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Determinants of Improved Groundnut Varieties Adoption among Farmers in Northwest Nigeria

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Abstract:
Given their proven, financial and environmental benefits, such as increased production and income for farmers, the adoption of improved groundnut varieties among farmers in sub-Saharan Africa remains small. Groundnut is Nigeria's primary export commodity, rendering Nigeria the fifth largest producer in the world, accounting for 50% of Africa's needs and 30% of global needs. To date, however, minimal studies have been undertaken to analyze the degree to which new groundnut varieties have been embraced, in particular in sub-Saharan Africa. The research, therefore, looked at the determinants of the adoption of improved groundnut varieties among farmers in Northwest Nigeria through the technical skills of extension officers, mobile extension networks, and extension methods. Primary survey results were collected from 339 farmers from four northwestern states in Nigeria using purposeful and random sampling techniques. Data is evaluated using descriptive statistics and multiple regression approaches. The findings indicate that the adoption by farmers of improved groundnut varieties is significantly related to the technical skills of extension agents, the usage of radio as an extension tool, and group and individual extension methods. The group extension approach provides the most significant contribution to the adoption of improved groundnut varieties. It is therefore essential to provide regular training of extension agents on suitable extension teaching methods, which will include ample awareness of the characteristics of the different strategies and the ability to familiarize themselves with the characteristics of the respondents, thereby promoting the selection of correct methods for

each community of farmers. Programs aimed at growing the ability of extension staff in various capabilities should be put in motion for the efficient transition of technology to farmers.
Keywords: Technology adoption; Improved varieties of groundnuts; Farmers; Northwest Nigeria.

1.0 Introduction

The adoption of improved crop varieties is essential for the agricultural growth, food security and income, especially among smallholder farmers in developing countries (Asfaw et al., 2012; Ghimire et al., 2015; Chandio & Yuansheng, 2018; Rattunde et al., 2013). Better crop varieties have early ripening times, are immune to disease and drought, experience lower development costs and produce strong yields, which are crucial to substantially decreasing deprivation by increased incomes and farmers' welfare (Byerlee et al., 2011). In Mexico, for example, the average income of adoptors of better maize varieties was around 136 Mexican pesos higher. Than the non-adopters (Becerril & Abdulai, 2010). The implementation of improved maize varieties in Ethiopia has cut production costs by an average of 26.4% per kg of maize (Kassie et al., 2018). Acceptance of enhanced cowpea varieties in Nigeria improved household income and property ownership by 17 per cent and 24 per cent, respectively, and decreased deprivation by an average of 5 per cent (Manda et al., 2019). Adopting better crop varieties further decreases the risk of chronic food shortages, resulting in higher production growth, higher household income rates and the probability of residing in less deprivation, as well as having a positive effect on household welfare. Besides, the cost-benefit study showed that the introduction of hybrid crop varieties would result in lower production costs (Amare et al., 2012; Danso-Abbeam, 2017; Ali & Rahut, 2018).

Given the advantages of improved crop varieties, acceptance among farmers is still weak throughout the least developed and emerging countries and regions. The total production of groundnuts in Africa is 668 kg/ha, way below the global level of 1602 kg/ha (Food and Agriculture Organization Corporate Statistical Database or FAOSTAT, 2011). The overall rate of acceptance of improved grain legumes across sub-Saharan African countries is 41.42% compared to 58.58% of non-improved legumes, according to Van Heerwaarden (2018). In Ethiopia, the rate of adoption of maize seed increased by just 23 per cent (Ahmed et al., 2017). The uptake and effect analysis of new groundnut varieties reported an uptake rate of 31 per cent in Nigeria (Ndjeunga et al., 2013). Groundnut pod yields from farmland in Kano, Nigeria remained small at an estimate of 1082 kg/ha relative to an on-site yield of 3000 kg/ha (Shuaibu, 2018). Likewise, a survey conducted by Rekwot et al. (2015) in Nigeria found that the yield of farmers (800 kg/ha) was far below the expected on-site production of 3000 kg/ha. In order to resolve the issue of low adoption of improved groundnut varieties among farmers, the Nigerian Government has partnered with the Agricultural Development Programs (ADPs) as the country's extension nexus to promote the adoption of improved groundnut varieties. Also, the project promotes SAMNUT 21-26 varieties, which have many benefits over conventional varieties in terms of improved yields of an average 2–2.5 tons/ha compared to less than 1 ton/ha; animal feed of approximately 2.5–3 tons/ha; early maturity of 80–95 days compared to 120 days obtained by other varieties; and higher oil content of approximately 45 per cent fat (Samuel & Ocholi, 2017). Nonetheless, the performance of the scheme needs an appreciation of the factors that affect the decision of the farmers to adopt the promoted improved seeds. The decision to incorporate agricultural innovations, like better crop varieties, involves a scientific process that is influenced by multifaceted forces (Rogers, 1995).

According to Meijer et al. (2019), the knowledge, attitudes and perceptions of farmers on the benefits and difficulties of technology play a crucial role in their decision-making, as well as their socio-economic characteristics, the capacity of extension officers, strategies of extension of transmission and means of dissemination of knowledge. It is therefore vital to investigate the determinants of the acceptance of improved groundnut varieties to achieve better yields and enhance the livelihoods of farmers.
This paper, therefore, discusses the research void alluded to and extends the literature in this field by addressing the motivating factors for the adoption of improved groundnut varieties, which rely on the socio-economic and demographic expansion of farmers in Northwest Nigeria. Little empirical research has been performed in Nigeria on the determinants of the acceptance of improved groundnut varieties (Ekunwe et al., 2013; Muhammad, 2015; Rakwot, 2015; Olayide et al., 2018). The main disadvantage to these studies is that they have all been carried out in one area of study and, as a result, the information for broader inference or generalization is lacking. The present work is also regionally focused, spanning four states of Northwest Nigeria that may accurately be used for inferences or generalizations. Past experiments have also utilized various factors, such as the technical capabilities of extension agents, radio transfer of information, individual and group extension methods, and the socio-economic concerns of the farmers in order to examine the degree and significance of the determinants for the adoption of improved groundnut varieties. Few of the recent reports on the adoption of enhanced groundnut varieties have merged these factors with extension agents and farmers who are main participants in the adoption of technologies.
The next segment addresses the main reasons for the introduction of agricultural technology. The study method is defined in Section Three, and Section Four discusses the results of the research and, finally, Section Five introduces the review, suggestions and conclusions.

2.0 Literature Review

Several studies have examined factors influencing the adoption of improved crop varieties, including the socio-economic characteristics of farmers, farm characteristics, technological characteristics and environmental and institutional effects (Table 1). Accurate details on the possible benefits of enhanced groundnut varieties can affect their acceptance (Amare et al., 2012; Grabowski et al., 2012; Timu et al., 2014). Education has also been quoted as a significant determinant of the implementation of improved agricultural technology in Africa, with the main reason for its significance being that educated farmers have greater exposure to information and can understand interest and profit of adopting better varieties (Manda et al ., 2018). In line with that view, Mariano et al. (2012) demonstrated a positive correlation between formal education and the speed of the adoption by Philippine farmers of modern rice varieties technology and good management practices. Trained farmers are better equipped to implement methods that increase the probability of high yield harvesting and reduce supply constraints. In the same vein, education has been identified as one of the determinants of the uptake of improved maize varieties among resource-poor households in Kano and Katsina, Nigeria (Umar et al., 2014). Johnson (2018) studied the factors influencing the adoption of drought-tolerant bean varieties in Kenya have shown a significant and robust correlation between the rates of education and uptake. Although some studies have shown that cooperative participation has a favourable and vital effect on the rate of absorption of improved rice (Awotide et al., 2016), others have reported the opposite. Smale et al. (2018) studied the adoption of improved hybrid sorghum seed in the Sudan Savannah of West Africa. They noticed that the presence of village plot managers in a registered cooperative does not seem to affect the likelihood of sowing improved varieties of sorghum on the plot since registered cooperatives are primarily used for inputs and services linked to cotton and corn seed but not the seed of sorghum.

Literature shows that farmers with broad capital are more inclined to adopt new agricultural techniques (Ali et al., 2020). For example, work by Van Heerwaarden (2018) on the adoption of enhanced grain legumes in sub-Saharan Africa has shown that larger farm sizes provide more significant incentives for the adoption of grain legumes technology. This finding may be explained by an adequate replication of grain legumes seed technology, as well as a risk mitigation by a broader farm experiment with new technologies. As for the influence of extension programs on agricultural technologies, research carried out in Mexico by Sánchez-Toledano et al. (2018) has shown that the extension of contacts created by farmers on best farming practices has a significant impact on the rate of adoption. Continued interaction with farmers and extension agents keeps them informed of emerging innovations and how to implement them, and farmers' understanding of progress depends primarily on their degree of awareness and intelligence, which can increase their rate of adoption. Farmers' knowledge of new agricultural technology may be improved by the usage of extension agents and communication sources for agriculture.

Literature also shows that farmers' wages compensate for significant variations in the adoption of agricultural technology (Abro et al., 2014). In Northern Ghana, for example, Ibrahim et al. (2012) have shown that the factors influencing the probability of a farmer accepting enhanced variety include the possession of the private property, membership in a farm association, technology, and position of a farmer. In Tanzania, farmers with non-farm income are three times more likely to use maize varieties than farmers with farm income (Mmbando et al., 2016). Domestic involvement in off-farm production, therefore, provides greater impetus to investment in better maize technology. Some modern, advanced technology needs farm inputs, and its implementation depends on the ability to obtain inputs such as fertilizers and seeds. Off-farm gains would henceforth explicitly boost spending in new technology. High returns from the adoption of improved chickpea have lowered the median level of poverty in Ethiopia, but little data has been provided as to how adoption has allowed poor households to climb above the $1.25 poverty line (Verkaart et al., 2017). Relating to the relationship between family size and improved rates of seed acceptance, while some literature (e.g. Melesse et al., 2018) farmers with a large family are more inclined to follow better groundnut practices, Ouma et al. (2014) stated that the opposite is valid in Eastern Kenya, where the higher the number of family members, the lower the rate of adoption. Farmers engaged in growing crops with the highest number of family members have less money to spend because a substantial portion of their income is invested in self-sufficiency and maintenance responsibilities.

Likewise, the literature reported conflicting results on the effect of farmers' age on increased seed adoption. Beshir and Wegary (2014) and Manda and others (2019) find the age of the growers it had a significant positive impact on the uptake of high-quality maize varieties and increased the uptake of cowpea. Older farmers are expected to have more savings and more expertise, making them more likely to seek out modern technology. Conversely, Nathanel et al. (2015) observed that a rise in the age of farmers has a detrimental impact on the adoption of technology, indicating that the older the farmer will be, the lower the rate of adoption. Younger farmers are more inclined to take on modern technologies than older farmers, as they are risk-bearers of decision-making, less responsible and more daring than older farmers. Exploring the engines of technical achievement is thus essential for the adequate preparation, growth and execution of short-and long-term agricultural investment projects to ensure food protection for growers, their communities and the country as a whole. Previous research, which looked at the core determinants of farmers' adoption of improved crop varieties, is outlined in Table 1.

Table 1. Critical Determinants of Farmers' Adoption of Improved Crop Varieties

	Study Setting	Data collection and analysis	Determinants
Todua & Gogitidze (2017)	USA	In-depth survey (*N* = 611), analysis of variance and Pearson's correlation coefficient	Education and age.
Luo et al. (2016)	China,	Survey (*N* = 150), descriptive statistics	Cost, risks, observability, complexity, compatibility, and trialability.
Kaliba et al. (2018)	Tanzania	Survey (*N* = 822), multiple-hurdle Tobit model	Knowledge, extension contact, intensity of extension activities, market participation, marital status.
Donso-Abbeam et al. (2017)	Ghana	Survey (*N* = 200), multinomial logit model and Tobit model	Age, education, household size, experience, farm workshop attendance, access to credit, membership of an organization, availability of labour, and extension contacts.
Ibnu & Hutabarat (2016)	Indonesia	Survey (*N* = 350), Structural Equation Model	Attitude, perceived behavioural control, perceived technology usefulness, resource availability, and perceived risks.
Chandio & Yuansheng (2018)	Pakistan	Survey (*N* = 220), Probit regression model	Education, farming experience, soil type, farm machinery ownership, market information, and extension contact.
Ghirime et al. (2018)	Nepal	Households survey (*N* = 416), Probit regression model	Education, extension services, access to seeds.
Anik & Abdussalam (2015)	Bangladesh	Survey (*N* = 300), Probit model and truncated regression model	Quality of extension services, access to credit.
Kalinga et al. (2014)	Zambia	Survey (*N* = 350), Tobit regression model.	Gender, farm size, membership of farmer organizations, output price, and yield.
Simtowe et al. (2016)	Malawi	Survey (*N* = 440), Probit regression	Age, education, household size, distance to the market, membership of social/faith-based group, farm size, and access to credit.
Onyuka et al. (2017)	Kenya	Ex-post facto research design (*N* = 332), multiple regression analysis	Gender, age, experience, income, land size.

Cavane & Donovan (2011)	Mozambique	Survey (*N* = 293), exploratory and confirmatory factor analyses	Ecological conditions, knowledge, production traits, and crop marketability.

3.*0 Methodology*
3.1 Study setting
The Northwest region of Nigeria is situated between latitudes 90 10' N and 130 50' N and longitudes 30 35' and 90 00' E. The area comprises nearly 226,662 km2 of the total land surface, equal to around 25.75 per cent of the total land area of the nation (Danjuma et al . , 2018). According to the population census of 2016 (NPC, 2006), the country was inhabited by 31,030,573 million inhabitants, with over 90 per cent engaged in agriculture as their primary source of income. The zone consists of seven counties, namely Jigawa, Kano, Kaduna, Katsina, Zanfara, Kebbi and Sokoto. They have low annual rainfall rates of 50–120 cm and average annual temperatures of 25–30 ° C (Adakayi et al., 2016). The flora of the area is savannah grassland, and the atmosphere is marked by two distinct seasons: the rainy season from May to September and the dry season for the remaining months. The area is arid and marked by low humidity and rainfall with an annual temperature of between 3,279 and 7, 1480 C (Butu et al., 2019).
This region is the country's primary producer of groundnuts, but its yields have decreased due to the impacts of climate change, such as drought and disease. As such, the Government has introduced programs to revitalize groundnut development to satisfy local, African and international consumer demands, provided that Nigeria is one of the largest producer nations in the world (Samuel & Ocholi, 2017). Such investment projects include agricultural science and the production of improved seed varieties through collaborations with the National Agricultural Seeds Council, the Institute for Agricultural Science, Ahmadu Bello University, and the United States Agency for International Development (USAID), the Semi-Arid Tropics International Crops Research Institute, and Agricultural Development Programme. Many improved groundnut varieties (SAMNUT 20-26) have been introduced over 1998-2018 to introduce disease-resistant (especially rosette), drought-tolerant, early-ripening, high oil content and high-yielding cultivars (Echekwu et al., 2017). Since 2007, state ADPs have been promoting the adoption of improved groundnut varieties via the Tropical Legume Project (TL III) through face-to-face contact, radio and cell phone (Manyo & Varshney, 2016). Currently, few research analyze the scale of the adoption of such latest varieties in order to assess which of the media has had a substantial effect on the adoption by farmers of improved groundnut varieties.

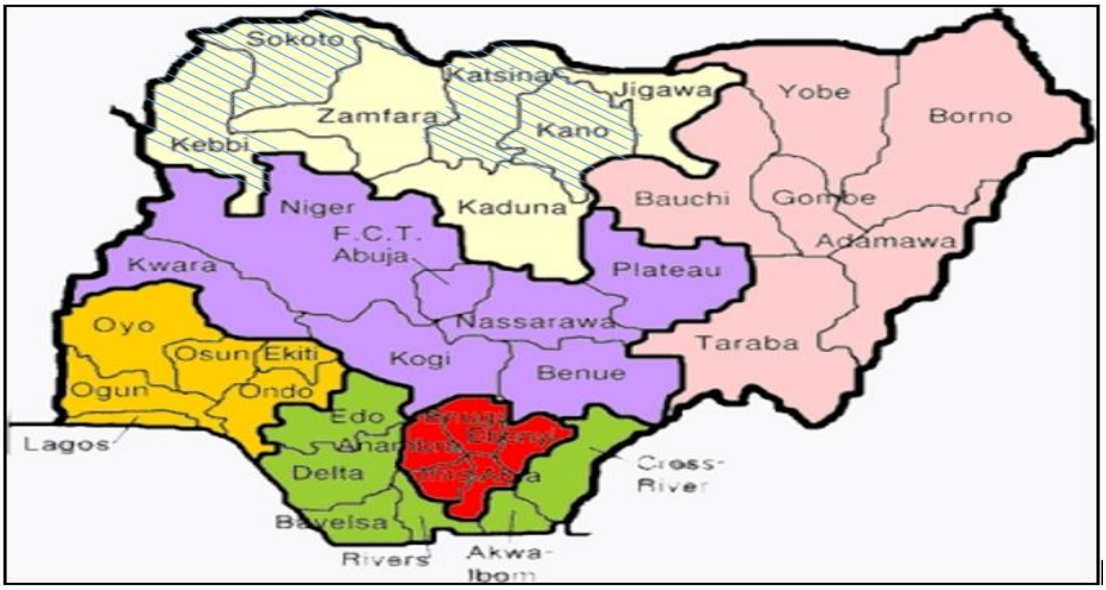

Figure 1. Map of Nigeria with the cream colour showing participating states and blue stripped area indicating the selected study locations

3.2. Data collection and analysis

This research used a survey questionnaire, a useful data collection tool, to assess the frequency of an event, such as the distribution of knowledge for agricultural extension. A two-stage sampling procedure has been used to determine the correct sample size for the analysis. The Northwest Region consists of seven states, but only six states have engaged in the TL III initiative. In the first point, four of these states were chosen, namely Katsina, Kano, Kebbi and Sokoto (see Figure 1), since they have the highest population in the area, thereby allowing for sufficient generalization inferences. The study used the calculation of sample size method developed by Yamane (1967). It adopted and updated by Israel (1992), which offers a more straightforward formula for determining the correct sample size depending on the population of farmers participating in the system from each Province. Using the list of farmers involved in the project from the four states (sample frame) collected from the ADPs (2762 farmers), the analysis then collected the sample size (349) with the corresponding number of farmers for each state: Katsina = 187, Kano = 83, Sokoto = 47, and Kebbi = 32. In the second level, purposive sampling was used for the collection of groundnut farmers from each of the four countries involved in the project.

The questionnaire design was focused on previous related research (Ndjeunga et al., 2013; Shuaibu et al., 2018) and was divided into four parts. The first segment covered the socio-demographic details and characteristics of growers, consisting of age group, family size and wages, cooperative participation, educational status, planted varieties of groundnuts and the total size of cultivated land. The second segment addressed the technical skills of improved groundnut varieties, which are unique to the activities known to farmers. The third segment deals with concerns on exposure to groundnut technology information via face-to-face contact, radio and cell phone networks, exposure to groundnut technology information via face-to-face contact, radio and cell phone networks. Eventually, the fourth segment covered a variety of individual and group extension approaches used for technology transfer.

The dependent variable was provided by the query "What is the extent of the usage of enhanced groundnut processing techniques disseminated to you (1 = low, 2 = moderate, 3 = high)?" Many of the questions were closed, needing answers from categorical choices on the Likert 6-point scale from very bad to a very good. Many questions included a list of answers.

The questionnaire was drawn up in English with the translation of Hausa (the native language of local farmers). Analysis ethics, such as the anonymity of producers, voluntary involvement in the research and the usage of survey results for scientific purposes only, have been taken into account.

Results were analyzed using descriptive (frequency, percentage) and inferential statistics (multiple linear regression) with the aid of SPSS 20 tools. Multiple regression analysis (MLR) was used to assess the effect of technical abilities of extension agents, contact networks, individual and group extension processes, and socio-demographic characteristics of farmers as control variables in predicting the extent of acceptance of improved groundnut varieties, as used in previous studies. Based on Gray (2009) and Kolasa-Wiecek (2015) studies, the use of MLR is justified because the dependent variable is measured as a scale variable. The MLR model is used to analyze the effect of individual independent variables (X1, X2, X3 ... Xk) on a single dependent variable (Y).

4.0 Study findings

4.1 Demographic characteristics of the respondents

Table 2 provides comprehensive data on the demographic characteristics of the respondents: sex, size of the family, size of the cooperative and size of the estate. The most significant number of respondents, or 31.6%, were 41–50 years of age, 13.6% were 21–30 years of age, 28.9% were 31–40 years of age, and 21.5% were 21–30 years of age. The majority of respondents were adults, indicating their experience in the development of groundnuts.

The results further showed that 34.8% of respondents had a household size of 5–10 members, followed by 33.0% with a household size of fewer than five members. Approximately 17.7% of the respondents had a household size of 11–15 members, 7.4% had a household size of 16–20 members, and 7.1% had a household size of more than 20 members. The comparatively high numbers of families, which make up the bulk of families, are offset by reductions in agricultural labour costs. Furthermore, the empiric studies have demonstrated a strong association between household scale and tolerance of innovation (Melesse, 2018; Aryal et al., 2018).

In the case of farmers 'cooperative participation, more than two-thirds of the respondents (83.2 per cent) were leaders of farmers' associations relative to the remaining 16.8 per cent who did not engage in any organization. Cooperative participation acts, among other things, as a source of knowledge and lending facilities. Several quantitative research has shown a strong correlation between the involvement of farmers in cooperatives and the enhanced adoption of agricultural technology (Wossen et al., 2017).

Table 2. Respondents' Socio-Demographic Characteristics.

Variable	*Frequency*	*Percentage*
Gender		
1 = Male	237	69.9
2 = Female	104	30.1
Age in years		
1 = 20 or less	4	1.2
2 = 21–30	46	13.6
3 = 31–40	98	28.9
4 = 41–50	107	31.6
5 = 51–60	73	12.5

6 = More than 60 years	11	3.2
Household size		
1 = 5 or less	112	33.0
2 = 6–10	118	34.8
3 = 11–15	60	17.7
4 = 16–20	25	7.4
5 = 20 or more	24	7.1
Membership of Cooperatives		
1 = Yes	282	83.2
0 = No	57	16.8

Moreover, the results in Table 3 indicate that 11.5% and 6.2% of respondents have a National Education Certificate (NCE) and a Higher National Diploma (HND) respectively, while 1.5% had a Bachelor's degree. 26.3 per cent of respondents did not seek formal schooling. Seeing that a vast number (72.3 per cent) of respondents skipped formal schooling or were trained only up to high school, the poor standard of knowledge among respondents is a significant threat to the acceptance among innovation. Past research has also shown that there is a clear link between the educational level of farmers and the recognition of innovation (Ghimire et al., 2015).
In terms of farm size, the majority of respondents (69.9%) owned 1–5 hectares of farmland, 8.8% owned 6–10 hectares of farmland, and 6.0% owned 11–15 hectares of land, while 20.6% owned 0–0.9 hectares of farmland. The results suggest that comparatively limited land holdings are used by groundnut-growers, which may hinder the adoption of technology. Empirical studies also indicated that the size of the farm directly affects the adoption of technology by farmers (Udimal et al., 2017).

Table 3. Respondents' Education Level and Farm Size.

Variable	*Frequency*	*Percentage*
Educational Level		
• No Formal Education	89	26.3
• Primary education	82	24.2
• Secondary Education	74	21.8
• National Diploma (ND)	39	11.5
• National Certificate in Educ. (NCE)	29	8.6
• Higher National Diploma (HND)	21	6.2
Farm size in hectares		
> 1ha	70	20.6
1 - 5ha	237	70.0
6 - 10ha	30	8.8
> 10ha	2	0.6

4.2 Factors associated with the adoption of improved groundnut varieties

Table 4 summarize the findings of a multiple regression used to determine the degree to which the level of acceptance of improved groundnut varieties is determined by the ranking of farmers relating to the technical skills of extension agents, the extension medium used (radio), the individual extension method and the community extension process, and control variables such as age and education of farmers. Such variables have been shown to have a clear and substantial effect on farmers' acceptance of better groundnut practices at a trust level of 95%. However, the single type of extension it is only significant at a confidence level of 90% (β = 0.103, p = 0.052). Furthermore, the results in Table 4 show that increasing the technical skills of extension agents by one unit in the ranking of farmers would increase the degree of adoption of improved groundnut varieties by 0.210 units, all other things being equivalent. In comparison, an improvement of one unit in the radio delivery system will raise the rate of absorption of better groundnut varieties by 0.171 units. In comparison, the dependent variable adoption increased by 0.224 units despite an improvement of 1 point in the group method appraisal score.

Table 4: Results of Multiple Linear Regression Analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
Constant	2.908	0.363		8.019	0.000
Ext Agent Tech. Skill	0.085	0.022	0.210	3.866	0.000
Radio	0.131	0.040	0.171	3.265	0.001
Indi. Method	0.057	0.029	0.103	1.953	0.052
Group Method	0.182	0.041	0.224	4.396	0.000

Significant; *$P < 0.05$. R^2 =0.528, Adj. R^2 = 0.520

The definition in Table 5 indicates the modified R^2 value of 0.528, suggesting that approximately 52% of the variation in the adoption of improved groundnut varieties can be clarified by the control variables of technical skills, radio and individual extension methods and community extension methods. In comparison, 48% was attributed to unexplained factors not considered.

Table 5: Model summary of the regression estimates of *R*-Square and Adjusted *R*-Square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.727	0.528	0.520	0.32656

5. Discussion and recommendations

The findings of the MLR review performed in this study indicate that the technical capabilities of extension agents, radio contact networks, and individual and community extension methods, can explain about 52% of the variation in the degree of adoption of improved groundnut varieties among farmers in Northwest Nigeria,. The low degree of acceptance may be attributed to inadequate literacy among farmers because most of the respondents (72.3 per cent) fall into the categories of non-formal education, primary education and secondary education; insufficient extension agents; and seed loss. The results are compatible with the work by Rekwot et al. (2015) the adoption by the Institute for Agricultural Research of improved groundnut varieties for livestock development in the state of Jigawa, Nigeria, revealed a degree of uptake of 38% due to lack of availability of seed and inadequate extension for continued uptake. Besides, work on the uptake and influence of modern groundnut varieties in Nigeria (Ndjeunga et al., 2013) noticed an uptake rate of 22.44% and illustrated the need to increase the uptake of groundnut varieties in the nation by establishing and introducing efficient distribution through a fast multiplication and distribution of seeds.

The favourable association between the technical skills of the extension agents and the adoption means that the technical skills of the agents in the development activities linked to enhanced groundnut varieties are more likely to increase the acceptance of farmers. This result is consistent with the findings of a study by Haruna and Abdullahi (2013) which showed that awareness of extension agents and practical skills are essential tools for the implementation of extension policies and the wider dissemination and acceptance of new and improved agricultural technologies. Likewise, Mariyono and Sumarno (2015) have demonstrated that agricultural schooling offers technical skills and practical information for growers. Farmers who have engaged in agricultural training shall learn the necessary technical skills of practices which will boost their adoption of agricultural technology. Recent studies have established a significant correlation between technical skills and the implementation of improved agricultural technology. Lambrecht et al. (2014) and Khan et al. (2015) have shown that farmers subjected to on-farm research have increased awareness of technical skills relevant to the practical application of the development guidelines proposed by the researchers. The standard of schooling of farmers often creates expertise and understanding of the technological skills of the profession, and practical information for growers. Farmers who have engaged in agricultural training shall learn the necessary technical skills of practices which will boost their adoption of agricultural technology. Recent studies have established a significant correlation between technical skills and the implementation of improved agricultural technology. Lambrecht et al. (2014) and Khan et al. (2015) have shown that farmers subjected to on-farm research have increased awareness of technical skills relevant to the practical application of the development guidelines proposed by the researchers. The standard of schooling of farmers often creates expertise and understanding of the technological skills of the profession.

Similarly, the present analysis showed that the radio-channel coefficient was positive and essential for the adoption of better groundnut varieties. Implies that agricultural extension through radio programs has provided farmers with the requisite technological information on the use of suggested growth practices and the advantages of enhanced groundnut seeds, thereby promoting their adoption. The earlier research emphasized that radio has proved to be an essential tool for the dissemination of agricultural information in rural areas (Yahaya et al., 2019). Besides, the useful information received by farmers has a positive impact on their behaviour towards the adoption of new or and better agricultural practices. The findings of this research are also compatible with the report by Hudson et al. (2017), which found that the participatory radio initiatives undertaken by Farm Radio International in sub-Saharan Africa (SSA) have raised visibility among farmers and enhanced agricultural practices. Other earlier studies have documented the contribution of radio to the acceptance and use of agricultural innovation by farmers. The Radio Extension System was used to teach farmers about vulnerability to sunray skin cancer, accompanied by potential prevention steps, follow-up preventive tests, and adaptation steps within 12 months have demonstrated that farmers have been more comfortable with them (Gorman et al . , 2018). Radio transmissions reported a rise of 23 per cent in Niger and 20 per cent in Burkina Faso, with the adoption of triple-bag storage (Moussa et al., 2011).

Also, this study found that the method of group extension had a positive and significant effect on the level of adoption. Similarly, research by Cai et al. (2016) in China showed that the involvement of farmers in the community extension process significantly led to the acceptance and yield of tomato technology being promoted in Beijing. In a similar vein, Bhattarai and GC (2015) argued that 66 per cent of the participants had integrated pest control technology was implemented by the participants in the community extension method at a farm field school in the Chitwan District of Nepal. Within the same way, Kondylis and Mueller (2013) have shown that farmers find demonstration plots and field days strategies to be an appropriate extension, as these techniques increase consciousness of new technology and thus encourage farmers to add expertise to their fields. Previous findings agreed on a positive association between the group extension method and the use of innovation by farmers (Roche et al., 2015; FAO, 2016; Ritter et al., 2017; Yigezu et al., 2018).
In comparison, the coefficient of the individual extension method suggests a favourable and vital effect on the adoption of improved groundnut varieties at a trust level of 90%. Means that face-to-face interactions between extension agents and farmers are a predictor of their level of adoption. They are corroborated by the findings of the Al-Rimawi et al. study (2016), which found that face-to-face extension contact provides direct personal attention to the specific needs of farmers and is highly effective in disseminating and adopting the latest agricultural technologies among the farming community, thereby increasing production and living standards. In a similar vein, Aldosari et al. (2019) showed that the usage of mobile phones for extension contact has a beneficial impact on the adoption of creativity and the development of smallholder farms. A body of literature supports a close correlation between both face-to-face and cell phone extension approaches and the adoption of agricultural technology by farmers (Lwoga et al., 2011; Mittal and Mehar, 2012; Khatam et al., 2013; Ogunniyi and Ojebuyi, 2016; Aker, 2016; McFadden and Gorman, 2016; Tata and McNamara, 2018; Akinwale et al., 2019; Michels et al., 2020). According to Joko and Sumarno (2015), the Chilean Farmers' Cooperative utilizes text messaging to transmit knowledge on agronomic activities and weather alerts that boosted growth, contributing to reliable performance and profitability. Enmeana (2020) also argued that the use of digital technologies such as mobile phones would help farmers to access the information they need, as well as overcome the challenges faced by conventional agricultural extensions and advisory services, thus accelerating the adoption of agricultural technology. Also, Aker (2011) noticed that cell phones dramatically reduce contact costs for low-income rural people, keep them well informed regarding agricultural technology, and increase farm market rates, weather forecasts, and input and export transport tariffs via voice messages, short texts, and others.

Conclusion

The agricultural sector, particularly extensive groundnut output, makes an enormous contribution to Nigeria's economy by generating jobs and improving domestic product (GDP) growth. As Nigeria ranks third of the largest groundnut-producing nations in the world (Echekwu et al., 2017), therefore the present research revealed the four major deciding factors for the acceptance of improved groundnut varieties be preserved and further enhanced. State governments ought to provide adequate resources for a productive working environment and the recruitment of extension agents to enhance their skills and competencies in the delivery of their duties. Also, radio extension programs should be strengthened at the appropriate time, and non-technical languages should be used for transmitting information to farmers. The radio programming will often concentrate on current topics relevant to the problems, wishes and demands of growers. Continuous training of extension agents on appropriate extension teaching methods would provide sufficient knowledge of the characteristics of the different approaches. Familiarity with the characteristics of the respondents will also promote the selection of suitable approaches for the growing community of farmers. Hence, by equip with technical skills and good delivery approaches among extension agents might influenced the adoption of improved groundnuts varieties among Nigerian farmers, particularly in the Northwest region of Nigeria.

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