition to shelled groundnut, farmers obtain higher prices and households' income from sale to enable them patronise production inputs.

Conclusion

There are several of studies conducted on improved crop seed adoption and adoption intensity in Africa. However, most of these studies concentrated on other crops rather than groundnut. Meanwhile, groundnut farmers face production losses through Aflatoxin infestation and bad weather conditions such as heavy down pours, delay rains and drought which require the use of right planting materials. Therefore, this study was conducted to identify the determinants of certified groundnut seed (CGS) adoption and use intensity in Northern Ghana. The result indicates that, factors that significantly affect farmers' decision to adopt CGS includes; sex of farmer, membership of farmer-based organization (FBO), extension service, price of groundnut seed, distance to output market, distance to input market, and form of groundnut produce sale. Also, the factors that predict farmers' adoption intensity of CGS include; sex of farmer, household size, education, extension service, previous income from groundnut farm, price of groundnut seed, distance to output market, distance to input market, and form of groundnut produce sale.

Recommendations

The study recommends that Ministry of Food and Agriculture (MoFA) should intensify extension service delivery and promotions on CGS. Farmers should endeavour to join farmer-based organizations and village savings and loan associations to enable them get necessary information capacity to acquire CGS. Farmers should take advantage of planting for food and jobs so as to have access to CGS.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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