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The Estimation Model of Determinant of Mobile Phone Apps' Usage by Smallholder Farmers in North West Nigeria

Abdullahi Abubakar Khidir[1], Idowu Oladimeji Oladele[2], Daniel Ekpa [3]
[1]*Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Federal University Dutsin-Ma, Katsina State, Nigeria*
[2] *Sasakawa African Fund for Agricultural Extension Education, Nigeria/Ethiopia*
[3] *Department of Agricultural Economics, Federal University Dutsin-Ma, Katsina State, Nigeria*
**Corresponding Author Email: abua374@gmail.com*

Abstract

This study examined the determinants of frequency of cellphone applications' usage among farmers in North-West Nigeria using Negative Binomial Regression Model (NBRM). Using ex-post-facto research design, multi-stage sampling procedure was employed to select 385 respondents from ADP geo-ecological zones of three agrarian states (namely Katsina, Kano and Kaduna) for the study. Thereafter, three Local Government Areas (LGAs) were randomly selected from each state and from which 5 communities were randomly selected from each of the LGAs in Katsina and Kaduna, and 10 from the most densely populated Kano state. Data were collected using a pre-tested structured questionnaire and summarized using frequency counts, percentages and mean. Though most frequently used mobile applications include voice call app (mean value of 1.410), SMS app (0.932 mean score) and Opera with 0.640 mean value, weighted mean values showed that all the apps were rarely being put to use by the farmers, indicating generally low frequency of usage. NBRM analysis results showed that educational attainment, knowledge, phones farmers operate well, phone as information garget, app store, social media and agencies as sources of apps positively influenced the frequency of mobile apps usage. A well guided effort through appropriate policies that would encourage the frequency of mobile phone usage by farmers for information accessing, should be put in place by major stakeholders of rural and agricultural development in the area.

Keywords: Frequency of app usage; mobile phone apps; farmers; North West Nigeria

1. Introduction

Information is crucial and an important means of enabling farmers to benefit from agricultural inventions and innovations. It is through information that adoption of the new innovations and inventions is made possible. The role of information becomes more significant in a developing economy like Nigeria that is characterized by very poor literacy levels and high rate of poverty, mainly in rural neighborhood (Olojede et al., 2013).

In Nigeria, as in many African countries like Kenya, Uganda and Tanzania there are obvious potentials for development in the use of ICTs. The arrival of mobile phones in the late 90s and early 2000 brought new possibilities to the continent of Africa in general and Nigeria in particular (Aker & Mbiti, 2010). Mobile phones, as the focus of this study have, in the last decade, bridged the urban-rural and rich-poor divides by connecting individuals to individuals, passing information about markets and services. The use of mobile phone technology in diverse agribusiness sub-sectors has recorded immense growth in Nigeria and many other developing nations because it

provides different opportunities to transfer knowledge and information among players in the agribusiness value or supply chain, including government (Osadebamwen and Ideba, 2017). Despite mobile phone being mainly used by urban dwellers, Aker and Mbiti (2010) found its social and economic usefulness for the rural inhabitants in terms of the assembling of vital data on weather, market, and other related concerns. Consequently, the Nigerian government in recognition of the importance of communication devices in agricultural activities, established policies and projects in this regard; among which were the launching of the Global System of Mobile (GSM) communication-making phone lines more accessible nationwide and the Growth Enhancement Support Scheme (GES), which was created to directly provide farmers with government subsidized farm inputs via their cell phones (Ebgule et al., 2013). Extension agencies can adequately serve the farmers with needed agricultural information in case ICT component such as mobile are employed in real time.

With the current state of rural transformation, the evolution of cellphone is inspiring a revolution in rural connectivity for small-holder farmers and other small-scale rural producers in developing countries (Osadebamwen and Ideba, 2015). Given the rapid expansion in infrastructural networks, the mobile phone is enhancing communication, information exchange, and innovation in service delivery among larger part of the rural populace (Donner, 2008). In addition, Qiang et al (2011) posited that Mobile phone-based services have proliferated in recent years, providing new and better pathways of accessing price and market data, and coordinating input/output resources that also include transport, logistics, finance and production methods. Therefore, it can be argued that the need for better information through mobile phones can be considered as the prerequisites for the farmers to benefit from using mobile communication technologies to improve need access (Niemi et al., 2015) as well as a tool for development at local and community levels (Amir et al., 2016). Hence, using modern technologies is considered as an appropriate medium to meet farmers' information needs and increase in out-put (Shaukat et al., 2013), as these approaches increase farmer's basic knowledge and ability to make their own choices and decision on particular technologies (Sousa et al 2016). This implies that as the rate of apps' usage by farmers increase, the rate of information flow and access followed suit. This is evident from the findings of Xioalin and Shaheen (2012) that showed that as a result of introduction of a mobile phone based e-Extension intervention programme by the UK E Engineering and Physical Science Research Council (EPSRC) tagged Knowledge Help Extension Technology Initiative (KHETI) project in India for rural farmers, extension activities increased speedily as it was reported that the average estimated quality index (QI) rose from 0.57 prior to the intervention to 0.92 after the intervention with a 61% gain above the previous services. Similarly, Raj et al (2011) reported that the introduction of mobile phone based intervention technologies (SMS and interactive voice response system) among farming communities in India led to improvement in cultural practices among farmers in the intervention farming communities and an appreciable reduction in the cost implications of production activities which resulted increase in net income for the farmers that adopted the technology by an upward difference of over 15% above non-adopters; as well as reduction in farming expenditures and securing good market for their farm produce because they were able to frequently access information and were always up-to-date. This implies that the more an enabling condition to frequently use mobile phone apps is created for farmers, the more they are likely to use mobile phone apps at their disposal and the more they are properly guided to make a better decision for an enhanced farm production, increased income and improved socio-economic status.

Despite the high diffusion rate of mobile phone technologies among farmers in Nigeria, and the study area in particular (Yusuf, Abdullahi and Haruna, 2015; Ekpa, 2017), reported minimal usage of these technologies by farmers in the area; as a result, the desired impact on the socio-economic condition of rural farmers in the study area has always remained a mirage, given the prevalence of high incidence of endemic poverty that has remained a glaring feature of rural communities in the study area. Such apps are not popularly being engaged by farmers in the study area as evidenced from previous study (Abdullahi et al., 2019) for farming activities and as a result, the technology is making minimal impact on their production evidenced by the persistence low agricultural production despite the high farmers' population and vast arable land. More so, extension activities in the area has remained very poor despite the upsurge in technological breakthrough in virtually all spheres of human endeavour as evidence by the wide spread and diffusion of ICTs tools and gadgets like the mobile phone technology. In light of these unhealthy scenarios despite the healthy diffusion of mobile phone technology in the area, this study was informed and sorts to investigate the determinants of frequency of mobile phones apps' usage by farmers in North West Nigeria using Negative Binomial Regression Model (NBRM). In addition, despite NBRM popularly recommended for nonnegative digits, this has not been used to determine the frequency with which farmers use mobile phone apps in the North West Zone of Nigeria. This study is intended to fill this gap. To achieve this, the study is guided by the following objectives:

1. To determine the frequency with which farmers in the area use mobile phone apps at their disposal; and
2. To examine the determinants of the frequency of apps's usage by the farmers using NBRM.

The main models usually adopted for estimation of count data generally include the Negative Binomial Regression Model (NBRM), the Poisson Regression Model (PRM), the Zero Inflated Poisson (ZIP) as well as the Zero Inflated Negative Binomial (ZINB) (Samson, Julius and Noel, 2011). However, PRM and NBRM have become more popular for analysis of variables characterized by nonnegative digits (Greene, 2008). The limitation of PRM stemmed from an assumption that "the dependent variable y given vector of predictor variables x has a Poisson distribution with mean equal to variance" (Samson et al., 2011), which, according the authors, placed a restriction on how well the model could be useful. For instance, Wooldridge (2002) and Greene (2008) explained that the restrictions enforced by the model on the stability status of the dependent variable often discourage its use due to the fact that the observed data frequently exhibit high dispersion; and according to Wooldridge, (2002) and Samson et al (2011), high dispersion could lead to bloated variance of the coefficient estimates than expected mean which will results in poor, potentially unfair parameter estimates and deceptively small standard errors. This limitation, according to Greene (2008), informed the adoption of NBRM, an upshoot of PRM.

2. Materials and Methods

This study was conducted in North West Nigeria, located between latitude $9^{0}10^{1}$ and $13^{0}50^{1}$ to the North; and longitude $3^{0}35^{1}$ and $9^{0}00^{1}$, with land area coverage of about 168.719km^{2}, which is equivalent to about 18% of the country's total land mass. The zone consists of seven states that include Kano, Kaduna, Katsina, Sokoto, Zamfara, Jigawa and Kebbi States. All the farmers from all the farming households of states in the zone were considered the population of the study; and according to (National Agricultural Extension Research and Liaison Services [NAERLS] and Federal Department of Agricultural Extension [FDAE], 2015) in Abdullahi, Oladele and Yusuf (2019), this was established to be approximately over 9,000,000; as it was further reported that farming households in the three selected states (Katsina, Kano and Kaduna) were estimated to be 6,895,014; i.e. 1,361,094, 4,316,100 and 1,217,821 respectively. The zone was selected for this study because farming is engaged on by majority (80%) of the population (Multi-Sector Needs Assessment [MSNA] – Northwest of Nigeria, March 2022) and poor extension activities characterized information flow pattern in the area (Tijjani, Akpoko and Abdullahi, 2015).

Using ex-post-facto research design and multi-stage sampling procedure, farmers were selected from ADP geo-ecological zones of the study area. With the convenience sampling technique (Nenna, 2016), three states acknowledged to be mainly characterized by agrarian environment were purposively selected from the geopolitical zone namely, Katsina, Kano and Kaduna States. This is followed by the random selection of three Local Government Areas (LGAs) from each of the selected state. Subsequently, five (5) communities were randomly selected from each of these LGAs in Katsina and Kaduna States while ten (10) from Kano State (due to its larger farmer population size), giving a total of sixty communities for the study. Katsina state has 34 LGAs, out of which 15 communities with 76 farming households were randomly selected; 30 communities with 241 farming households from Kano state having a total of 44 local government areas; and 15 communities with 68 farming households from Kaduna state with a total of 23 local government areas; which implies that a sample size made up of 385 farmers randomly selected was adopted for the study. The sample size also corresponds with that generated using ROASOFT sample size calculator at 95% confidence level when a population of 6,895,014 was used.

The essence of validity is to ensure that the data collection instrument measures what it is expected to measure. The face validity and close examination of the research instrument (questionnaire) was carried out by a team of professionals and experts in the field of agricultural extension and administrators in South Africa and Nigeria in order for them to judge the extent to which the instrument measures the highlighted issues as well as the extent to which they conveyed the intended meaning to the respondents.

Reliability, on the other hand, is to establish the consistency of the data collection instrument. A pre-test of the instrument was carried out in Zamfara State Nigeria using the split-half method of reliability. With a high reliability coefficient of 0.88 obtained, it implies that a good and desirable consistency of the instrument was achieved. According to Kuder and Richardson (1937), a reliability coefficient that is not less than 0.85 shows that the instrument is highly consistent and reliable.

Data for the study were collected using a well-structured pre-tested interview schedule validated by experts in the field of agricultural extension and rural development. The questionnaires were administered on the farmers with the aid of skilled personnel from Katsina State Agricultural and Rural Development Authority (KTARDA), Kano and Kaduna States Agricultural Development Projects (ADP) to complement field enumerators drawn from the Department of Agricultural Economics and Extension, Federal University Dutsinma, Katsina State and National

Agricultural Extension Research and Liaison Services (NAERLS), Zaria and Kano stations while secondary data were collected from NAERLS, and available works of literature. Data collected from NAERLS include data on extension activities in the zone covering a population of farmers in each state of the zone, number of farms, farmers/extension agent ratio, number of subject matter specialist and extension agent visits while that from the service providers include mobile phone apps in the region and the ones commonly used as well as rate of usage. The frequency of usage of the apps is dependent variable measured using perceptional responses of the farmers on 17 mobile apps at farmers' disposal based on a 3 point Likert-type corresponding to use for: 'all activities' (AA) – 3, 'most activities' (MA) – 2 and 'few activities' (FA) – 1. These apps were arrived at based on literature reviews and reconnaissance survey of the zone.

Based on the highlighted scales, the frequency of usage of the apps by farmers was considered using the likert model specified as follows:

$\ddot{X}_W = [n_3 (3) + n_2 (2) + n_1 (1)] \div n$ …… (1)

Where;

$\ddot{X}_W$ = Weighted Mean Score; n = No. of farmers/respondents

$\ddot{X}_S = S_{max} + S_i + \ldots\ldots\ldots\ldots S_{min} \div N$..... (2)

Where $\ddot{X}_S$ = Score Mean; S_{max} = Maximum scale value; S_{min} = Minimum scale value;

S_i = other scale values; and N = Number of the scale points.

Using an interval of 0.05, the cut points will be:

Minimum cut point = $\ddot{X}_S - 0.05$…….... (3)

Maximum cut point = $\ddot{X}_S + 0.05$…….. (4)

Decision rule:

If $\ddot{X}_W$ < Minimum cut point, the result is low i.e. rarely in use;

If $\ddot{X}_W$ > Maximum cut point, the result is very high i.e. frequently in use;

If $\ddot{X}_W \geq$ minimum cut point < maximum cut point, the result is moderate, that is, occasionally in use.

With an interval limit of 0.05, a mean below 1.95 out of the actual mean of 3 was adopted to identify apps that were rarely being put to use; mean between 1.95 and 2.05 was adopted to identify apps that were occasionally being used; and mean above 2.05 was adopted to identify apps that were frequently being put to use.

With the aid of Statistical Package for the Social Sciences (SPSS 14.0 specifically) the data collected were sorted and analyzed while the regression component was sorted out using STATA 13; and the data summarized using frequency counts, percentages and mean. The factors influencing the extent of mobile phone apps usage by the farmers in the area were computed using Negative Binomial Regression Model (NBRM). The explicit form of the model in line with Greene (2008), is specified as:

$E(y_i/ x_i) = \exp(\alpha + X' \beta + \varepsilon)$ ……(5)

Where:

$E(y_i/x_i)$ is the use intensity of the mobile phone app; X' is a vector of explanatory variables that, according to Samson, Julius and Noel (2011), include farmer socio-economic specifics, mobile phone use specifics etc (i.e. X_1= Age, X_2= Sex, X_3= Educational attainment, etc); α is the dispersion parameter (Greene, 2008); β a vector of unidentified coefficient; and ε an error term. The dependent variable for frequency of mobile phone apps' usage by farmers is taken as total of farmer's usage of app measured on scale 1 for few activities, 2 most activities and 3 for all activities. This is specified as:

$T_i = [A_3+A_2+A_1]_1 + \ldots\ldots\ldots\ldots [A_3+A_2+A_1]_j$ ..... (6)

Where;

T_i is the use total for respondent T for i^{th} app; A_3, A_2 and A_1 correspond to scores recorded by the farmer for the i^{th} app under consideration base on the usage scale stated above.

3. Results and Discussion

Table 1 presents results showing the frequency of apps' usage by respondents in the study area. The results show that the majority (51.7%) of the respondents used the call app for a few activities, (with a mean score of 1.410 out of possible 3). This implies that though the majority of the respondents use this app, it is not frequently being used (below 1.95). The results further reveal that majority (61.9%) of the respondents use SMS app for few activities with a mean score of 0.932 out of 3, indicating usage frequency below 1.95; a situation of underutilization of the app by farmers in the region. These findings are substantiated by Susan and Charles (2016) in their study of why farmers do not use

phones in rural Kenya, where they also observed that though many farmers had phones few used it primarily because they assumed cell phones to be devices that sustain verbal exchange of ideas among their close ones (families and friends). In the case of the SMS app, the authors harangued that this had been a reflection of many studies. Sirajul and Ake (2011) also discovered in Bangladesh, that majority (57%) of the farmers disagree that it is so interesting to access the SMS app. This, notwithstanding, farmers still consider the app friendly, a reason for this aberration is explained in the argument of the author that a person who has high self-efficacy achieve compatibility towards adopting a new technology over time by exerting the required efforts. This may suggest why farmers still adopt SMS despite being difficult to operate. One of the strategies adopted to sustain the adoption of SMS, as illustrated by the author, was that when farmers receive SMS they use to seek the help of family members, neighbours or friends to interpret it. In line with the above observations, Susan and Charles (2016) also reported that the habit of sending and receiving a text message is not widespread among rural Kenyan farmers due to the perceptions that inputting text is cumbersome. The table further shows that the apps least frequently used by the farmers in the area include Tubenet (mean value of 0.003) IMO, WhatsApp (0.005); bank transfer code (0.008); and mobile banking app (0.010). the findings here conform with that of Caroline (2015) which showed that, apart from call app that had 4.42 mean score, all other apps had less than 2 mean value. The inference is that the poor extent of usage is as a result of the fact that the apps require smartphones, which most farmers do not possess.

Table 1. Extent of Mobile Phone Apps' Usage by the Farmers in the Study Area (n=385) *

Mobile Apps	All Activities	Most Activities	Few Activities	Mean	Remark
Call app	14(3.6)	151(39.2)	199(51.7)	1.410	Rarely used
SMS app	5(1.3)	53(13.9)	238(61.8)	0.932	Rarely used
Facebook	0(0)	15(3.9)	105(27.3)	0.351	Rarely used
WhatsApp	0(0)	12(3.1)	71(18.4)	0.247	Rarely used
Opera	0(0)	1(0.3)	61(15.8)	0.640	Rarely used
Flash share	0(0)	0(0)	38(9.9)	0.099	Rarely used
Bluetooth	0(0)	3(0.8)	78(20.3)	0.218	Rarely used
Tubenet	0(0)	0(0)	1(0.3)	0.003	Rarely used
Imo	0(0)	0(0)	2(0.5)	0.005	Rarely used
E-mail	0(0)	2(0.5)	31(8.1)	0.091	Rarely used
Instagram	0(0)	0(0)	5(1.3)	0.013	Rarely used
E-Wallet	0(0)	1(0.3)	10(2.6)	0.034	Rarely used
WhatsApp Youth and Educated Adult	0(0)	1(0.3)	0(0)	0.005	Rarely used
Mobile banking app	0(0)	0(0)	4(1)	0.010	Rarely used
Bank payment code	0(0)	0(0)	8(2.1)	0.021	Rarely used
Bank transfer code	0(0)	0(0)	3(0.8)	0.008	Rarely used
FarmerHelpLine	0(0)	0(0)	4(1)	0.010	Rarely used

*Figures in parentheses are percentages

3.1 NBRM Estimation of Determinants of the Frequency of Apps' Usage by the Farmers

Table 2 reveals that the likelihood ratio statistics as shown by the chi-square value are highly significant at 1 percent level of significance ($p < 0.000$) indicating that much of the variability on the dependent variable is explained by the included covariates, which suggests that the model has a strong demonstrative impact and well fitted. Furthermore, the adjusted R-square value of 0.1901 revealed that 19.01% of the variation in the frequency of Apps' Usage by the Farmers can be explained by the explanatory variables included in the model, implying that the model has a strong inferential influence. Ten factors were found to significantly determine the frequency with which smallholder farmers use mobile phone apps in the area. These variables were: age (Z= -0.012); educational attainment (Z= 0.086); Knowledge on the use of mobile phones (Z= 0.030); type of phones farmers can operate very well (Z= 0.215); amount farmers are willing to pay for apps (Z= 0.060); mobile phone as source of apps for farmers' use (Z= 0.183); app store as source of apps for farmers' use (Z= 0.311); social media as source of apps (Z= 0.170); agency as farmers' source of apps (Z= 1.079); and association as source of apps for farmers (Z= -1.109).

The results further show that the coefficient of educational attainment, knowledge of mobile phone usage, type of mobile phones farmers can use very well, amount farmers are willing to pay for apps, mobile phone as source of apps, app store as farmers' source of apps, social media apps source for farmers and agencies as source of apps were positive meaning a direct relationship with the dependent variable. These indicate that as the farmers advances in educational attainment, acquire prerequisite knowledge of mobile phone apps technologies usage, master the use of any type of

mobile phone, secure favourable price for apps, have access to apps on their cell phones, able to access apps in app store, secure apps from social media and agencies, the higher the likelihood that the farmers would frequently use mobile phones apps at their disposal. These imply that educational exposure facilitate frequency of apps usage because education expands one exposure, contacts and needs for information. In addition, proficiency of an educated person is more enhanced and encourages frequent use of available technologies like mobile phone. Furthermore, farmers in the study area are not opposed to monetary values attached to acquisition of apps, provided it is affordable. These results correspond to the findings of Samson et al (2011) and Biswajit et al (2017) who also recorded and established direct relationship between farmers' educational status and frequency of mobile phone apps' usage, signifying that as farmers advance in educational level, the rate at which they use mobile phones' apps is also likely to increase. This is because education facilitates exposure to more apps and knowledge of phone usage usually encouraged through more network of social setting and engagements. More so, the findings according to Shawn and Nilesh (2016) showed that most farmers are not disposed to high cost of apps, implying that the more favourable the cost implications of apps are, the high probability that farmers will regularly use the apps as established by the direct relationship between cost of apps and frequency of apps' usage contained in the results of these findings. In addition, the results showed direct link between access to apps via app store, social media, agencies and regular use of mobile phone applications, implying that the easier it is for farmers to access apps from these sources, the high the likelihood that the rate at which they use the apps will increase; and could be inferred that this is so because apps through these routes are often obtained freely and in some cases fundamental information about the benefits of the apps are made available to the users through relevant agencies.

On the contrary, the coefficient of age and association as source of apps were negative indicating an inverse relationship with the dependent variable. These imply that an increase in the parameter of these variables decreases the likelihood of the farmers to frequently use cell phone mobile applications. Biswajit et al (2017) in India equally established inverse relationship between farmers' age and the frequency with which they use mobile phone apps. This suggests that as farmers in remote areas advanced in age, the rate at which they use mobile phone apps drop, perhaps because as the farmers become aged, they are likely to have develop unique input and output flow channel that would require minimal contacts and communication; or constrained by huge financial burdens such as increased household size, need for expansion in housing space and capacity implying huge cost burden etc. These tend to usurp the ability of the farmers to bear cost implication of regular apps' usage. Furthermore, the negative coefficient recorded with respect to association as source of apps, indicates that the more farmers are made to rely on farmer association or group, the less the likelihood that farmers in the study area will frequently use mobile phone apps probably because the more they intimate together through group formation, the more they share information directly and less the need to make calls to source for information.

Table 2. NBRM Estimation of Determinants of the Extent of Apps' Usage by the Farmers in North-West Nigeria.

Description	Z(SE)	t-stat	P>/t/
Age	-0.012(0.0051)	-2.25	0.024**
Education	0.086(0.0331)	2.59	0.010*
Knowledge	0.030(0.0053)	5.68	0.000*
Phones farmers operate well	0.215(0.0505)	4.27	0.000*
Mobile phones as source	0.183(0.0855)	2.14	0.032**
App store as source	0.321(0.1007)	3.19	0.001*
Social media as source	0.170(0.0809)	2.10	0.035**
Agencies as source	1.079	3.20	0.001*
Association as source	-1.109(0.4931)	-2.25	0.024**
Constant	-0.305(0.4556)	-0.67	0.503
Number of Observation	385		
Pseudo R^2	0.1901		
LR $chi^2(35)$	300.08		
Prob > chi^2	0.0000		
Log likelihood	-639.40434		

Source: Computation from Computer Printout of Negative Binomial Regression Model Analysis. Note: *, ** and ***means 1%, 5% and 10% level of significance respectively

4. Conclusion and Recommendation

This study showed that the most frequently used apps include voice call app (mean value of 1.410), SMS app (0.932 mean score) and Opera with 0.640 mean value. This showed that none of the apps in the area are optimally being put to use as none recorded the set minimum mean value of 1.95. Furthermore, among the users of these apps, young farmers use these apps more frequently than the elderly farmers as the inferential statistic showed negative relationship between age and frequency of apps' usage. More so, spread of farmers groups tends to limit frequency of app usage among farmers. However, with the current reality orchestrated by the global pandemic (Covid-19) that discourage mass gatherings, it is expected that mobile phone apps usage would frequently being resorted to for information transfer among the farmers. Additionally, easy access to apps via channels like phones with many apps, access to apps stores, social media and agricultural agencies would encourage increase in the rate at which the farmers put mobile phone apps to usage.

Therefore, all stakeholders like extension agencies, government at all level, should come up with policies that focus more on how to encourage frequent use of mobile phone technologies for information accessing/sharing among farmers and extension agents. This will no doubt lead to an upsurge in the rate of apps usage in the area, particularly for contacting extension agents and fellow farmers in real time. Farmers could also regularly go on net to access relevant information that would aid well informed decisions.

Some of the limitations to this study include worsening poverty situation that limit farmers' access to phone that could access the net for information sourcing, souring cost of airtime and data amidst abject rural poverty and poor power supply making it a challenge to keep phone batteries charged always. Hence in most times the farmers' phones do not have airtime, data (for the few that have access to android/iPhones) and charged batteries.

The is the need to study how frequent farmers in the area use mobile phone apps to access extension delivery services in the area. The study should highlight apps farmers in the area explore the more in accessing these services and identify apps with great potential to enhance information flow through extension pathways.

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