Macrothink Institute™

International Journal of Social Science Research
ISSN 2327-5510
2022, Vol. 10, No. 2

Examining the Relationship Between the use of Mobile Phones and Extension Methods in Adoption of Groundnut Farming Practices in Northwestern Nigeria

Tijjani Abu Rimi (Corresponding author)

Department of Agricultural Extension and Rural Development. Federal University,

Dutsin-Ma, 5001, Katsina State, Nigeria

E-mail: taburimi@fudutsinma.edu.ng

Nur Bahiah Mohamed Haris (Corresponding author)

Department of Agriculture Technology, Faculty of Agriculture, Universiti Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia

E-mail: nurbahiah@upm.edu.my

Salim Hassan

Department of Agriculture Technology, Faculty of Agriculture, Universiti Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia

Jasmin Arif Shah

Department of Agriculture Technology, Faculty of Agriculture, Universiti Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia

Siti Rabaah Hamza

Department **of** Professional Development and Continuing Education's Universiti Putra, Malaysia

Received: May 8, 2022 Accepted: June 16, 2022 Published: July 13, 2022

doi:10.5296/ijssr.v10i2.20074 URL: https://doi.org/10.5296/ijssr.v10i2.20074

Abstract

Adoption of recommended farm practices has been acknowledged to attain food security on groundnut production in Nigeria. Extension agents and other technology developers are now often using various channels of communication, as a means of reaching farmers with improved farm practices to ensure compliance. The aim of the paper is to examine the relationship between the use of mobile phones, individual and group extension methods, technology transfer mechanism in the adoption of improved groundnut farming practices, employing cross-sectional survey in four North-western states of Nigeria. A multi-stage sampling procedure was adopted for interviewing three hundred and thirty-nine farmers. Descriptive and correlation analysis were used to analyze the data. The findings shows that farmers' had moderate usage levels of mobile phones and individual extension methods, and a high level on group extension methods. Mobile phone, individual and group extension methods had significant relationship with adoption at one percent. While, challenges to the use of mobile phones, individual and group extension methods identified to include; low farmers' literacy, unstable power supply, poor network, low patronage of extension workers, and also knowledge is restricted to members of the group. It was concluded that the use of mobile phone, individual and group extension methods need to be sustained and improved via government and other stakeholders' provision of extension agents', training on utilization of extension methods and mobile phones application for effective technology transfer. Development of farmers' knowledge on appropriate utilization of mobile phone gadgets will assist them to become receptive and embrace the practices promoted.

Keywords: mobile phone, extension methods, groundnut farming practices

1. Introduction

Groundnut became a primary producer of edible oil in Nigeria from 1956 to 1967, and was responsible for 70% of the country's export earnings during that period (Edet et al., 2020). In the 1960s, the nation became world's largest producer and exporter with an output of 500,000 metric tons, reaching its peak in 1973, with a production capacity of 1.6 million metric tons (Mohammed et al., 2021). However, the drought of 1974/75, accompanied with pest invasion, culminated into a huge loss to farmers and about 750**,** 000 hectares of the crop (Aboki et al., 2018). Additionally, crude oil discovery has significantly drawn back the sector as the nation move towards energy-driven economy at the expense of agriculture (Gavrilova**,** 2020). To boost the decline in production situation, several collaborative researches were undertaken in the 1990s in collaboration with multifaceted research institutes within and outside the country (Vabi et al., 2019). However, the yield of the crop stood at 800kg/ha, far below the obtainable yield of 3000kg/ha (Vabi et al., 2019). This concurred with previous empirical research in adoption of groundnut practices conducted in Kano state Northwestern Nigeria reported farmers' yield of 800-1100kg/ha (Shuaibu, 2018). Low yields obtained has hindered both the domestic and global supply requirements by 90% (Thawur et al., 2021). With its attendant poor export records of less than 1%, the country lost its position amongst the world's major producing countries (Melesse, 2021). Hence, it became a net importer of the product (Aboki et al., 2019). Efforts to salvage the dismal production performances led to a thirteen-year collaborative research between the Federal Government of Nigeria (FGN) and Bill and Melinda Gate Foundation (BMGF) on groundnut production improvement under the auspices of the Tropical Legume (TL III) Project (Ahmed et al., 2020). The technology dissemination approaches encompassed the establishment of demonstration plots at various centers and farmers' fields respectively, harnessing individual and group extension methods, in addition to the use of mobile phones, to augment technology transfer (Varshney et al., 2019). Nevertheless, none of the studies on groundnut production in the Northwestern Nigeria examine the relationships between the sources of knowledge transfer and farmers' adoption of improved groundnut practices.

The specific objectives were to;

1) Ascertain farmers' level of use of mobile phone, individual and group extension methods on the adoption of groundnut farming practices and

2) Examine the relationship between the use of mobile phones, individual and group extension methods on the adoption of groundnut farming practices.

3) Identify challenges to the use of mobile phone, individual and group extension methods

2. Literature Review

2.1 Adoption of Improved Groundnut Farming Practices

Previous findings on adoption of improved groundnut practices have been reviewed and accordingly, Elakkia et al. (2021) revealed that more than two-third of farmers adopted TNAU groundnut varieties recommendations. Whereas, Vabi et al. (2019) outlines the extent

of utilization of both the varietal and accompanying crop and aflatoxin management practices being promoted in both Sokoto and Kebbi States. The pooled results show that mean uptake rates for groundnut varietal technologies (the seed) adoption is 81% in Project Local Government Areas (PLGA) compared to 19% in Non-project Local Government Areas (NPLGA). Similarly, mean uptake rate of on-farm management practices is 76% in PLGA as against 24% in NPLGA, the mean uptake of post-harvest management technologies is 75% in PLGA compared to 25%. In the same vein, Bhuvaneswari et al. (2021) documented that the mean total of farmers adopted groundnut improved irrigation management techniques was 486 mm that was considerably lesser than conventional method which utilized 639 mm water and quantity of water saving by 31.87 per cent. Similarly, Kadiyala et al. (2021) reported that farmers' adaptation of climate change strategies on groundnut production increase groundnut yields at the farm level and reduce the unit cost of production. The higher price and reduced production cost will provide an incentive to farmers to adopt yield increasing technologies and management options on larger areas.

2.2 Level of Farmers' Utilization of Mobile phone, Individual and Group Extension Methods

Previous studies have reported a varying utilization level of mobile phone, individual and group extension approaches by farmers'. This was attested by Kassem et al. (2020) found high level of farmers' (63.88%) utilization of mobile-based advisory services information, whereas, the moderate level accessed fewer (42%) information, on the other hand, low level accessed the fewest information (21%). In line to this, Musungwini (2018) found low levels of household mobile phone usage, with only 50% of households were found to be using mobile telephony in support of a farming activity. In the same note, Akinwale et al. (2019) discovered the low utilization level of internet, WhatsApp, Facebook and emails

2.3 Relationships Between the use of Mobile phones, Individual and Group Extension Methods on the Adoption of Groundnut Farming Practices

The outcome of numerous empirical researches has documented positive relationship between respondents' use of mobile phones, individual and group extension methods and adoption of groundnut farming practices and this was affirmed by Kante et al. (2019) discovered a strong relationship between farmers' usage of' mobile phone farm information and adoption of farm practices. This concurred with Butt et al. (2020) found ICTs mobile phone applications have significant relationship with farmers' ability to implement production recommendations. Likewise, Mittal and Hariharan (2018) recognized that mobile-phone enabled agro-advisory services have the potential relationship to influence farmers' improved technology adoption through minimizing information gaps and create awareness about improved technologies. Furthermore, significant relationship existed between individual extension method and intensity of adoption strategies among small holder farmers has been documented in South Africa by Ojo et al. (2021). This corroborate with Thinda et al. (2020) show cases strong correlation between on-farm demonstrations individual extension method and intensity of adoption of climate change adaptation strategies. More so, Narine et al. (2019) showed significant association between farmers' contact with extension agents individually and use of agronomic practices. This was buttressed by Saeed

et al. (2020) who found the multiplying effects of individual extension approach in farmers' uptake of weed management practices in wheat-maize mix cropping system. Equally, previous discoveries highlights positive correlations between group extension methods and farmers implementations' of crop recommendation. This was in conformity with Emerick and Dar (2021) acknowledged that farmer field days group initiatives has positive relationship with adoption, by providing avenues for farmers to meet, discuss and learn about new technology. This is in tandem with Norton and Alwang (2020) reported that farmer groups' technology diffusion mechanism has positive relationship with farmer adoption of new practices. Likewise, Alwang et al. (2019) postulated that group demonstration extension techniques has sufficient relationship that stimulate the adoption of relatively simple integrated pest management practices. In the same context, Joffre et al. (2019) shows that the use of farm clustering dissemination approach of aquaculture practices has a positive relationship with the adoption of water quality management, feed inputs, and disease control practices

3. Conceptual Model of the Study

3.1 Technology Acceptance Model

Conferring to Davis (1989), Technology Acceptance Model (TAM) describes and envisages acceptance and use of the technology by the end-user. Moreover, TAM was the first among its equals to propose that human psychological factors could influence the acceptance of technology. According to Ambong and Paulino (2020), perceived ease of use and perceived usefulness can elucidate the acceptance of the user towards a particular technology correspondingly. TAM was adapted in this study to determine how farmers' exposures to knowledge on improved groundnut practices disseminated via mobile phone, individual and group extension approaches, supplement them to find ease in use of the practices to their own situation and anticipate high returns that derived their attitude towards using the recommendations, behavioral intension to use and actual usage (adoption), as the dependent variable.

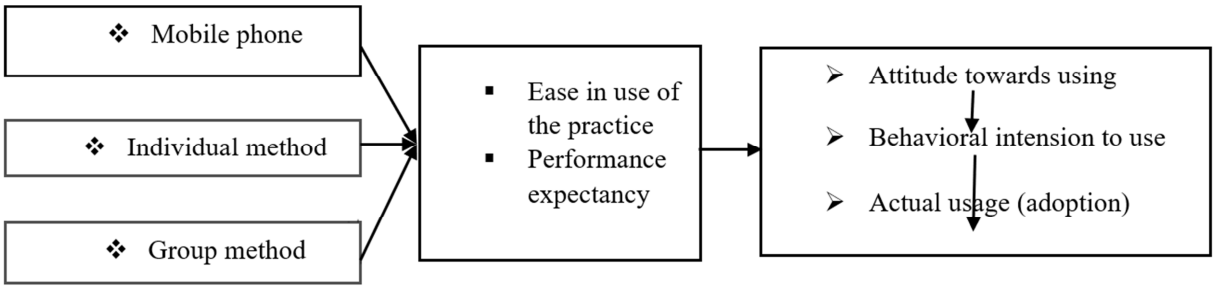

Figure 1. Conceptual Framework

4. Materials and Methods

This study employs a quantitative survey approach that aims to measure objective realities by

concentrating on research variables. In addition, to examining large and small populations by choosing and investigating selected samples from that population to find the relative interrelation of the independent variables and dependent variable (Alston and Bowles, 2020). The study variables includes; mobile phone, individual and group extension methods as independent variables and adoption as the dependent variable.

4.1 Sample and Sampling Procedure

The research population is all farmers participate in groundnut improvement collaboration initiative under the Tropical Legume Project (TL III) in four states of the Northwestern part of Nigeria. While the reachable population as a sampling frame obtained from the Agricultural Development Programmes (ADPs), of the aforesaid area totaling 2762 farmers. A multi-stage sampling procedures were employed to select the respondents of the study. First, convenient sampling was used to select four states (Katsina, Kano, Sokoto and Kebbi) that were free from incessant attacks by bandits. Second stage involves random selection to choose three Local Government Areas (LGAs) each from four states, making twelve (12) LGAs and two villages each from 12 LGAs, making 24 villages. In the third stage, based on the lists of 2762 groundnut farmers obtained from ADPs, the research adopted Israel (1992) sample size determination formula, employing random sampling to select 339 farmers proportionately, comprising 237 male, and 102 female respectively. The formula provides a simpler model for the measurement of sample sizes and considered 95% confidence level, which is equivalent to 0. 05 (5%) alpha level of significance. That is, the significance level or alpha level is the probability of making the wrong decision when the null hypothesis is true. The sample was taken proportionally as shown in Table 1.

Table 1. Distribution of population and sample

SN	State	Sampling frame	Population	Respondents	Percentage
1	Katsina	2762	1478	53.52 x 339 = 181 100	1478 x 100 = 53.51% 2762
2	Kano		655	23.75 x 339 = 81 100	655 x 100 = 23.71% 2762
3	Sokoto		373	13.50 x 339 = 46 100	373 x 100 = 13.50% 2762
4	Kebbi		256	9.26 x 339 = 31 100	256 x 100 = 9.27% 2762
Total	**4**		**2762**	**339**	**100%**

4.2 Sample Context

This research was conducted from March 2021 to December 2021, in the Northwestern part of Nigeria, using farmers as the unit of analysis. The research covers four states within the

aforementioned region of the country, employing a survey design to examine the relationship between farmers' use of improved groundnut production practices communicated via mobile phone, individual extension and group extension methods, information sources as independent variables, towards adoption of improved groundnut production practices as a dependent variable.

4.3 Measurement

The study data were collected using a questionnaire, and the respondents are farmers that partake under (TL III) Project. The subjects responses to the questionnaire administer is accurate towards meeting the research objectives. The questionnaire was made using 6-point scale with six alternative answers, namely: very poor (score 1), poor (score 2), moderately poor (score 3), moderately good (score 4), good (score 5) and very good (score 6)

4.4 Data Analyses

The study data was analyzed using (i) Descriptive analysis and (ii) Chi-square test. The descriptive analysis was to determine the level of respondents' use of mobile phone, individual extension and group extension methods, knowledge source on improved groundnut production practices and constraints to the use of mobile phone, individual extension and group extension methods. The Chi-square test was conducted to determine the relationship between farmers' use of mobile phone, individual extension and group extension methods knowledge source on the adoption of improved groundnut recommended production practices.

5. Results

5.1 Respondents Level of Mobile phone Usage

Results in Table 2 show that majority 140 (41.3%) of the respondents' had a moderate utilization of mobile phone agricultural information contact with extension agents, research station and other providers of knowledge related to groundnut recommendation, followed by 114 (33.6%) with a high, and 85 (25.1%) occupying low category. The moderate level of mobile phone utilization by the majority showcases commendable improvement on the use of the gadget, even though, more development is required to meet with the dynamism.

Table 2. Level of Mobile phone Usage

Mobile phone	Frequency	Percentage
Low	85	25.1
Moderate	140	41.3
High	114	33.6

5.1.1 Respondents Utilization Level of Individual Extension Method

Table 3 gives a detailed evaluation of individual extension method respondents had on the

adoption of groundnut farming practices. The findings indicated that the majority 133 (41.0%) were at moderate level. In contrast, 98 (28.9%) were at high level, and 108 (30.1%) at lower level respectively.

Table 3. Utilization Level of Individual Extension Method

Individual extension method	Frequency	Percent
Low	108	30.1
Moderate	133	41.0
High	98	28.9

5.1.2 Respondents Utilization Level of Group Extension Method

Table 4 depicts the extent of respondents' usage level of group extension approach on adoption of groundnut farming practices. The analysis unveil that 209 (61.6%) recorded high level, whereas, 81 (23.9%) recorded a moderate level and 49 (14.5%) were at a low level of use of group extension approach on adoption. High level use of group approach.

Table 4. Farmers' Level of Usage of Group Extension Method

Group Extension methods	Frequency	Percent
Low	49	14.5
Moderate	81	23.9
High	209	61.6

5.2 Relationship between Mobile Phone, Individual and Group Methods and Adoption of Groundnut Farming Practices

Findings of correlation analysis in Table 5 depicts a significant relationship at 1% level between respondents' utilization of mobile phone, individual and group extension methods on adoption of groundnut farming practices.

Table 5. Relationship between mobile phone, Individual and Group Methods and Adoption of Groundnut Farming Practices

Variables	$X_{1\ \text{Mobile phone}}$	$X_{2\ \text{Ind. method}}$	$X_{3\ \text{Group method Y}}$
Mobile Phone	1		
Individual method	.370**	1	
Group method	.252**	.188**	1
Y Adoption	.433**	.633**	.414**
Significant	.000	.000	.000

Note. Correlation is Significant at $p<0.01$.

5.3 Constraints to Farmers' Utilization of Individual and Group Extension Methods and Mobile Phone

5.3.1 Constraints to Utilization of Individual Methods

Findings in Table 6 indicates constraints to individual extension method, which majority (31.6%) complaints of having limited extension agents' patronage. Also, (28.9%) lamented of poor execution of demonstrations/trainings of innovative practices that has to do with poor funding, which hinders early preparations. More so, (21.5%) of the respondents have vehemently lamented of ill-timely execution of the practices. More so, (13.6%) documented poor road network deprived them from reaching extension services. Additionally, (4.4%) experience weak delivery outputs from the change agents and this may have connection with the absence of regular capacity building supposed to be engage with.

Table 6. Constraints to Farmers' Utilization of Individual Extension Method

Variable	Frequency (n =339)	Percentage
Individual Method		
Low patronage of extension workers	107	31.6
Poor execution of the programs	98	28.9
Ill-time execution of the activity	73	21.5
Poor road network	46	13.6
Weak extension delivery	15	4.4

5.3.2 Constraints to Farmers' Utilization of Group Extension Method

The result of analysis in Table 7 portrays constraints to group extension method. It adduces that (33.0%) confirms that their counterparts; progressive or well to do farmers, always dominate all the initiatives brought, rendering them passive audience with less interested. Furthermore, majority (34.8%) establish that the approach did not permit appropriate attention to their individual farming challenges. The finding also reveal that (17.7%) admits that due to divergence views, it takes time before a decision reach maturity. On the other hand, (7.4%) attest that owing to audience backgrounds, it takes time and most often difficult to reach a final decision. Consequently, about (7.1%) signify that the method has an element of biasness, it exclusively focus on targeted group.

Table 7. Constraint to Utilization of Group Extension Method

Variable	Frequency (n-339)	Percentage
Group Method		
Few dominate discussion	112	33.0
Individual problems not well solve	118	34.8
Time consume to reach a decision	60	17.7
Difficult to agree on issues	25	7.4
Knowledge is restricted to members of the group	24	7.1

5.3.3 Constraints to Farmers' Utilization of Mobile phone

The findings in Table 8 outline various challenges impeding farmers to effective utilization of mobile phone, which shows that majority (26.3%) indicate low literacy negate their ability to make use of various applications for adequate communication. Also, (24.2%) affirm that unstable network services hinder their efforts to communicate adequately. While, (21.8%) mostly female having limited access, partly due to marriage custom and tradition, which favored men as head of households and hence, deprive them from owning mobile phone. Further result indicates that (11.5%) lack of adequate resources become obstacle to afford calling credits. Whereas, (8.5%) attributed their challenges to unstable power supply, and (6.2%) consider the services as limited to urban areas.

Table 8. Challenges to Farmers' Utilization of Mobile Phone

Variable	Frequency (n =339)	Percentage
Mobile Phone		
Low farmers literacy	94	27.8
Poor network connection	82	24.2
Limited access to women farmers	74	21.8
Low economic status	39	11.5
Unstable power supply	29	8.5
Concentration of network services in urban areas	21	6.2

5.4 Discussion

Result of the analyses in Tables 2, 3 and 4 present respondents' utilization level of mobile phone, individual and group extension methods. The findings in Table 2 indicate that farmers' utilization of mobile phone indicate moderate response level of the majority on the communication channel to access knowledge on groundnut recommended practices that is quite commendable, considering the level of literacy of farmers' in the third world countries with its attendant consequences of inadequate infrastructure. However, the finding is contrary to the low usage identified by Abdullahi et al. (2019) study that out of the 14 apps at disposal,

only two (voice call and SMS apps) considered were prominently put to use by farmers in the North West Nigeria. Similarly, the findings in Table 3 reveal a moderate utilization level of individual extension method. Conversely, Ayanda (2019) research in Southwestern part of Nigeria found high level (88.42%) utilization of home visit individual extension teaching approach by the respondents. In addition, the study result in Table 4 reveal high level use of group extension approach. This corroborate with empirical evidences in Nepal that recorded respondents' high level utilization of group extension method (Baral et al., 2018)

Moreso, the finding of correlation analysis between respondents' utilization of mobile phone, individual and group extension methods on adoption of groundnut farming practices in Table 5 depicts a significant relationship at 1% level to all the aforementioned three variables. The significant association documented between farmers' use of mobile phone information and implementation of groundnut practices, is consistent with Quand et al. (2020) demonstrated a positive association between agricultural information communicated via mobile phone and farmers implementation of maize recommended production practices. Similarly, results of correlation analysis between respondents' use of individual extension method and adoption prove a significant relationship. This concurred with Apu and Ejike (2018) found a significant relationship between technology transfer at individual farms and their intense adoption. Likewise, Declaro-Ruedas and Bais (2019) opined a positive relationship between one-on-one individual extension communication and implementation of livestock management practices. Consequently, the correlation results between respondents' use of group extension method and adoption of groundnut practices reveal a significant relationship. This corroborates the empirical evidences by Singh et al. (2018) viewed that there is a significant relationship between farmers' attendance at demonstrations plot and adoption of conservation practices.

Additionally, the findings in Tables 6, 7 and 8, unveil constraints to utilization of mobile phone, individual and group extension methods. Various challenges impeding farmers to effective utilization of mobile phone, in Table 6, shows that gross inadequate literacy is amongst the major impediments to the use of various mobile phone applications for effective communication. Consistence to this, Thapa et al. (2020) deduced that, most farmers were illiterate and lack know-how to use of ICT-mobile phone tools. Also, unstable network services jeopardize appropriate contact with knowledge sources. Moreso, gender disparity, due to marriage ties negate female adequate access and owning the gadget, as the tradition of the study area favored men as the head of the farming family. This corroborate with Partey et al. (2020) and Tsige et al. (2020) that inequality between men and women's access to production resource have also been identified to hinder more agricultural productivity in other parts of sub-Saharan Africa. Further result indicate that (11.5%) farmers' low economic status to have adequate units for regular contacts with information source stood as another obstacle, unstable power supply has also aggravated more challenges to efficient communication. Further, impediment to effective communication include, residence of the communication gadgets that mostly situated in the urban areas, which hamper wider extension coverage, due to non-networking of the rural enclaves. This concurred with Ele et al. (2021) who postulated that in many developing countries, mobile phone is mostly accessible to urban areas, while, in

rural areas that are characterized to be the major food producers lag behind. The result of the finding in Table 7 portrays the challenges of farmers to the use of individual extension approach, most respondents lamented on low extension agent's patronage, within the growing season. This corroborate with Haruna and Abdullahi (2013) cited in Mohammed (2019) that the ratio of extension agents/farmers in the areas is higher that it hinders recommended visits extension agents supposed to have with farmers in the season. Also, poor implementation of extension activities such as demonstrations/trainings of farmers on innovative practices. Consistence to this, Camillone et al. (2020) lamented that considering farmers' population in Nigeria, the funding level of agricultural extension remains low. Furthermore, ill-timed execution of the practices and poor road networks tremendously affects proper dissemination of proven technology to the faming families. Additionally, weak extension delivery has become prevalent manifestation of farmers' low outputs that may have connection with irregular training of extension agents. In line with this, Davis et al. (2019) found that, at present, the extension service in Nigeria seems to be very weak and farmers are very much on their own because of the weak output of the extension advisory services.

The result of analysis in Table 8 describes respondents' constraints to utilization of group extension method. Some portend that progressive or well to do farmers, always dominate session, rendering them less important. Furthermore, majority established that group approach did not permit appropriate attention to their individual farming challenges. Equally, some are of the view that it becomes difficult to reach a consensus at group approach, due to divergent views, and as such, others concluded their argument that it is even difficulty to resolve on issues presented. Whereas, others complaint that the method has an element of biasness, because, it exclusively focus at members of the targeted groups.

6. Conclusion

The aim of conducting this study is to examine the relationship between the use of mobile phones and extension methods in farmers' adoption of groundnut farming practices in Northwestern Nigeria. The independent variables subjected to various tests are mobile phone, individual and group extension methods against the dependent variable that is adoption of groundnut farming practices. Moreover, farmers' had moderate usage levels of mobile phone and individual extension method, whereas, had high usage level in group extension method. Furthermore, significant relationships found at one percent between all the three independent factors and adoption of improved groundnut farming practices. Additionally, challenges bedeviling the use of mobile phone includes; inadequate literacy, unstable network services, gender disparity, low economic status, concentration of network services in urban areas. While, challenges to individual extension method are; low extension agent patronage, poor and ill-timed execution of the activity/programme and poor road networks. On the other hand, impediments to group extension method involves a situation where individual farming challenges become unattended to, difficult to reach a consensus and exclusive focus on the targeted groups. Henceforth, the study has established a strong relationships between the independent and dependent variable, and this factors need to be strengthened and sustained, through government and other stakeholders' initiatives on capacity building training engagements of extension agents into various extension teaching approaches for effective

applicability. To further hasten information transmission in the current era of globalizations, significant improvement of mobile phone infrastructure to rural enclaves need adequate attention. In the same vein, policy makers should articulate strategies that would enhance both extension agents' and farmers' education on utilization of mobile phones applications.

References

Abdullahi, K. A., Oladele, O. I., & Yusuf, O. J. (2019). Use of mobile phone applications by farmers in North West Nigeria. *Journal of Agricultural Extension*, *3*, 182–195. https://doi.org/10.4314/jae.v23i3.16

Aboki, E. (2019). Profitability analysis of groundnut production in Ardo-Kola Local Government Area of Taraba State, Nigeria. *South Asian Research Journal of Agriculture and Fisheries*, *2*, 1–6. https://doi.org/10.36346/sarjaf.2019.v01i02.001

Aboki, E., Bashir, M. B., Nakwe, S. H. G., Ndaghu A. A., & Abdulazeez, A. W. (2018). Resource use efficiency in groundnut production in Gassol Local Government Area of Taraba State, Nigeria. *J. of Agri. and Vet. Sci.*, *3*, 51–56.

Ahmed, B., Echekwu, C. A., Mohammed, S. G., Ojiewo, C., Ajeigbe, H., Vabi, M. B., … O. C. Nwahia. (2020). Analysis of Adoption of Improved Groundnut Varieties in the Tropical Legume Project (TL III) States in Nigeria. *Agric. Sci.*, *11*, 143–156. https://doi.org/10.4236/as.2020.112009

Ahmed, T. A., & Adisa, R. S. (2017). Perceived Effectiveness of Agricultural Extension Methods Used to Disseminate Improved Technologies to Rice Farmers in Kogi State, Nigeria. *International Journal of Agricultural Science, Research and Technology in Extension and Education Systems*, *1*, 27–34. Retrieved from http://ijasrt.iau-shoushtar.ac.ir

Akinwale, J. A., Owoade, E. O., & Oloruntobi, D. O. (2019). Analysis of utilization of mobile phones in agricultural information dissemination among maize farmers in Ondo State, Nigeria. *Journal of Agriculture and Environment*, *15*(2), 39–49. ISSN: 1595-465X

Alston, M., & Bowles, W. (2020). *Research for social workers: An introduction to methods* (p. 522). Routledge. ISB N 978-1-76029-744-2. https://doi.org/10.4324/9781003117094

Alwang, J., Norton, G., & Larochelle, C. (2019). Obstacles to widespread diffusion of IPM in developing countries: lessons from the field. *Journal of Integrated Pest Management*, *10*(1), 10–18. https://doi.org/10.1093/jipm/pmz008

Ambong, R. M., & Paulino, M. A. (2020). Analyzing Rice Farmers' Intention to Adopt Modern Rice Technologies Using Technology Acceptance Model (TAM). *Asian Research Journal of Agriculture*, *13*(1), 21–30. https://doi.org/10.9734/arja/2020/v13i130094

Apu, U., & Ejike, O. S. (2018) Dissemination of agricultural development programme technologies by extension agents in rivers state, Nigeria. *Journal of Agriculture Economics, Extension & Science*, *4*(1), 25–32.

Ayanda, I. F. (2019). Rice farmers preferred extension teaching methods for capacity building

in Kwara State, Nigeria. *Journal of Agricultural Extension*, *23*(2), 13–21. https://doi.org/10.4314/jae.v23i2.2

Baral, P. R., Paudel, B. B., Adhikari, M. S., & Jaishi, M. (2018). Effectiveness of Extension Methods: A Case of Western Mid-Hills in Nepal. *Journal of the Institute of Agriculture and Animal Science*, *1*, 47–57. https://doi.org/10.3126/jiaas.v35i1.22513

Bhuvaneswari, J., Thiyagarajan, G., Manikandan, M., Thenmozhi, S., & Natarajan, S. K. (2021). Impact of Improved Water Management Technique for Groundnut in LBP Command Area. *Int. J. Cur. Micro. Bio. App. Sci.*, *10*(01), 1457–1462. https://doi.org/10.20546/ijcmas.2021.1001.173

Butt, T. M., Shahbaz, B., Hassan, M. Z. Y., & Khan, M. (2020). A critical analysis of e-learning agricultural technical capacity for rural development: lessons from Pakistan. *Geo. Journal*, *6*, 1–13. https://link.springer.com › article

Camillone, N., Duiker, S., Bruns, M. A., Onyibe, J., & Omotayo, A. (2020). Context, Challenges, and Prospects for Agricultural Extension in Nigeria. *Journal of International Agricultural and Extension Education*, *27*(4), 144–156. https://doi.org/10.5191//jiaee.2020.274144

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Davis, K., Lion, K., & Arokoyo, T. (2019). Organizational capacities and management of agricultural extension services in Nigeria: current status. *South African Journal of Agricultural Extension*, *47*(2), 118–127. https://doi.org/10.17159/2413-3221/2019/v47n2a508

Declaro-Ruedas, M. Y., & Bais, L. S. (2019). Communication Modalities Used in the Delivery of Extension Programs to Small Scale Livestock Raisers in San Jose, Occidental Mindoro, Philippines. *International Journal of Agricultural Extension*, *7*(1), 39–44. https://doi.org/10.33687/ijae.007.01.2786

Edet, E. O., Udoe, P. O., & Ifang, E. D. (2018). Resource use efficiency of groundnut farmers in Bekwara Local Government Area, Cross River State, Nigeria. *Global Journal of Agricultural Sciences*, *1*, 75–84. https://doi.org/10.4314/gjass.v17i1.9

Elakkia, S., Pushpa, J., Mahandrakumar, K., & Prabakaran, K. (2021). Impact Assessment on Improved Groundnut Varieties and Technologies in Cuddalore District. *Ind. J. Pure App. Biosci*., *9*(1), 145–149. https://doi.org/10.18782/2582-2845.8504

Ele, B. I., Odey J. A., & Frank, N. E. (2021). Localized Farmer's Information Dissemination System in Nigeria Using Mobile Networks. *International Journal of Information Technology and Applied Sciences*, *3*(2), 63–68. https://doi.org/10.52502/ijitas.v3i2.26

Emerick, K., & Dar, M. H. (2021). Farmer field days and demonstrator selection for increasing technology adoption. *Review of Economics and Statistics*, *4*, 680–693. https://doi.org/10.1162/rest_a_00917

Gavrilova, N. G. (2020). *Impediments to the development of Nigeria's agricultural exports* (vol. 2, pp. 1–6). In IOP Conference Series: Earth and Environmental Science. https://doi.org/10.1088/1755-1315/548/2/022085

Israel, G. D. (1992). *Sampling the Evidence of Extension Program Impact*. Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD5. October

Joffre, O. M., Poortvliet, P. M., & Klerkx, L. (2019). To cluster or not to cluster farmers? Influences on network interactions, risk perceptions, and adoption of aquaculture practices. *Agricultural systems*, *173*, 151–160. https://doi.org/10.1016/j.agsy.2019.02.011

Kadiyala, M. D. M., Nedumaran, S., Padmanabhan, J., Gumma, M. K., Gummadi, S., Srigiri, S. R. & Whitbread, A. (2021). Modeling the potential impacts of climate change and adaptation strategies on groundnut production in India. *Science of the Total Environment*, *776*, 145996. https://doi.org/10.1016/j.scitotenv.2021.145996

Kante, M., Oboko, R., & Chepken, C. (2019). An ICT model for increased adoption of farm input information in developing countries: A case in Sikasso, Mali. *Information Processing in Agriculture*, *6*(1), 26–46. https://doi.org/10.1016/j.inpa.2018.09.002

Kassem, H. S., Bello, A. R. S., Alotaibi, B. M., Aldosri, F. O., & Straquadine, G. S. (2019). Climate Change Adaptation in the Delta Nile Region of Egypt: Implications for Agricultural Extension. *Sustainability*, *11*, 685. https://doi.org/10.3390/su11030685

Melesse, M. (2021). *Food Security and Household Welfare Impacts of Adoption of Improved Groundnut Varieties in Nigeria*. Retrieved from https://hdl.handle.net/20.500.11766/12867

Mittal, S., & Hariharan, V. K. (2018). Mobile-based climate services impact on farmers risk management ability in India. *Climate Risk Management*, *22*, 42–51. https://doi.org/10.1016/j.crm.2018.08.003

Mohammed, G. (2019). *Relationship between knowledge, attitude, and practices towards the adoption of improved varieties of pearl millet in Nigeria*. PhD thesis, University Putra Malaysia.

Mohammed, S. G., Halliru, M., Jibrin, J. M., Kapran, I., & Ajeigbe, H. A. (2021). Impact assessment of developing sustainable and impact-oriented groundnut seed system under the tropical legumes (III) project in Northern Nigeria. In *Enhancing Smallholder Farmers' Access to Seed of Improved Legume Varieties Through Multi-stakeholder Platforms* (pp. 81–96). Springer, Singapore. https://doi.org/10.1007/978-981-15-8014-7_6

Musungwini, S. (2018). Mobile phone use by Zimbabwean smallholder farmers: A baseline study. *The African Journal of Information and Communication*, *22*, 29–52. https://doi.org/10.23962/10539/26171

Narine, L. K., Harder, A., & Roberts, T. G. (2019). Farmers' intention to use text messaging for extension services in Trinidad. *The Journal of Agricultural Education and Extension*, *25*(4), 293–306. https://doi.org/10.1080/1389224X.2019.1629970

Norton, G. W., & Alwang, J. (2020). Changes in agricultural extension and implications for farmer adoption of new practices. *Applied Economic Perspectives and Policy*, *1*, 8–20. https://doi.org/10.1002/aepp.13008

Ojo, T. O., Ogundeji, A. A., & Belle, J. A. (2021). Climate change perception and impact of on-farm demonstration on intensity of adoption of adaptation strategies among smallholder farmers in South Africa. *Technological Forecasting and Social Change*, *172*, 121031. https://doi.org/10.1016/j.techfore.2021.121031

Partey, S. T., Dakorah, A. D., Zougmoré, R. B., Ouédraogo, M., Nyasimi, M., Nikoi, G. K., & Huyer, S. (2020). Gender and climate risk management: evidence of climate information use in Ghana. *Climatic Change*, *158*(1), 61–75. https://doi.org/10.1007/s10584-018-2239-6

Quandt, A., Salerno J. D., Neff, J. C., Baird, T. D., Herrick, J. E., & McCabe, J. T. (2020). Mobile phone use is associated with higher smallholder agricultural productivity in Tanzania, East Africa. *PLoS ONE*, *15*(8), e0237337. https://doi.org/10.1371/journal.pone.0237337

Saeed, M. M., Chaudhry, K. M., Ashraf, I., Usman, M., Ejaz, R., Shoaib, M., & Riaz, I. (2020). Impact of public extension services for effective weed management practices in wheat-maize cropping pattern in Faisalabad Punjab, Pakistan. *Biological and Clinical Sciences Research Journal*, *2020*(1). https://doi.org/10.54112/bcsrj.v2020i1.32

Shuaibu, H. (2018). Adoption and impact of improved groundnut seed varieties among groundnut farmers: Case of Albasu Local Government Area of Kano State, Nigeria. *Nigerian Journal of Basic and Applied Sciences*, *1*, 132–140. https://doi.org/10.4314/njbas.v26i1.15

Singh, A., MacGowan, B., O'Donnell, M., Overstreet, B., Ulrich-Schad, J., Dunn, M., & Prokopy, L. (2018). The influence of demonstration sites and field days on adoption of conservation practices. *Journal of Soil and Water Conservation*, *73*(3), 276–283. https://doi.org/10.2489/jswc.73.3.276

Thapa, A., Shrestha, D., Baudhacharya, N., Ramtel, R., Thapa, S., & Poudel, S. (2020). Information and Communication Technology (ICT) Mediated Extension Services in Agriculture in Nepal-A Review. *Acta Informatica Malaysia* (AIM), *4*(2), 33–36. http://doi.org/10.26480/aim.02.2020.33.36

Thawur, P., Hadiza, S. N., Yusuf, L. I., & Gadzama, A. A. (2021). Factors Influencing Adoption of Improved Groundnut Varieties among Women Farmers in Southern Part of Borno State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, *7*(1), 89–103. http://www.jaeess.com.ng. ISSN: 2476 – 8423

Thinda, K. T., Ogundeji, A. A., Belle, J. A., & Ojo, T. O. (2020). Understanding the adoption of climate change adaptation strategies among smallholder farmers: evidence from land reform beneficiaries in South Africa. *Land Use Policy*, *99*, 104858. https://doi.org/10.1016/j.landusepol.2020.104858

Tsige, M., Synnevåg, G., & Aune, J. B. (2020). Gendered constraints for adopting climate-smart agriculture amongst smallholder Ethiopian women farmers. *Scientific African*,

7, e00250. https://doi.org/10.1016/j.sciaf.2019.e00250

Vabi, M. B., Mohammed, S. G., Echekwu, C. A., Mukhtar, A. A., Ahmed, B., Ajeigbe, H. A., & Eche, C. O. (2019). *Best Choices for Enhancing Groundnut Productivity in Nigeria*. Retrieved from http//EXPLOREit.icrisat.org. ISBN 978-93-86527-02-8

Vabi, M. B., Sadiq, S. A., Mustaph, A., Suleiman, A., Affognon, H. D., Ajeigbe, H. A., & Kasim, A. A. (2019). Patterns and drivers of the adoption of improved groundnut technologies in Northwestern Nigeria. *A. J. of Agri.*, *1*, 1–16. www.internationalscholarsjournals.org

Varshney, R. K., Ojiewo, C., & Monyo, E. (2019). A decade of Tropical Legumes projects: Development and adoption of improved varieties, creation of market‐demand to benefit smallholder farmers and empowerment of national programmes in sub-Saharan Africa and South Asia. *Plant Breeding*, *4*, 379–388. https://doi.org/10.1111/pbr.12744

Verter, N. (2017). The performance of groundnut products in the world: A case of peanut pyramid in Nigeria. 20th International Scientific Conference "Enterprise and Competitive Environment", March 9–10, 2017, Brno, Czech Republic. Government's agricultural transformation agenda. *J. of Agri. Ext.*, *2*, 98–104.

Copyrights